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PERFORMANCE ANALYSIS OF THE INTERSECTION OF FOUR VETERAN ROADS, MARABAHAN DISTRICT, BARITO KUALA REGENCY

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ABSTRACT

The population and motor vehicle growth in Marabahan City, South Kalimantan, as a result of the designation of East Kalimantan as the new capital of Indonesia, has led to a significant increase in traffic volume, particularly at the Marabahan four-leg intersection—a non-signalized intersection that serves as a key route for community activities during peak hours. This study aims to evaluate the current performance of the intersection, determine when its performance begins to decline, and propose appropriate mitigation measures, using methods based on the 2023 Indonesian Highway Capacity Guidelines (PKJI 2023) and analysis conducted with Excel. Traffic volume data collected over 12 hours on November 24 and 25, 2024, along with population data from Barito Kuala Regency, were analyzed, revealing peak hours on Sunday at 17:00–18:00 and Monday at 07:15–08:15, with an existing performance showing a level of service C. Forecasting indicates a decline in performance to the level of service D by the 14th year, necessitating intervention. Two alternative solutions are proposed: converting the intersection into a signalized (APILL) intersection with an average delay of 25 seconds/pcu (LOS B) and widening the geometric layout, resulting in a degree of saturation (DS) of 0.873, delay of 16.674 seconds/pcu, queue probability of 45.506%, and maintaining a level of service C.

Keywords: Intersection Performance, Indonesian Highway Capacity Guidelines 2023 (PKJI 2023), Signalized Intersection (APILL), Level of Service Index, Capacity, Degree of Saturation.

1. INTRODUCTION

Population growth continues to increase, especially in the Kalimantan region, due to the establishment of East Kalimantan as the country's capital. This also has an impact on increasing the number of people in South Kalimantan, especially Marabahan City because along with the increase in the population, the number of vehicles used as a means of transportation for various daily activities is also increasing.

Simpang Empat Marabahan, which is an intersection without traffic lights, was chosen as the research location because based on observations, congestion often occurs, especially during peak hours between 06.30 WITA - 08.30 WITA and 16.00 WITA - 17.30 WITA. This intersection connects four directions, with the north and south arms which is Jalan

Gawi Sabumi, with the north arm serving as the main road for student traffic as well as shortcut access to Wangkang Market. The east arm leads to the Rumpiang Bridge, while the west arm is Veteran Street which leads to the city center. Traffic jams at this intersection often cause obstacles for motorcyclists and cars, especially those who pass through Veteran Street as a crossing route for students. Meanwhile, the eastern arm, which is the main access to schools in Marabahan, experienced an increase in traffic volume during peak hours, thus aggravating the congestion conditions at the intersection.

2. THEORETICAL FOUNDATION

Junction

An intersection is a meeting point between two or more roads that function as a connection for traffic flow from various directions. In the context of transportation, intersections have an important role in regulating and flowing vehicles, thus affecting the overall performance of the transportation system in an area.

The performance of the intersection is greatly influenced by a variety of factors, including vehicle volume, peak traffic time, and the geometric design of the intersection itself. Research shows that well-designed intersections can reduce congestion and improve traffic safety. For example, intersections that have sufficient lane width and efficient signal arrangement can reduce delay time and vehicle queues, thereby increasing the capacity of such intersections (Keke & Siswoyo, 2021). On the other hand, poorly designed intersections can cause severe congestion and increase the risk of accidents, especially during rush hour (Sidiq et al., 2021).

Factors Influencing Simpang Performance

The performance of a signaled four-stroke intersection is affected by several interrelated factors, including traffic volume, geometric conditions, and driver behavior. Heavy traffic volumes often lead to congestion, especially during peak hours, which can increase delay times and the chances of queues at the intersection (Pratama & Elkhasnet, 2019). In addition, geometric factors such as road width and turn angles also contribute significantly to intersection performance. Inadequate road widths can hinder traffic flow and increase the risk of accidents (Waris, 2022).

