International Journal of Mechanical, Electrical and Civil Engineering
Volume. 1 No. 4 October 2024
e-ISSN : 3047-4531, and p-ISSN : 3047-4523, Page. 01-17
DOI: https://doi.org/10.61132/ijmecie.v1i4.29
Available online at: https://international.aritekin.or.id/index.php/IJMECIE

Performance Evaluation and Analysis Of Unsignaled Interceptions
(Case Study: Raya Blega Street-Rajawali Street Bangkalan District)

[1] Afada Lazuardi Irhamni , [2] Ibnu Sholichin , [3] Nugroho Utomo ,
[1,2,3] Universitas Pembangunan Nasional "Veteran" Jawa Timur

Rungkut Madya Street No.1, Gunung Anyar, District. Gunung Anyar, Surabaya, East Java 60294
Korespondensi penulis: afadairhamni38@gmail.com, Ibnu.ts@upnjatim.ac.id

Abstract. *The Raya Blega Street intersection is one of the intersections with a relatively high vehicle volume in Bangkalan Regency. There is no APILL (Traffic Signaling Device) available at this intersection, so it has an impact on traffic flow at the intersection. The existence of the market causes many side obstacles which reduce the optimal performance of the intersection. This condition causes the intersection to experience traffic delays, especially during peak hours such as when leaving work or when leaving. In this research, researchers want to identify the problem of congestion at the Raya Blega street-Rajawali street intersection by calculating and analyzing the performance of the Raya Blega street-Rajawali street intersection using the PKJI 2023 method so that it can be used as a benchmark for assessing the performance of unsignalized intersections and assisting related parties in handle problems at the intersection and it is hoped that they can handle the problems that occur at the intersection so that it can create security and safety for passing users.In this study, the highest value was obtained for existing conditions on Monday, April 29 2024, at morning peak hours (07.00-08.00) at approach point A (east Raya Blega street) with an intersection capacity value of 2297,96 smp/hour and the value obtained The degree of saturation is 0,36 and the delay value is 8.44 sec/smp so it is included in Level of Service B. So the status of the Raya Blega street-Rajawali street Bangkalan Regency intersection is still suitable to be maintained.*

Keyword *: Raya Blega Street Intersection, Unsignalized Intersection, PKJI 2023, Degree of Saturation, Delay*

1. INTRODUCTION

Traffic problems, especially at unsignalized intersections in urban areas, generally cause congestion problems due to drivers who are impatient to pass through the intersection and therefore do not pay attention to the yield traffic signs at the intersection. This is one of the factors that often occurs in unsignalized intersection areas. Another factor that causes traffic problems is the population growth which increases every year. With this increase in population, the number of vehicle owners also increases, causing traffic problems such as congestion. Since 2022, Sampang Regency has started preparing the construction of a southern highway, which aims to facilitate the preparation of a technocratic draft for the 2025-2029 National Medium-Term Development Plan (RPJMN) within the Java Island region. (East Java Communications and Information Service, 2022). The construction of the southern highway aims to connect regions and develop the economy, it is also an alternative way to avoid traffic jams that often occur on the main Tanah Merah-Blega Bangkalan route. The Raya Blega street-Rajawali street Bangkalan Regency intersection is one of the closest accesses that connects the Tanah Merah-Blega Bangkalan national road with the southern highway in Sreseh District. The Raya Blega street-Rajawali street intersection is one of the intersections that has a fairly high level of vehicle volume in Bangkalan Regency (Herdiyana, 2024). At this intersection there is no APILL (Traffic Signaling Device) available, so this has an impact on irregular traffic flow and

Received: June 19, 2024; Revised: July 25, 2024; Accepted: August 10, 2024;
Online Available: August 13, 2024;

causes traffic delays. The intersection of Raya Blega street-Rajawali street, Bangkalan Regency has become busy due to economic activities in the surrounding area. The existence of the market causes many side obstacles which reduce the optimal performance of the intersection. This condition causes the intersection to experience traffic delays, especially during peak hours such as when leaving work or when leaving. From the problems that have been presented, researchers want to identify the problem of congestion at the Raya Blega street-Rajawali street unsignalized intersection by calculating and analyzing the performance of the Raya Blega street section in the Raya Blega market area using the PKJI 2023 method so that it can be used as a benchmark for assessing the performance of the non-signaled intersection. signal and assist the Bangkalan Regency Transportation Service in handling problems at the intersection so that it can create security and safety for passing users.

2. THEORITICAL REVIEW

Intersection

An intersection is a node on a road network where roads meet and vehicle paths intersect. Traffic at each leg of the intersection shares the road space with other vehicles at the intersection (Aryandi & Munawar, 2014). According to Law Number 22 of 2009 concerning Road Infrastructure and Traffic, an intersection is defined as a meeting point or branching of roads, whether at the same level or at different levels.

