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PERFORMANCE EVALUATION OF THE APPARATUS AT THE INTERSECTION OF JL. TEUKU UMAR-JL. PEMUDA AND JL. SAWUNGGALING - JL. BASUKI RAHMAT BOJONEGORO DISTRICT

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ABSTRACT

Along with the increasing progress and development in society, the desire to use time and money is very necessary. Population growth in an urban area is always followed by an increase in space requirements. In Bojonegoro itself, which is one of the cities of industry, tourism, and education that cannot be separated from the movement of traffic in and out of both people and goods. So there are many intersections that connect roads to shopping centers, offices, government, housing, and roads to the city center. One of the intersections in Bojonegoro is the intersection of Jl. Teuku Umar-Jl. Pemuda and Jl. Sawunggaling-Jl. Basuki Rahmat Bojonegoro Regency which has a fairly high transportation density during working time hours, so the use of traffic signals is needed. This causes the traffic flow that passes through to continue to experience changes in vehicle volume, especially at certain hours which causes delays in travel due to increased traffic flow. In order to avoid travel delays due to increased traffic flow, improvements in traffic management are needed. This study aims to analyze and evaluate the performance of the intersection of Jl. Teuku Umar-Jl. Pemuda and Jl. Sawunggaling-Jl. Basuki Rahmat Bojonegoro Regency using the PKJI 2023 method. From the results of the analysis, it is found that there is a need for an additional phase from 2 phases to 4 phases so that there is no queue length and the number of vehicles stopped on the East Approach (Jl. Pemuda) is too long and many.

Keyword: *intersections, traffic, transportation, traffic signals.*

1. INTRODUCTION

An intersection is an area where two or more roads join or intersect, including roads and roadside facilities for traffic movement therein [1] . An intersection is a node in the transportation network where two or more roads meet and at this intersection there is a potential conflict that may occur. This conflict can then become a factor in causing traffic accidents[2][3].

Intersections are areas that usually cause congestion, especially if the location of the intersection is close to the center of the crowd in an area[4]. Intersections, as the meeting point of vehicle flows from various directions, often become conflicts of movement that can cause congestion as well as traffic accidents[5].

Along with the increase in progress and development in society, the desire to use time and money is very necessary. Population growth in an urban area is always followed by an increase in space requirements [2][6]. In Bojonegoro itself, which is one of the cities of industry, tourism, and education that cannot be separated from the movement of traffic in and out of both people and goods. So there are many intersections that connect roads to shopping centers, offices, government, housing, and roads to the city center[7]. This causes the traffic flow that passes through to continue to experience changes in vehicle volume, especially at certain hours which causes delays in travel due to increased traffic flow. In order to avoid travel delays due to increased traffic flow, improvements in traffic management are needed.

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One of the intersections in Bojonegoro is the intersection of Jl. Teuku Umar-Jl. Pemuda and Jl. Sawunggaling0Jl. Basuki Rahmat Bojonegoro Regency which has a fairly high transportation density during working time hours, so the use of APILL is very necessary. The use of APILL (Traffic Signaling Devices) at signalized intersections aims to regulate traffic movements with alternating green, yellow, and red lights, to reduce the risk of inter-vehicle collisions and improve the efficiency of traffic flow[8][9].

Based on the researcher's observations and information from several local residents, the condition of one lane from the east to west direction shows the intensity of the vehicle is quite dense, often some vehicles stop in the middle of the intersection to wait for time to turn. The heavy volume of vehicles at certain times from the east to the west can result in the risk of accidents, which increases the risk of accidents occurring. In addition, the intersection of Jl. Teuku Umar-Jl. Pemuda and Jl. Sawunggaling-Jl. Basuki Rahmat only has 2 phases and visibility is limited due to buildings at the corners of the intersection.

Based on the background that has been described, the researcher is inspired at this location to be used as research with the title Apill Performance Evaluation at the Intersection of Jl. Teuku Umar-Jl. Pemuda and Jl. Sawunggaling-Jl. Basuki Rahmat Bojonegoro Regency PKJI 2023 Method.[10] With the aim of the study to analyze and evaluate the performance of the Apill intersection at the intersection of four Jl. Teuku Umar-Jl. Pemuda and Jl. Sawunggaling-Jl. Basuki Rahmat Bojonegoro Regency.

2. RESEARCH METHOD

Research location is made at the intersection of Jl. Teuku Umar - Jl. Pemuda and Jl. Basuki Rahmat - Jl. Sawunggaling Bojonegoro Regency. The final project research location can be seen in Figure 1.

