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TRAFFIC PERFORMANCE ANALYSIS OF SECTIONS JL. PATI RAYA-JUWANA AT THE INTERSECTION OF ALUN-ALUN JUWANA PATI REGENCY USING THE MKJI 1997 METHOD

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Abstract. The signaled interchange at Jl. Pati Raya-Juwana is one of the influential transportation infrastructure for road users who will go to Pati City, Rembang and the industrial center in Juwana. During rush hour the area often has traffic jams. Therefore, this study was carried out with the aim of analyzing signaling intersections, replanning cycle times, knowing the traffic characteristics of the Pati Raya-Juwana road section. Data collection was carried out for 4 days by taking peak hours at 06:30 WIB – 07:30 WIB and 16:00 WIB – 17:00 WIB. Themethod of data retrieval carried out is traffic flow, volume, and cycle time at *traffic light*. The results of the study were pthere were existing conditions chosen alternative A as the best alternative for replanning traffic cycle time with 2 phases tonario 1 dwith t saturation degree 0.68, queue length 34.83 m and delay 15.06 seconds on the south shortening, then on the western approach for the saturation degree 0.51, queue length 23.51 m and delay of 11.07 seconds, and 0.19 degrees of saturation, a queue length of 12.32 m, and a delay of 11.39 seconds on the north quarter. From the results of the analysis, it can be concluded that the results of the traffic performance evaluation at the Juwana square intersection obtained the highest volume on Monday, July 3, 2023, so it is recommended to reset the traffic cycle time.

Keywords: **:** intersection performance, signaling intersection, cycle time, saturation degree, queue length, delay.

1. Introduction

Technological developments have made the need for transportation increase (Hidayat &; Aprillianto, 2022). The growth of the community has led to an increase in the need for transportation, causing an increase in road users in Pati Regency. According to the Central Bureau of Statistics of Central Java Province, in 2021 in Pati regency, the number of passenger car users was 57,694 units, buses 1,362 units, trucks 25,636, and motorcycles 633,573 units, so in 2021 road users were around 718,265 units (bps.go.id, 2021). Judging from these data, it indirectly creates problems related to the mobility of the people of Pati district. The increasing number of road users without being followed by road widening causes congestion problems (Hidayat &; Aprillianto, 2022).

According to (MKJI, 1997) congestion is a situation where the traffic flow exceeds the capacity of the road which results in the free speed of the road section approaching or exceeding 0 km / h causing vehicle queues. This can be interpreted that congestion is a situation or condition where traffic stalls or stops caused by the large number of vehicles that exceed the capacity of the road.

Jl. Pati Raya-Juwana is one of the influential transportation infrastructure for road users who will go to Pati City, Rembang and the industrial center in Juwana. Along the road there is a fairly crowded place known as Juwana square. During rush hour the area often has traffic jams. In the area there are many activities that make roadside obstacles one of the *factors* that cause congestion.

According to Khisty (2005) Simpang can be interpreted as an area where two or more roads intersect or merge, which includes roads and roadside facilities for traffic movement. The performance of an intersection is key in optimizing the function of the intersection, with a decrease in the performance of the intersection will cause losses to road users due to a decrease in speed, a large number of vehicle queues resulting in increased vehicle operating costs and decreased environmental quality (Hidayat &; Aprillianto, 2022).

The study was conducted to determine traffic performance on the installation of traffic light by analyzing traffic capacity and behavior using an approach method, namely the Indonesian Road Capacity Manual Method (MKJI, 1997).

2. Methods

2.1. Types of Research

The research method used in this study is the MKJI 1997 method on signaling intersections.

2.2. Time and Location of Research

This study was conducted at the intersection of Juwana square in the morning and evening for four days, for the morning at 06:30-07:30 WIB and in the afternoon at 16:00-17:00 WIB.

2.3. Data Collection Techniques

Data collection techniques use questionnaires and direct surveys in the field. The data used are primary data and secondary data as follows:

1) Primary Data
   Primary data is collected directly from the field including geometric conditions, environmental conditions, vehicle types, and traffic flow volumes.
2) Secondary Data
   Secondary data needed in this research include data from the Population and Civil Registration Office or data from the Central Bureau of Statistics of Pati Regency to determine the population and to determine the city.

2.4. Data Analysis Techniques

Data obtained from primary data (field survey) and skunder data are then processed and analyzed to determine the performance of traffic flow on the Pati Raya-Juwana road at the intersection of the Juwana square market, Pati regency. These analyses include:

1) Reset Traffic cycle time
2) Selected Recommendations

3. Results and Discussion

3.1. Reset traffic cycle time

Alternative A: Planning using traffic lights 2 phase scenario 1

This alternative solution is planned at the intersection of the Juwana square. Where this alternative is re-planning the traffic light cycle time. For example, the calculation used is Monday, July 3, 2023 at morning peak hours. The analysis used uses the 1997 MKJI method. In the calculation of the 1997 MKJI signalized intersection there are 5 forms that must be filled in, because formulars 1 and 2 have been fulfilled, all that remains is to fill in the next 3 forms as follows:

1) Form SIG – III: inter-green time and lost time
   a. The total lost yellow time is obtained from 3 seconds multiplied by 2 phases then 6 seconds is obtained.
   b. Total lost time (LTI)
      LTI = Σ (all red + lost time)
      = Σ (2+6)
      = 8 seconds

2) Form SIG – IV : determination of signal timing and capacity
   a. The value of S in obtained by using Press 2.9
      $S = S_o \times Fcs \times F_{SF} \times F_G \times F_P \times F_{RT} \times F_{LT}$ smp/hour
      = 7980 smp/hour
   b. Saturation current ratio
      saturated current (FR) and phase ratio value, then obtained junction current ratio (IFR).
      FR = Q/S
      = 0.26
      IFR = 0.56 smp/hour
   c. Phase ratio (PR)
      PR=FRcrit/IFR
      = 0.26/0.56
      = 0.46
   d. Cycle time and green time (seconds)
      a.) Cycle time before adjustment
      Calculate the cycle time before adjustment (cua.) for fixed time control, and enter the result into the box marked "cycle time" at the bottom of Column 11 of Form SIG-IV. Here is an example of a calculation on the southern shortcut.
      cua = (1.5 × LTI + 5) / (1 - IFR)
      = (1.5 x 8 + 5)/ (1 – 0.56)
      = 46 sec
      Where:
      cua = Cycle time before signal adjustment (sec)
      LTI = Total lost time per cycle (sec) (From the bottom left corner on Form SIG-IV)
      IFR = Simplin current ratio (FRCRIT) (From the bottom of Column 19)
      b.) Green time
      Calculates green time (g) for each phase:
      gi = (cua - LTI) × PR i

= (4,6 – 8) x (0.56)
= 21 sec

The gi value in the southern short is the same as the gi value in the northern short because both of the short are in 1 phase. Where:
Gi= Green time display in phase i (sec)
Cua= Cycle time before adjustment (sec)
LTI = Total lost time per cycle (bottom of Column4)
PRi = FRcrit / (FRcrit phase ratio (from Column 20)

c.) Customized cycle times

c = $\Sigma g + LTI$
= 47 + 8
= 55 seconds

e. Capacity

Calculate capacity with the formula:
C = S × g/c (smp/hour)
C = g/c x S
= 21/55 x 7980
= 3046.91 SMP/hour

f. Degree of saturation

DS = Q/C

DS = Q/C

= 2082.1/ 3046.91

= 0.68

3) Form SIG – V: queue length, number of stopped vehicles and delays.

a. Queue Length

Tocalculate the length of the queue, Press is used. 2.18.

NQ1 = $0{,}25 \times C \left[(DS-1) + \sqrt{(DS-1)^2 + \frac{8\times(DS-0{,}5)}{C}}\right]$

= $0{,}25 \times 3046{,}91 \left[(0{,}68-1) + \sqrt{(0{,}68-1)^2 + \frac{8\times(0{,}68-0{,}5)}{3046{,}91}}\right]$

= 0.69

GR = Green Ratio g/c
= 21/55
= 0.38

NQ2 = $c\,\frac{1-GR}{1-GR.DS}\,X\,\frac{Q}{3600}$

= $55\,\frac{1-0{,}38}{1-0{,}38.0{,}68}\,X\,\frac{2082{,}1}{3600}$ = 11.50

Total NQ = NQ1 + NQ2
= 0.69 + 11.50
= 12.19

QL = $\frac{\text{NQ maks x 20}}{W\ masuk}$

= $\frac{12{,}19\ x\ 20}{7}$

= 34.83 m

b. Delay

DT = $c\ x\ \frac{0{,}5\ x\ (1-GR)^2}{1-GR\ x\ DS} + \frac{NQ1\ x\ 3600}{C}$

= $55\ x\ \frac{0{,}5\ x\ (1-0{,}38)^2}{1-0{,}38\ x\ 0{,}68} + \frac{0{,}69\ x\ 3600}{3046{,}91}$

= 15.06 seconds

The following is the result of an allternative calculation of traffic cycle time replanning at the Juwana square intersection:

Table 1 Performance of Alternative Interchange A

Approach	Traffic flow (smp/hour)	Green time (seconds)	Cycle time (c)	DS	Panjang queuen QL=(m)	Delay (dethics)	Service level
South	2082,1	21	55	0,68	34,83	15.06	B
West	1830,3	26	55	0.51	23,51	11.07	B
North	364,6	21	55	0.19	12,32	11,39	B

Source : Researcher Analysis 2023

From the calculation above, the result of a cycle time of 55 seconds with a queue length of 34.83 m in the southern quarter, and a delay of 15.06 sec with service level B. In the West, the cycle time is 55 seconds with a queue length of 23.51 m, and a delay of 11.07 sec with service level B. Then in the northern quarter, the cycle time is 55 seconds with a queue length of 12.32 m and a delay of 11.39 sec with service level B. To compare the alternatives above, other alternatives will be used.

Alternative B: Planning using 2-phase traffic lights scenario 2
After planning an alternative using 2 phases, scenario 1 is then planned to set up another 2 phase traffic lights. The following is a 2-phase planning picture and the calculation results from alternative B.