Unsignalized Intersection

According to the Directorate General of Highways (2023), Unsignalized intersections are typically used in urban residential areas and inland regions for intersections between local roads with low traffic volumes, with right-of-way arrangements that prioritize traffic coming from the left. For intersections involving roads of different classes and functions, traffic on minor roads must be regulated using "yield" or "stop" signs.

Capacity of Unsignalized Intersections

The capacity of an unsignalized intersection (C) is calculated for the total incoming flow from all intersection arms and is determined by multiplying the basic capacity of an unsignalized intersection (C_O) with correction factors that account for differences between environmental conditions and ideal conditions.

$$C = C_O \times F_{LP} \times F_M \times F_{UK} \times F_{HS} \times F_{BKi} \times F_{BKa} \times F_{Rmi} \quad \text{..... (1)}$$

With C = Intersection capacity (SMP/hour), C_O = Basic intersection capacity (SMP/hour), F_{LP} = Average approach width correction factor, F_M = Median type correction factor, F_{UK} = City size correction factor, F_{HS} = Correction factor side obstacles, F_{BKi} = Left turning current ratio correction factor, F_{BKa} = Right turning current ratio correction factor, F_{Rmi} = Current ratio correction factor from minor roads.

Basic Capacity of Unsignalized Intersections (C_O)

Intersection grouping is based on the number of intersection arms, the configuration of lanes on the minor road, and the number of lanes on the major road. The type of intersection is assigned a three-digit code, where the first digit represents the number of intersection arms, the second digit indicates the number of lanes on the minor road approach, and the third digit represents the number of lanes on the major road approach.

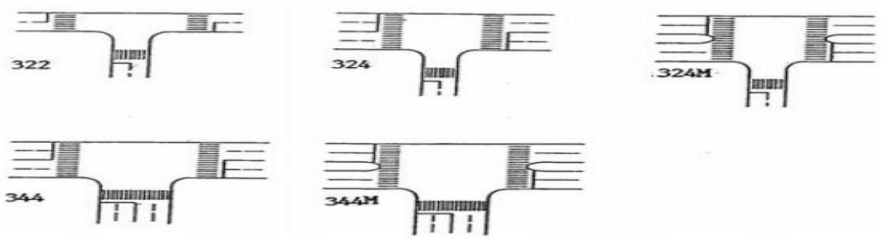


Figure 1. Types of road intersections according to IT code

(Source: MKJI 1997)

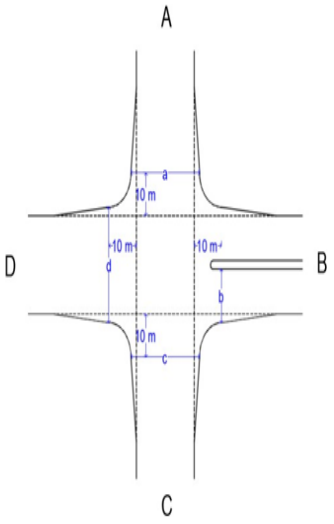
Table 1. Basic capacity of intersection-3 and intersection-4

Intersection Type	C_O, SMP/hour
322	2700
324	3200
344	3200
422	2900
424	3200

Source: Ministry of PUPR, 2023

Average Width Correction Factor

The CO value in this context depends on the type of intersection and its determination must be based on geometric data. The geometric data needed to determine the type of intersection includes the number of intersection arms and the number of lanes at each approach.



Lebar rata-rata pendekat mayor (B-D) dan minor (A-C)	Jumlah lajur (untuk kedua arah)
$L_{RP\,BD} = \frac{(b + \frac{d}{2})}{2} < 5{,}5\ m$	2
$L_{RP\,BD} \geq 5{,}5\ m$ (ada median pada lengan B)	4
$L_{RP\,AC} = \frac{(\frac{a}{2} + \frac{c}{2})}{2} < 5{,}5\ m$	2
$L_{RP\,AC} \geq 5{,}5\ m$	4

Figure 2. Determination of the number of approach lanes

(Source: PKJI 2023)

To find the average approach width value, use the following equation:

For intersection type 422: $F_{LP} = 0{,}70 + 0{,}0866\ L_{RP}$ ..... (2)

For intersection type 424 or 444: $F_{LP} = 0{,}61 + 0{,}0740\ L_{RP}$ ..... (3)

For intersection type 322: $F_{LP} = 0{,}73 + 0{,}0760\ L_{RP}$ ..... (4)

For intersection type 324 or 344: $F_{LP} = 0{,}62 + 0{,}0646\ L_{RP}$ ..... (5)

Median Correction Factor on Roads (F_M)

A median is considered wide if it allows passenger cars to take cover within the median area without disrupting traffic flow, meaning the median width is greater than or equal to 3.0 meters.

Table 2. Correction factors for major roads

Intersection Condition	Median Type	Correction Factor, F_m
There are no medians on major roads	There isn't any	1,00
There are medians on major roads with a width of <3 meters	Narrow median	1,05
There are medians on major roads with a width of ≥3 meters	Wide median	1,20

Source: Ministry of PUPR, 2023

City Size Correction Factor (F_{UK})

The city size factor is differentiated based on the size of the population in the area under consideration.