Figure- 1 Research Area

In this study, data collection included primary data from survey results at the study site and secondary data from the CCTV of the Bojonegoro Regency Transportation Office. The flow chart in this research can be seen in Figure 2 below:

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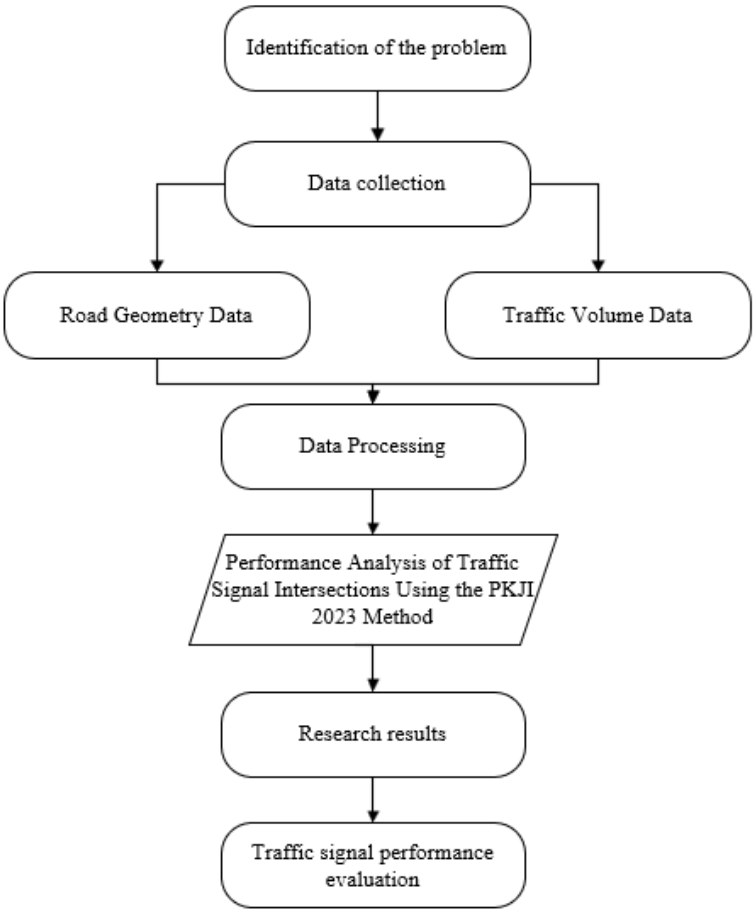

Figure- 2 Research Flow

The analysis in this study uses the PKJI 2023 method. Calculations can be done manually using Microsoft Excel or with the help of other software. This method is used because of the changes in guidelines made by Kementerian Pekerjaan Umum Dan Perumahan Rakyat Indonesia[10]. The main goal in evaluating the traffic performance of the operated traffic signal intersection is to calculate and assess DJ, PA, NKH, and T, which are the basis for analyzing the traffic performance of the traffic signal intersection. The main data are geometry data, traffic flow settings, traffic signal intersection environmental conditions, and existing traffic data. The following are the steps in evaluating the performance of a traffic signal intersection

1. Step A of Traffic Signal Design: Define Input Data;

$$R_{BKi} = \frac{q_{BKi}}{q_{Total}} \quad (1)$$

Where :
RBKi = left-turn ratio
qBKi = left turn vehicle flow
qTotal = total vehicle flow

$$R_{BKa} = \frac{q_{BKa}}{q_{Total}} \quad (2)$$

Where :
R_{BKa} = right-turn ratio
q_{BKa} = right turn vehicle flow

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q_{Total} = total vehicle flow

$$R_{KTB} = \frac{q_{KTB}}{q_{KB}} \quad (3)$$

Where :
R_{BKa} = ratio of non-motorized vehicles
q_{BKa} = non-motorized vehicle flow
q_{Total} = total flow of non-motorized vehicles

2. Step B Traffic Signal Design: Define Signal Use;

$$w_{MS} = Max \begin{cases} \frac{L_{KBR} + P_{KBR}}{V_{KBR}} - \frac{L_{KDT}}{V_{KDT}} \\ \frac{L_{PK}}{V_{PK}} \end{cases} \quad (4)$$

Where :
L_{KBR}, L_{KDT}, L_{PK} = distance from the stop line to the conflict point for departing vehicles, arriving vehicles, and pedestrians, respectively, in meters.
P_{KBR} = length of the departing vehicle, in meters.
V_{KBR}, V_{KDT}, V_{PK} = speeds for departing vehicles, arriving vehicles, and pedestrians, respectively, in m/s.