Forecasting

Traffic forecasting on intersections is an important aspect in of planning and managing transportation infrastructure. In this context, the analysis of probability distribution and optimal control at a road intersection can provide valuable insights into expected traffic conditions (Harjono et al., n.d.).

3. METHOD

This study uses a field method (observation) in the form of observation and direct recording at the location. This research was conducted at the intersection of Jalan Veteran, Marabahan City, Barito Kuala. This observation was focused on taking data directly in the field for 12 hours. The data collected consists of primary and secondary data.

4. RESULTS AND DISCUSSION

Intersection Geometric Data

Based on surveys conducted on Sunday, November 24, 2024 and Monday, November 25, 2024. Data related to Simpang Empat Marabahan was obtained which has been input into the formula table in accordance with the 2023 PKJI guidelines.

The calculation at this intersection uses traffic volume data accumulated for 12 hours with an interval of every 15 minutes, following the survey guidelines from 06.00 to 18.00 WITA.

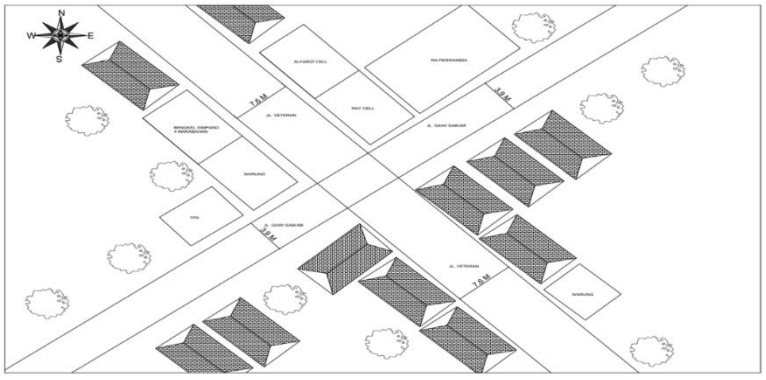

Figure 4. 1 Plans for Simpang Empat Veterans

The approach code uses the following notation:

- Veteran Street (Outside the City) is given the Approach Code T (East) 3.8 m
- Jalan Gawi Sabumi (State School) is given the Approach Code U (North) 1.95 m
- Veteran Street (Inner-City) is given the Approach Code B (West) 3.8 m

- Jalan Gawi Sabumi is given the Approach Code S (South) 1.95 m

Population Data

Marabahan sub-district obtained from the Central Statistics Agency (BPS) of South Kalimantan can be seen in Table 4.1.

Table 4. 1 Number of Population of Marabahan District (BPS Barito Kuala Regency)

Yes	Year	Population	Growth Rate (%)
1	2020	318.044	1.42
2	2021	313.020	-1.58
3	2022	321.769	2.80
4	2023	324.502	0.85
5	2024	326.740	0.69

Based on Table 4.1, the average population in the period 2020 to 2024 is 320,815 people, with a population growth rate of 0.69%. Referring to PKJI 2023, the number of residents puts this city in the category of a small-sized city.

Traffic Conditions

Traffic volume based on observations at the intersection of Jalan Veteran, the peak of traffic flow occurs at 07.15 – 08.15 WITA on Monday, with a recording interval every 15 minutes.