Table 3. City size correction factor

City Size	Population, Million People	F_{UK}
Very small	< 0,1	0,82
Small	0,1 – 0,5	0,88
Currently	0,5 – 1,0	0,94
Big	1,0 – 3,0	1,00
Very large	> 3,0	1,05

Source: Ministry of PUPR, 2023

Side Barrier Factors (F_{HS})

The influence of road environmental conditions, side obstacles, and the volume of vehicle flow generated by activities around the intersection are combined into one value called the side resistance correction factor.

Table 4. Side drag correction factor

Road Environment Type	Obstacle Side	F_{HS} for value R_{KTB}					
		0,00	**0,05**	**0,10**	**0,15**	**0,20**	**≥0,25**
Commercial	High	0,93	0,88	0,84	0,79	0,74	0,70
	Currently	0,94	0,89	0,85	0,80	0,75	0,70
	Low	0,95	0,90	0,86	0,81	0,76	0,71
Settlement	High	0,96	0,91	0,86	0,82	0,77	0,72
	Currently	0,97	0,92	0,87	0,82	0,77	0,73
	Low	0,98	0,93	0,88	0,83	0,78	0,74
Limited Access	High/ Currently/ Low	1,00	0,95	0,90	0,85	0,80	0,75

Sumber: Kementrian PUPR, 2023

Left Turn Ratio Factor (F_{BKi})

To find the value of the ratio factor, turn left using the following equation:

$$F_{BKi} = 0,84 + 1,61\ R_{BKi} \quad (6)$$

Right Turn Ratio Factor (F_{BKa})

To find the value of the ratio factor, turn right using the following equation:

For intersection-4: $F_{BKa} = 1,0$ (7)

For intersection-3: $F_{BKa} = 1,09 - 0,922\ R_{Bka}$ (8)

Minor Road Flow Ratio Correction Factor (F_{RMi})

To find the value of the minor road current ratio factor, use the equation in the following table:

Table 5. Minor road current ratio correction factor

Intersection Type	F_{mi}	R_{mi}
422	$1{,}19 \times R_{mi}^2 - 1{,}19 \times R_{mi} + 1{,}19$	0,1–0,9
424 and 444	$16{,}6 \times R_{mi}^4 - 33{,}3 \times R_{mi}^3 + 25{,}3 \times R_{mi}^2 - 8{,}6 \times R_{mi} + 1{,}95$	0,1–0,3
	$1{,}11 \times Rmi^2 - 1{,}11 \times Rmi + 1{,}11$	0,3–0,9
322	$1{,}19 \times R_{mi}^2 - 1{,}19 \times R_{mi} + 1{,}19$	0,1–0,5
	$-0{,}595 \times R_{mi}^2 + 0{,}595 \times R_{mi} + 0{,}74$	0,5–0,9
324 and 344	$16{,}6 \times R_{mi}^4 - 33{,}3 \times R_{mi}^3 + 25{,}3 \times R_{mi}^2 - 8{,}6 \times R_{mi} + 1{,}95$	0,1–0,3
	$1{,}11 \times R_{mi}^2 - 1{,}11 \times R_{mi} + 1{,}11$	0,3–0,5
	$-0{,}555 \times R_{mi}^2 + 0{,}555 \times R_{mi} + 0{,}69$	0,5–0,9

Source: Ministry of PUPR, 2023

Degree of Saturation at Unsignalized Intersections (D_J)

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

With D_J = Degree of saturation, C = Intersection capacity (SMP/hour), q = all motor vehicle traffic flows on all intersection arms (SMP/hour)

Table 6. Level of service at the intersection

Service Level	Information	Degree of Saturation
A	Free flow conditions with high speeds and low traffic volume	0,00-0,20
B	In stable flow conditions, the driver has sufficient freedom in choosing speed	0,21-0,44
C	In stable flow conditions, the driver is limited in choosing speed	0,45-0,74
D	Approaching a less stable flow, where almost the volume of service corresponds to a tolerable capacity	0,75-0,84
E	Traffic volume is at capacity and flow is unstable with frequent stops	0,85-1,00
F	Traffic flow conditions are at low speeds, there are long queues, and there are large obstacles	>1,00

Source: Ministry of PUPR, 2023

Delays at Unsignalized Intersections

$T = T_{LL} + T_G$ ..... (10)

With T_{LL} = The average traffic delay for all motorized vehicles entering the intersection from all directions, T_G = geometric average delay.

To find the average traffic delay (T_{LL}) value, use the following equation.

For $D_J \leq 0{,}60$: $T_{LL} = 2 + 8{,}2078\ D_J - (1 - D_J)^2$ ..... (11)

For $D_J > 0{,}60$: $T_{LL} = \frac{1{,}0504}{(0{,}2742 - 0{,}2042 DJ)} - (1 - D_J)^2$ ..... (12)

To find the geometric mean delay (TG) value, use the following equation.