$$w_{HH} = \Sigma_i(w_{MS} + w_K)_i \quad (5)$$

Where :
w_{MS} = all-red time, in seconds.
w_K = yellow time, in seconds.
w_{HH} = total green time lost.

$$s = \frac{(1{,}5\ x\ w_{HH} + 5)}{1 - \Sigma R_{q/J\ kritis}} \quad (6)$$

Where :
S = cycle time, in seconds.
w_{HH} = total green time lost.
$R_{q/J}$ = flow ratio, i.e. the flow divided by the saturation flow, q/J.
$R_{q/J\ kritis}$ = highest Rq/J value of all the approaches that departing on the same phase.
$\sum R_{q/J\ kritis}$ = ratio of flow, i.e. current divided by saturation flow, q/J.

$$w_H = (\ s\ - w_{HH}\ )\ x\ \frac{R_{q/J\ kritis}}{\Sigma_i(R_{q/J\ kritis})i} \quad (7)$$

Where :
W_H = green time in phase i, seconds.
S = cycle time, in seconds.
$\sum$i = index for phase i.
$R_{q/J\ kritis}$ = highest Rq/J value of all the approaches that departing on the same phase.

3. Step C Traffic Signal Design: Setting Signal Times and Capacity;

$$J = J_0 \times {}_{FHS} \times F_{UK} \times F_G \times F_P \times F_{BKi} \times F_{Bka} \quad (8)$$

Where :

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J = saturated flow (SMP/hour).
F_{HS} = correction factor J0 due to side obstacles road environment.
F_{UK} = J_0 correction factor related to city size.
F_G = correction factor J0 due to longitudinal slope of the approach.
F_P = correction factor J0 due to the stopping line distance at the mouth of the approach to the first parked vehicle.
F_{BKi} = J_0 correction factor due to left-turning traffic flow.
F_{BKi} = J_0 correction factor due to right-turning traffic flow.

4. Step D: Determine Traffic Performance;

$$D_J = \frac{q}{C} \quad (9)$$

Where :
D_J = degree of saturation.
C = capacity of the road segment, in SMP/hour.
q = traffic volume, in SMP/h, which in the capacity analysis.

$$P_A = N_q \frac{20}{L_M} \quad (10)$$

Where :
P_A = queue length.
L_M = width of the entrance lane.
Nq = average number of vehicle queues (SMP) at the beginning of the signal green light signal.

$$T_i = T_{LL} + T_G \quad (11)$$

Where :
T_i = average delay for an approach i.
T_{LL} = traffic delay.
T_G = geometry delay.

5. Step E: Change the APILL intersection plan for Improve its Traffic Performance
6. Step F: Define Output

3. RESULT AND DISCUSSION

3.1. Geometri Data

Table 1. Road Geometry Data

Approaches	At the Start of the Lane (m)	On the Stop Line (m)	In the Left Turn Lane (m)	On the Exit Lane (m)
North (Jl. Sawunggaling)	3.70	3.90	-	3.75
South (Jl. Basuki Rahmat)	3.90	3.90	-	3.30
East (Jl. Pemuda)	4.60	4.60	-	4.00
West (Jl Teuku Umar)	4.70	4.70	-	4.65

Source: location survey, 2024.

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3.2. Traffic Management

Table 2 Traffic Management

Approaches	Turn-on Time (seconds)			Total	Fase
	Green	Yellow	Red		
North (Jl. Sawunggaling)	35	3	42	80	1
South (Jl. Basuki Rahmat)	35	3	42	80	1
East (Jl. Pemuda)	35	3	42	80	2
West (Jl Teuku Umar)	35	3	42	80	2

Source: location survey, 2024.

3.3. Environmental Condition

Based on the data from the researcher's survey of the environmental conditions of the four intersections Jl Pemuda - Jl Teuku Umar and Jl Basuki Rahmat - Jl Sawunggaling Kab. Bojonegoro is stated to be commercial, there are no side obstacles and 0% slope for the entire intersection.