Table 2 Performance of Alternative B Interchange

Approach	Traffic flow (smp/hour)	Green time (seconds)	Cycle time (c)	DS	Panjang queuen QL=(m)	Delay (dethics)	Service level
South	2082,1	26	65	0,65	38.45	16.52	C
West	1830,3	31	65	0.48	27,31	11.44	B
North	364,6	26	65	0.18	13,80	11,61	B

Source : Researcher Analysis 2023

From the calculation above, the result of a cycle time of 6.5 seconds with a queue length of 3.8.45 m in the southern quarter, and a delay of 16.52 sec with service level C. In the West, the cycle time is 6.5 seconds with a queue length of 27.31 m, and a delay of 11.44 sec with service level B. Then in the northern quarter, the cycle time is 6.5 seconds with a queue length of 13.80 m and a delay of 1.1.61 sec with service level B.

3.2. Selected Recommendations
After analysis of the two alternatives, a comparison was produced between the existing conditions and the two alternatives. The following is a comparison table between existing conditions with two alternatives:

Table 3 Interchange Performance Comparison

CONDITION	DEGREE OF SATURATION (DS)	QUEUE LENGTH(m)	DELAY (kend/sec)	CORRELATION	KET
EXISTING PEAK HOURS	1,06	247,69	152,56	The DS value is too high, as well as queues and delays, therefore the intersection conditions are still too saturated and other alternatives are needed to optimize	NOT WORTH
Alternative 1 TL with 2 scanario phase 1	0,68	34,83	15,06	The DS value already meets the criteria of unsaturated current, which is ≤ 0.85, but for comparison, another alternative is needed	PROPER
Alternative 1 TL with 2 scanario phase 2	0,65	38,45	16,52	The DS value in alternative 2 phase scanario 2 is smaller than alternative 2 phase scenario 1, but s the value of the servant level index is greater than alternative 2 phase scenario 1	PROPER

Source : Researcher Analysis 2023

From the table above, it can be concluded that the most suitable alternative is alternative 1 with 2 phases scenario 1 because the service level is better than alternative 2 phase scanario 2 which has a service level of C while alternative 1 with 2 phases of scenario 1 has a service level B. As a comparison material, the following is the time cycle of the initial traffic signal.

Table 4 Initial Traffic Light Signal Time

No.	Data	Phase 1	Phase 2
1	Green Light	19	20
2	Red Light	55	37
3	Yellow Light	3	3
4	Cycle Time	77	77

Source : Researcher Analysis 2023

Figure 1 Initial Traffic Signal Time Diagram

The data above is time data for existing traffic signal signals. From the table above, it can be concluded that the most suitable alternative is alternative 1 with 2 phases scenario 1 because the service level is better than alternative 2 phase scanario 2 which has a service level C while alternative 1 with 2 phases scenario 1 has a service level B.

After planned alternative improvements to improve the performance of the intersection at the intersection of Juwana square. In alternative A, the result of the delay and queue length is shorter than alternative B, so alternative A was chosen as the best alternative for traffic light planning with 2 phases. The following is a signal time planning from alternative A.

Table 5 Traffic Signal Signal Time Calculation Results

No.	Data	Phase 1	Phase 2
1	Green Light	21	26
2	Red Light	31	26
3	Yellow Light	3	3
4	Cycle Time	55	55

Source : Researcher Analysis 2023

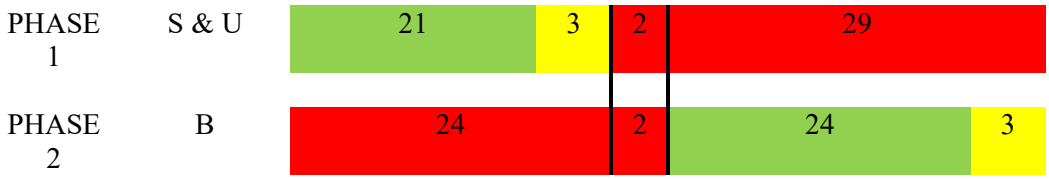

Figure 4. 1 Traffic Signal Time Chart

The data above is the result of calculating the time of the traffic signal signal that has been planned in each phase. For the traffic signal time diagram above are green, red and yellow time settings. For the yellow time is planned 3 seconds. As for the all red time (allred) 2 seconds where the all red time is obtained from the results of the SIG-III calculation.

4. Conclusion

The calculation of traffic cycle time improvement at peak hours is recommended to use alternative A with 2 phases of scenario 1 which has a total cycle time of 55 seconds in each phase, where after this cycle time improvement is obtained the degree of saturation (DS) of southern shortness 0.65, western shortness 0.51, northern shortness 0.19. Queue Length on South Approach 34.83 m, West Approach 23.51 m, North Approach 12.32 m. Delay on South Approach 15.06 seconds, West Approach 11.07 seconds , North Approach 11.39 seconds. As well as increasingservice to the Southern shortcut, namely B, the Western Approach B, and the Northern Quarter B.

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