For $D_J < 1$: $T_G = (1 - D_J) \times \{6\ R_B + 3\ (1 - R_B)\} + 4\ D_J$ ..... (13)

For $D_J \geq 1$: $T_G = 4$ second/SMP ..... (14)

With R_B = The ratio of turning flow to the total motor vehicle flow at the intersection.

Chances of Queuing at Unsignalized Intersections

Queuing probability (Pa) is expressed in the probability range (%). The upper limit queue opportunity value can be determined using the following equation.

Upper limit of opportunity: $P_a = 47{,}7\ D_J - 24{,}68\ D_J^2 + 56{,}47 D_J^3$ ..... (15)

Bottom limit of opportunity: $P_a = 9{,}02\ D_J - 20{,}66\ D_J^2 + 10{,}49\ D_J^3$ ..... (16)

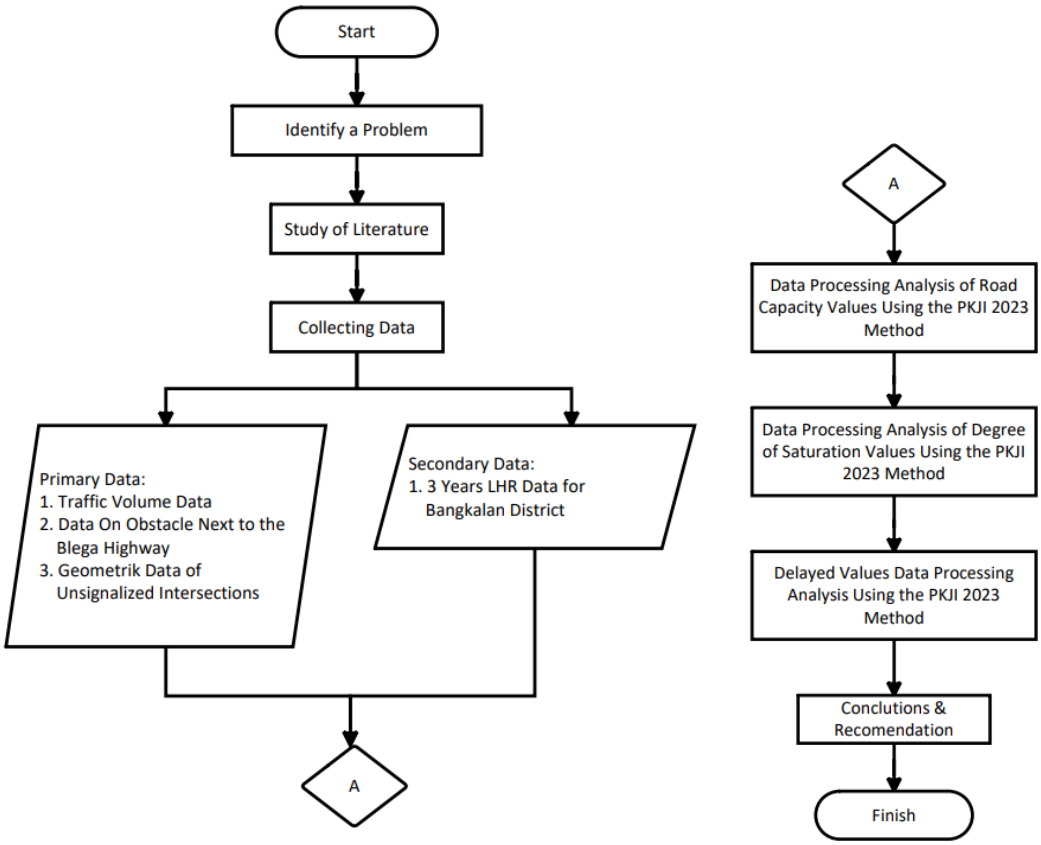
3. RESEARCH METHODS

In this research, a traffic volume survey was carried out to calculate the capacity at the intersection.

Data collection

1. Traffic volume data, taken from the results of a traffic survey of vehicles passing at the Raya Blega street-Rajawali street intersection based on PKJI 2023 provisions according to the planned time provisions.
2. Geometric data for unsignalized intersections, taken from survey results at the non-signalized intersection of Raya Blega street-Rajawali street in the form of road width, number of road medians, curb width, based on PKJI 2023 provisions according to the planned time provisions.
3. Data on side obstacles at Raya Blega market was taken from pedestrians, bicycle users and the number of vehicles parked on the side of the road around the Raya Blega market area according to the planned time requirements.

Research Flowchart



Gambar 3. Flowchart

So that this research can proceed systematically and in a directed manner according to the objectives to be achieved, a research flow chart is needed. The research flow chart is shown in Figure 3 below.