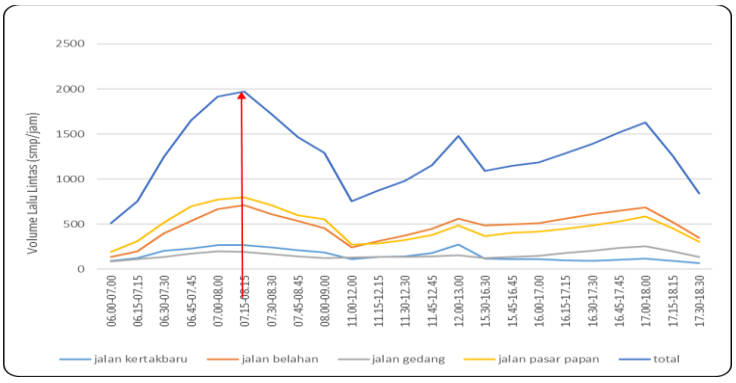

Figure 4. 2 Monday Traffic Flow Chart

Based on Figure 4.2 hours, the peak traffic on Monday occurred between 07.15 – 08.15 WITA with a volume of 1256.5 SMP/hour. The unit of traffic flow (smp/hour) is obtained by converting various types of vehicles, such as passenger cars, medium vehicles, and motorcycles into light vehicle equivalents using the EMP (Passenger Car Equivalent) value in accordance with the provisions of PKJI 2023. Vehicle volume data during peak hours can be seen in Table 4.2.

Table 4. 2 Vehicle traffic data during peak hours (Monday)

APPROACH	DIRECTION	SM	MP	KS
T (Jl. Veteran)	LT	141	12	0
	ST	554	110	0
	RT	449	16	0
U (Jl. Gawi Sabumi School)	LT	210	27	0
	ST	88	2	0
	RT	151	23	0
B (Jl. Veteran Center)	LT	223	23	0
	ST	773	121	3
	RT	292	7	0
S (Jl. Gawi Sabumi)	LT	67	2	0
	ST	159	1	0
	RT	140	5	0

A. Capacity Analysis

1. Basic Capacity

   The basic capacity is calculated on a basis determined based on the list of tables listed in the 2023 PKJI. The type of Simpang Empat Jalan Veteran used at this intersection is type 422 with a basic capacity of C0 of 2900 smp/hour.

2. Average Approach Width Correction Factor

   FLP = 0.70 + 0.0866 = 0.70 + 0.0866 (2.9) = 0.951

3. Median Correction Factor (FM)

   At this intersection there is no main road median, so the median adjustment factor of the main road obtained FM = 1.00

4. City Size Correction Factor (FUK)

   The number of people taken from data on the number of people according to age group (soul) in Marabahan District was obtained at ±320,815 people. So the FUK at the Junction of Four Veteran Streets is included in the size of the city is very small = 0.88.

5. Side Obstacle Correction Factor (FHS)

   The type of road environment is commercial, the side barrier (FHS) is medium for the class of moderate side resistance with the percentage of qKTB/qKB = 0.12. Based on this data, FHS = 0.827

6. Left Turn Current Ratio Correction Factor

   FBKi = 0.84 + 1.61 = 0.84 + 1.61 (0.19) = 1.146

7. Corrective Factors of the Right Turn Current Ratio

   Because intersection four of Jalan Veteran is intersection four, the value of the corrective factor of the right turn current ratio FBKa = 1.0.

8. Aurs Ratio Correction Factors from Minor Roads

   Rmi = $\frac{qmi}{qKB} = \frac{463,5}{1972,4} = 0,235$

   IMF = $1.19 \times 0.2352 - 1.19 \times 0.235 + 1.19 = 0.976$

   Based on the correction factors already mentioned, the capacity (C) is then calculated using the following formula.

   C = 2900 x 0.951 x 1 x 0.88 x 0.827 x 1.146 x 1 x 0.976 = 2244.921 cm/h

B. Saturation Degree Analysis

   DJ = $\frac{q}{c} = \frac{1972,4}{2244,921} = 0.879$

C. Delay

   TLL = $\frac{1,0504}{(0,2742-0,242\ x\ 0,879)} - (1 - 0,879)^2 =$ 17,070 det/smp

   TLLma = $\frac{1,0503}{(0,3460-0,2460\ x\ 0.879)} - (1 - 0,879)^{1,8}$ = 8,071 det/smp

   TLLmi = = 46,366 det/smp $\frac{1972,4\ x\ 17,070-1508,9\ x\ 8,071}{463,5}$

   TG = (1 – 0,879) x (6 x 0,48 + 3 (1-0,48)) + 4 x 0,879 = 4,053 det/smp

   To calculate the value of the delay, the following formula is used:

   T = TLL + TG = 17,070 + 4,053 = 21,123 det/smp

D. Peluang Antrian (PA)

   The upper limit percentage of the odds can be calculated as follows:

   Pa = 47.71 x (0.879) − 24.68 $(0.879)^2$ + 56.47 $(0.879)^3$ = 61.220 %

   The lower limit percentage of chances can be calculated as follows:

   Pa = 9.02 x (0.879) + 20.66 $(0.879)^2$ + 10.49 $(0.879)^3$ = 31.015 %

   Then the average queue chance = (61.220% + 31.015%)/2 = 46.117%

E. Service Level Analysis

   It was obtained that the average delay of intersections was 5,008 sec/smp on Sundays included in service level B and 21,123 on Mondays included in service

level C.

F. Forecasting

Based on the results of the current analysis, the performance of the Jalan Veteran Marabahan intersection is considered less than optimal. After *Forecasting* in the 14th year, the intersection showed a degree of saturation (DS) of 0.963 > 0.85, an average traffic delay of 25,522 > 10 sec/junior high school, a queue chance of 55.351% > 35%, and the service level index D which shows that the performance of the intersection no longer meets the service level requirements, there will be alternative improvements to overcome the problem.

G. Alternative Intersection Handling

Based on the results of the analysis of the performance of intersections ≥ 0.963 that exceeds the intersection performance limit set in PKJI 2023, namely Dj ≤ 0.85, efforts are needed to handle the alternative intersection. The recommended treatment alternatives are as follows:

1. Changes to the Traffic Signaling Device (APILL) at the intersection.
2. Geometric widening of the road

Table 4. 3 Recapitulation of Comparative Values of Intersection Conditions

No.	Junction management	Degree of Saturation (DJ)	Traffic Delay (TLL) det/smp	Junction Delay (T) det/smp	Peluang Antrian (Pa %)	ET C
1.	Existing (Sunday)	0,409	9,428	5,008	13,35	B
	Existing (Monday)	0,879	17,070	21,123	46,11	C
2.	Forecasting (14 Year)	0,963	25,522	29,538	55,351	D
3.	Changes to APILL Phase 4 Junction	0,744	31,9	24,60	-	C
4.	Change APILL Junction Phase 3	0,562	20,3	9,75	-	B
5.	Geometric Widening	0,873	16,67	20,73	45,51	C

5. CONCLUSIONS AND SUGGESTIONS

Conclusion

From the problems and discussions in this study, it can be concluded that:

1. In the existing conditions, it is obtained from the results of the analysis that the saturation degree value (DJ) is 0.409 on Sunday and (DJ) 0.879 on Monday, the average delay is 5.008 sec/smp on Sunday and 21.123 on Monday, the chance of queue is 27.335% on Sunday and 27.68% on Monday and the service level index is C. Where it can be seen that in the existing condition, there is no signal, The performance of the intersection is still optimal.
2. Because the performance of the intersection in the existing condition is still optimal, forecasting calculations are carried out until the intersection is no longer able to work properly, therefore it was obtained in the 14th year with the Service Level Index (ITP) D. Because the performance of the intersection is no longer optimal, alternative handling planning is carried out. The first alternative that can be applied is to change the intersection to an APILL intersection, where from the results of the analysis it is obtained that the intersection delay is 9.75 seconds/smp with the index of Service Level B. The second alternative is with a change in the geometric widening of the road where from the results of the analysis it is obtained (DJ) 0.873 > 0.85, TLL 16.674 > 10 seconds/SMP, and Pa 45.506 % > 35% with ITP C.

Suggestion

The suggestions that have been given related to this Final Project include:

1. The addition of traffic signs at intersections such as signs prohibiting parking and stopping around intersections.
2. For phase planning, it is recommended to use 4 phases because it shows more optimal performance, but it is better for the next few years to still pay attention to the traffic growth rate according to the conditions in the field to improve the performance of the intersection.
3. It is recommended to make road geometric improvements for the next few years to continue to improve the performance of the intersection.

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