3.4. Data on Traffic Flow Conditions

As for the observation data of the traffic flow of the four intersections Jl. Pemuda - Jl. Teuku Umar and Jl. Basuki Rahmat- Jl. Sawunggaling Kab. Bojonegoro found that Motorcycles (SM), Passenger Cars (MP), Heavy Vehicles (KB), and Non-Motorized Vehicles (KTB) are the components of traffic flow data. The data used for the analysis is peak hour data, which took place on Monday, December 2, 2024 from 06.00 to 07.00 WIB

3.5. Effective Approach Width (L_E)

Table- 3 Effective Approach Width (LE)

Approaches	Effective Approach Width (L_E)			
	At the Start of the Lane (m)	On the Stop Line (m)	In the Left Turn Lane (m)	L_E
	L m	L_M m	L_K m	m
N	3.70	3.70	3.75	3.70
S	3.90	3.90	3.30	3.90
E	4.60	4.60	4.00	4.60
W	4.70	4.70	4.65	4.70

Source: location survey, 2024.

3.6. Basic Saturation Flow, (J_0)

From the results of the analysis, it was found that the basic saturated flow of the North Approach (Jl. Sawunggaling) was 2220 SMP / hour, the south approach (Jl. Basuki Rahmat) was 2340 SMP / hour, the East Approach (Jl. Pemuda) was 2760 SMP / hour and the West Approach (Jl Teuku Umar) was 2820 SMP / hour.

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3.7. Degree of Saturation (D_J)

From the results of the calculation it was found that the condition of the Degree of Saturation (D_J) was 0.137 North Approach (Jl. Sawunggaling), 0.134 South Approach (Jl. Basuki Rahmat), 0.335 East Approach (Jl. Pemuda), 0.265 West Approach (Jl Teuku Umar)

3.8. Queue Length (PA)

From the calculation results, it was found that the Queue Length (PA) condition was 9 m North Approach (Jl. Sawunggaling), 9 m South Approach (Jl. Basuki Rahmat), 24 m East Approach (Jl. Pemuda), 18 m West Approach (Jl. Pemuda).

3.9. Number of Stopped Vehicles (N_{KH})

from the calculation results obtained conditions Number of Stalled Vehicles (N_{KH}) 69 SMP North Approach (Jl. Sawunggaling), 68 SMP South Approach (Jl. Basuki Rahmat), 221 SMP East Approach (Jl. Pemuda), 174 SMP West Approach (Jl. Pemuda), and 533 SMP Total Stalled Vehicles on all approaches, and 0.57 SMP Average Stalled Vehicles on all approaches.

3.10. Delay (T)

From the results of the analysis, the average delay for the entire approach is obtained at 17.3 SMP.second

3.11. Traffic Performance Evaluation of Signalized Intersections

Based on the results of the analysis of traffic performance at the intersection of Jl. Teuku Umar - Jl. Pemuda and Jl. Basuki Rahmat - Jl. Sawunggaling Bojonegoro Regency, the overall degree of saturation is running well with a DJ value <0.85. And for the length of the queue for the north approach (Jl. Sawunggaling) of 9 meters, the south approach of 9 meters (Jl. Basuki Rahmat), the west approach of 18 meters (Jl. Pemuda) and the largest occurred on the east approach (Jl Teuku Umar) of 24 meters, with the largest number of stopped vehicles occurring on the east approach, namely on Jl. Pemuda of 221 SMP. And for the total delay of the entire intersection, it is obtained at 16138 SMP.detik and an average delay of 17.3 seconds / SMP. This is because the condition of the intersection of Jl. Teuku Umar - Jl. Pemuda and Jl. Basuki Rahmat - Jl. Sawunggaling Bojonegoro Regency only has 2 phases and there needs to be alternative planning for a new signal phase of 4 phases so as not to experience the length of the queue which is considered quite long.

4. CONCLUSION

Based on the results of the traffic performance analysis at the signalized intersection Jl. Teuku Umar - Jl. Pemuda and Jl. Basuki Rahmat - Jl. Sawunggaling Bojonegoro Regency, the overall degree of saturation has been running well with a DJ value <0.85. And for the length of the queue for the north approach (Jl. Sawunggaling) of 9 meters, the south approach of 9 meters (Jl. Basuki Rahmat), the west approach of 18 meters (Jl. Pemuda) and the largest occurred on the east approach (Jl. Teuku Umar) of 24 meters, with the largest number of stopped vehicles occurring on the east approach, namely on Jl. Pemuda of 221 SMP. And for the total delay of the entire intersection, it was found to be 16138 SMP.detik and an average delay of 17.3 seconds / SMP. This is because the intersection conditions of Jl. Teuku Umar - Jl. Pemuda and Jl. Basuki Rahmat - Jl. Sawunggaling Bojonegoro Regency only have 2 phases and there is a need for alternative planning of the new signal phase, namely 4 phases so as not to experience the length of the queue that is felt long enough and so that there is no queue length and the number of stopped vehicles on the East Approach (Jl. Pemuda) is too long and many.

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