4. RESULTS AND DISCUSSION

Traffic data was obtained by survey on Monday, April 29 2024 with a peak traffic duration of 2 hours. The survey was conducted in the morning from 07:00 to 09:00, then in the afternoon from 11:00 to 13:00, and finally in the late afternoon from 15:00 to 17:00. This data collection uses an application from a cellphone, namely *traffic counter*, which is an application for counting the number of passing vehicles. The grouping of vehicle types observed during the survey was grouped into 4 types of vehicles, namely:

1. Motorcycle (SM)

Vehicles that fall into this category are two-wheeled motorized vehicles that pass through the intersection of three Raya Blega street.

2. Passenger Car (MP)

Passenger vehicles that pass through the intersection of Raya Blega street include: private cars, official cars, passenger cars.

3. Heavy Vehicle (KB)

Heavy vehicles that pass through the intersection of Raya Blega street include: mini buses, buses, trucks and container trucks.

4. Non-motorized vehicles (KTB)

Vehicles that are categorized as non-motorized passing through the intersection of Raya Blega street include: bicycles, trishaws and carts.

The results of the traffic volume survey on Monday, April 29 2024 obtained the total value of vehicle flow per intersection. This survey data is then multiplied by a vehicle equivalent factor according to the type of vehicle and the total vehicle volume limit per hour. If the total vehicle volume per hour is <1000, then the passenger car equivalent factor is; motorbikes: 0.5, passenger cars: 1, heavy vehicles: 1.3. After multiplying the data by the appropriate vehicle equivalent factor, the data can be processed further to obtain an intersection service level value.

Presentation of Survey Results Data

Table 7. Total vehicle flow at the Raya Blega street-Rajawali street intersection

Observation Time	Vehicle Type (kend/hour)			Number of Vehicles (kend/hour)	Vehicles Type (smp/hour)			Number of Vehicles (smp/hour)	KTB
	SM	MP	KB		SM	MP	KB		
East Arm of Raya Blega Street									
07.00 - 08.00	841	305	61	1207	421	305	79	805	49
08.00 - 09.00	601	268	99	968	301	268	129	697	46
11.00 - 12.00	768	240	108	1116	384	240	140	764	43
12.00 - 13.00	508	248	78	834	254	248	101	603	28
15.00 - 16.00	605	130	69	804	303	130	90	523	20
16.00 - 17.00	506	140	26	672	253	140	34	427	17
West Arm of Raya Blega Street									
07.00 - 08.00	781	259	57	1097	391	259	74	724	53

08.00 - 09.00	630	160	50	840	315	160	65	540	42
11.00 - 12.00	618	80	43	741	309	80	56	445	35
12.00 - 13.00	539	105	53	697	270	105	69	444	24
15.00 - 16.00	515	136	59	710	258	136	77	471	21
16.00 - 17.00	334	119	64	517	167	119	83	369	17
Rajawali Street Arm									
07.00 - 08.00	420	58	8	486	210	58	10	278	40
08.00 - 09.00	255	34	14	303	128	34	18	180	33
11.00 - 12.00	251	72	12	335	126	72	16	214	32
12.00 - 13.00	202	21	6	229	101	21	8	130	22
15.00 - 16.00	139	22	5	166	70	22	7	99	12
16.00 - 17.00	239	26	3	268	120	26	4	150	19

Source: Survey results

Existing Condition Analysis

Based on the survey data on vehicle traffic flow volume, the values for total traffic flow volume (Qtot), minor road flow volume (Qmi) and major road flow volume (Qma) were obtained. For example, when calculating at approach point A East Arm of Raya Blega Street, the Qtotal value is 854 smp/hour, Qmi on Monday is 318 smp/hour, and Qma on Monday is 1631 smp/hour.

A complete data recapitulation of survey results at peak hours is presented in table 8 below.

Table 8. Existing traffic data at each peak hour for each approach point which has been multiplied by an equivalent factor

Approach point	Peak hours	Time Interval	Information	Number of Vehicles (smp/hour)								Total Motorized Vehicles (smp/hour)	
				SM		MP		KB		KTB			
Approach A (Monday)	Morning	07.00 - 08.00	qLrs	421	334	305	254	79	78	49	19	805	666
			qBki		87		51		1		30		139
	Day	11.00 - 12.00	qLrs	384	282	240	211	140	133	43	24	764	626
			qBki		102		29		8		19		139
	Afternoon	15.00 - 16.00	qLrs	303	221	130	118	90	87	20	11	522	426
			qBki		82		12		3		9		97
Approach B (Monday)	Morning	07.00 - 08.00	qLrs	391	344	259	256	74	74	53	35	724	674
			qBki		47		3		0		18		50
	Day	11.00 - 12.00	qLrs	309	266	80	73	56	55	35	19	445	393
			qBki		44		7		1		16		52
	Afternoon	15.00 - 16.00	qLrs	258	226	136	131	77	73	21	9	470	430
			qBki		32		5		4		12		40
Approach C (Monday)	Morning	07.00 - 08.00	qLrs	210	87	58	21	10	4	40	26	278	111
			qBki		124		37		7		14		167
	Day	11.00 - 12.00	qLrs	126	53	72	38	16	7	32	21	213	97
			qBki		73		34		9		11		116
	Afternoon	15.00 - 16.00	qLrs	70	36	22	13	7	1	12	7	98	50
			qBki		34		9		5		5		48

Source: Data Processing Survey Results

1. **Determine the width of the road approach and type of intersection**

a) The width of the minor road approach is L_C 4 m. The average width of the L_C minor approach is 4 meters, with a total of 2 lanes.

b) Width of approaches to the main road (eastern and western Raya Blega street). The width of the major road approaches is L_A 5,5 m and L_B 5,5 m. So the average width of major road approaches is L_{AB} 5,5 m with a total of 2 lanes.

c) The average approach width for major roads and minor roads is LRP = $(L_{Main} + L_{Minor})/2$ = (5,5 + 4)/2 = 4,75 m.

d) The type of intersection at the Raya Blega street intersection is intersection 3, the number of lanes at each road approach point is 2 minor lanes with 2 major lanes, so we get the intersection type 322.

2. Determine the intersection capacity

a) Basic capacity of intersection (C_O)

The type of intersection at the Raya Blega street-Rajawali street intersection is type 322, based on table 1, the basic capacity of C_O = 2700 smp/hour.

b) Average width correction factor (F_{LP})

The variable average width of all roads is L_{RP} 4,75 m and intersection type 322. So the following formula equation (4) is used:

F_{LP} = 0,73 + 0,0760 L_{RP}

= 0,73 + 0,0760 × 4,75

= 1,091

c) Median adjustment factor for main road intersections (F_M)

At the Raya Blega street-Rajawali street intersection there is no median on the road, so the road median correction value based on table 2 is 1,00.

d) City size correction factor (F_{UK})

Based on data from the Central Statistics Agency, the population of Bangkalan Regency is approximately 1.1 million people. Consequently, the F_{UK} value obtained from Table 3 is 1,00.

e) Side drag factor (F_{HS})

Based on survey data on side obstacles at the intersection of Raya Blega street-Rajawali street, it was found that the largest side resistance ratio was 0,04 and the frequency of occurrence was <100, so it was classified as a commercial environment type side obstacle class and a low side resistance class, so that obtained based on table 4, the F_{HS} value was 0,95.

f) Left turn adjustment factor (F_{BKi})

The input variable is the calculation of the left turn ratio R_{BKi} = 0,163 (obtained from the total volume of vehicles turning left divided by the total vehicle volume) with intersection type 322. The calculation used to find (F_{BKi}) uses the following equation (6):

$F_{BKi} = 0,84 + 1,61\ R_{BKi}$

$= 0,84 + 1,61 \times 0,163$

$= 1,1$

g) Right turn adjustment factor (F_{BKa})

At approach point A there is no right turn, so the input variable is adjusted based on PKJI 2023 provisions, right turn ratio R_{BKa} = 0,29 with intersection type 322. The calculation used to find (F_{BKa}) uses the following equation (8):

$F_{BKa} = 1,09 - 0,922\ R_{BKa}$

$= 1,09 - 0,922 \times 0,29$

$= 0,82$

h) Minor road current ratio correction factor (F_{Rmi})

The input variable is the calculation of the minor road ratio R_{Mi} = 0,326 (obtained from the total vehicle volume of minor roads divided by the total vehicle volume) with intersection type 322. The calculation used to find (F_{Rmi}) uses the equation in table 6 below:

$F_{Rmi} = 1,19 \times R_{mi}^2 - 1,19 \times R_{mi} + 1,19$

$= 1,19 \times 0,326^2 - 1,19 \times 0,326 + 1,19$

$= 0,928$

i) Intersection Capacity (C)

Calculation of intersection capacity uses the following formula (1).

$C = C_O \times F_{LP} \times F_M \times F_{UK} \times F_{HS} \times F_{BKi} \times F_{BKa} \times F_{Rmi}$

$= 2700 \times 1,091 \times 1,00 \times 1,00 \times 0,95 \times 1,1 \times 0,82 \times 0,928$

$= 2347,38$ smp/hour

Evaluation of the Value of the Degree of Saturation

Calculation of the degree of saturation (D_J) value based on equation (9) at morning peak hours on Monday, April 29 2024 at approach point A (East Arm of Raya Blega Street) after obtaining the capacity value for the unsignalized intersection C = 2347,38 smp/hour and $q_{total(A)}$ = 854 smp/hour, as follows:

$D_J = \frac{qtotal}{C}$

$= \frac{854}{2347,38}$

$= 0,36$

The results of processing the existing total peak hour data from Monday, April 29, 2024, indicate that the degree of saturation at approach point A for the three arms of the intersection is as follows.

Table 9. Value of the degree of total saturation on Monday, April 29 2024

Peak hours	Approuch Point	Degree of Saturation	Service Level
07.00 - 08.00	A	0,36	B
11.00 - 12.00	A	0,33	B
15.00 - 16.00	A	0,22	B

Source: Results of data analysis

Evaluation of Delay Value

Calculation of intersection delays at morning peak hours Monday, April 29 2024 at approach point A (East Arm of Raya Blega Street) after obtaining a value of degree of saturation (D_J) = 0,36 as follows:

1. Traffic delays at unsignalized intersections (T_{LL})

   If a D_J value is obtained ≤ 0.60, then use formula (11) as follows.

   $T_{LL} = 2 + 8,2078\ D_J - (1 - D_J)^2$

   $= 2 + 8,2078 \times 0,36 - (1 - 0,36)^2$

   $= 4,58$ sec/smp

2. Geometric delay (T_G)

   The input variables are the total vehicle turning ratio R_B = 0,26 (obtained from the value of the total volume of turning vehicles on Monday divided by the vehicle volume value of major roads plus minor roads) and D_J = 0,36. Calculating the geometric delay for a D_J value < 1 uses the following formula (13).

   $T_G = (1 - D_J) \times \{6\ R_B + 3\ (1 - R_B)\} + 4\ D_J$

   $= (1 - 0,36) \times \{6 \times 0,26 + 3\ (1 - 0,26)\} + 4 \times 0,36$

   $= 3,86$ sec/smp

3. Unsignalized intersection delay (T) using the following formula (10).

   $T = T_{LL} + T_G$

   $= 4,58 + 3,86$

   $= 8,44$ sec/smp

So the results of processing the existing total peak hour data on Monday, April 29 2024, show that the total peak hour delay value for the three intersection arms is at approach point A as follows.

Table 10. Total delay value on Monday, April 29 2024

Peak Hours	Approuch Point	Delay Value
07.00 - 08.00	A	8,44
11.00 - 12.00	A	8,10
15.00 - 16.00	A	7,07

Source: Results of data analysis

Evaluate the Queue Opportunity Value

Calculation of queuing opportunities during the morning peak hour Monday, April 29 2024 at approach point A (East Arm of Raya Blega Street) after obtaining a value of degree of saturation (D_J) = 0,36 as follows:

Calculation of the upper probability limit uses the following formula (15):

$$PA = 47,7\ D_J - 24,68\ D_J^2 + 56,47\ D_J^3$$

$$= 47,7 \times 0,36 - 24,68 \times 0,36^2 + 56,47 \times 0,36^3$$

$$= 16,80\%$$

Calculation of the lower probability limit uses the following formula (16):

$$PA = 9,02\ D_J - 20,66\ D_J^2 + 10,49\ D_J^3$$

$$= 9,02 \times 0,36 - 20,66 \times 0,36^2 + 10,49 \times 0,36^3$$

$$= 1,05\%$$

From the calculation results that have been presented, a range of queuing opportunity values is obtained QP% = 1,05% - 16,80%.

So the results of processing the existing total peak hour data on Monday, April 29 2024, show that the total peak hour queuing opportunity value for the three intersection arms is at approach point A as follows.

Table 11. Total queue probability value on Monday, April 29 2024

Peak Hours	Approuch Point	Lower Queue Opportunities (%)	Upper Queue Opportunities (%)
07.00 - 08.00	A	1,05	16,80
11.00 - 12.00	A	1,11	15,01
15.00 - 16.00	A	1,10	10,09

Source: Results of data analysis

5. CONCLUSION

Based on the evaluation and data analysis using the PKJI 2023 method for the Raya Blega Street-Rajawali Street intersection in Bangkalan Regency, the intersection capacity performance value under existing conditions was 2347,38 smp/hour. The highest total vehicle volume was recorded on Monday during peak morning hours, amounting to 1949 smp/hour. The highest degree of saturation value was 0,36, and the highest delay value was 8,44 seconds per smp at approach point A (East Arm of Raya Blega Street) during the morning peak hours. Based on Table 6, this falls within Level of Service B. From As a result of the evaluation and data analysis, the status of the Raya Blega street intersection in Bangkalan Regency is currently still worthy of being maintained.

6. SUGGESTION

Based on the results of the traffic performance analysis at the Raya Blega Street-Rajawali Street intersection in Bangkalan Regency, the following suggestions can be made for further research:

1. It is recommended that further research use more human resources so that more accurate traffic volume data can be obtained.
2. It is recommended to use more than 3 years of LHR data to simplify the data processing using the linear regression method.
3. 3. It is recommended that further research be carried out at the Raya Blega street-Rajawali street intersection in the next 4-5 years, because this intersection is the access point for the southern ring route of Madura Island.

BIBLIOGRAPHY

Adisatria, W., & Djakfar, L. (2015). Manajemen lalu lintas pada kawasan pasar Tanjung. *Jurnal Rekayasa Sipil*, *9*(1), 9.

Ali, M. I., & Abidin, M. R. (2019). Pengaruh kepadatan penduduk terhadap intensitas kemacetan lalu lintas di Kecamatan Rappocini Makassar. *Prosiding Seminar Nasional Lembaga Penelitian Universitas Negeri Makassar*, 68–73.

Anggraini, R. A., Sinaga, Y. E., Lestari, F., Pramita, G., & Kastamto, K. (2022). Evaluasi simpang tak bersinyal dan perencanaan Apill. *JICE (Journal of Infrastructural in Civil Engineering)*, *3*(2), 32. https://doi.org/10.33365/jice.v3i02.2152

Bappenas, Jawa Timur. (2022, Desember 13). Berita Tm Bappenas RI tinjau lokasi lintas selatan Madura di Kabupaten Sampang. Dinas Kominfo Jawa Timur. Retrieved from https://kominfo.jatimprov.go.id/berita/tim-bappenas-ri-tinjau-lokasi-jalan-lintas-selatan-madura-di-kabupaten-sampang

Direktorat Jenderal Bina Marga. (1997). *Manual kapasitas jalan Indonesia, 3860\CHAP1\R-1.WPD 8 Oktober 1996/HA/BH*.

Direktorat Jenderal Bina Marga. (2023). *Pedoman kapasitas jalan Indonesia*. Kementerian PUPR.

Hajia, M. C. (2022). Pengaruh pasar tradisional terhadap arus lalu lintas. *Jurnal Simki Economic, 5*(2), 165–171. https://doi.org/10.29407/jse.v5i2.152

Harisda, R. (2016). Analisis kinerja persimpangan tak berinisiyal (Studi Kasus: Simpang Sisingamaraja dengan Jalan Purnama dan Jalan Sentosa-Meulaboh) (Doctoral dissertation, Universitas Teuku Umar Meulaboh).

Hasibuan, D. Y. F. C., & Muttaqin, M. Z. (2021). Analisis kinerja simpang tak bersinyal persimpangan pasar Sibuhuan, Kabupaten Padang Lawas, Sumatera Utara. *Jurnal Saintis, 21*(1), 53–60. https://doi.org/10.25299/saintis.2021.vol21(01).6507

Herdiyana, I. (2024, April 09). Pengguna jalan tak berakhlak bikin macet jalan raya Blega dan pasar Tanah Merah. *Radar Madura*. Retrieved from https://radarmadura.jawapos.com/bangkalan/744529540/pengguna-jalan-tak-berakhlak-bikin-macet-jalan-raya-blega-dan-pasar-tanah-merah

Lalenoh, R. H., Sendow, T. K., & Jansen, F. (2015). Analisa kapasitas ruas jalan Sam Ratulangi dengan metode MKJI 1997 dan PKJI 2014. *Jurnal Sipil Statik, 3*(11), 737–746.

Lubis, M. (2022). Penerapan manajemen lalu lintas pada pembangunan pasar Sibolga Nauli Kota Sibolga. *Seminar Nasional Teknik (SEMNASTEK) UISU, 5*(1), 181–188.

Maghfiroh, L. (2023). Manajemen dan rekayasa lalu lintas pada jalan simpang tiga Mengkreng Kediri (Undergraduate thesis, UPN "Veteran" Surabaya).

Mu, A. (2019). Pengertian pasar menurut kegiatannya. *Pengertian Pasar Menurut Kegiatannya, 53*(9), 1689–1699.

Mustikarani, W., & Suherdiyanto. (2016). Analisis faktor-faktor penyebab kemacetan lalu lintas di sepanjang Jalan H Rais A Rahman (Sui Jawi) Kota Pontianak. *Jurnal Edukasi, 14*(1), 143–155.

Nabiliansyah, R. (2022). Manajemen lalu lintas di kawasan pasar Kembang Kota Surabaya (Undergraduate thesis, UPN "Veteran" Surabaya).

Ohotan, A., Kumaat, M. M., & Pandey, S. V. (2023). Analisis kinerja simpang tak bersinyal menggunakan metode PKJI 2014. *21*(84).

Prayoga, M. D., Ircham, & Anggorowati, V. D. A. (2020). Analisis daya tampung jalan dan manajemen lalu lintas. *Equilib, 01*(01), 41–52.

Rahadiyan, A. P. (2018). Analisis antrian dan tundaan kendaraan pada simpang tiga bersinyal Jl. Raya Pekayon. Retrieved Juli 2021, from http://repository.unj.ac.id/19/

Sudini, L. P., Amerta, I. M. S., & Pratiwi, N. M. W. (2021). Manajemen lalu lintas di jalan Akasia guna menghindari kemacetan. *Jurnal Abdi Daya, 1*(1), 28–36.

Tamin, O. Z. (n.d.). Hubungan volume. *Jurnal Teknik Sipil, Jurusan Teknik Sipil ITB*, 5, 1–11.

Waris, M. (2022). Analisis kinerja simpang tak bersinyal metode pedoman kapasitas jalan Indonesia 2014. *J-HEST Journal of Health Education Economics Science and Technology, 1*(1), 46–54. https://doi.org/10.36339/jhest.v1i1.20