ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14792203

The Performance of the Pue Bongo Intersection After the Construction of the Pue Bongo Bridge

[1]Reza Rofiz; [2]Arief Setiawan; [3]Ratnasari Ramlan

[1]Department of Civil Engineering, Tadulako University, Palu, Indonesia
[2]Department of Civil Engineering, Tadulako University, Palu, Indonesia
[3]Department of Civil Engineering, Tadulako University, Palu, Indonesia
Corresponding Author Reza Rofiz

Publication Date: 2025/02/04

Abstract: This study was conducted at the Simpang Pue Bongo intersection in Palu City, Central Sulawesi, Indonesia, which underwent geometric changes and alterations in traffic flow due to the construction of the Pue Bongo Bridge. Prior to the bridge's construction, the intersection had three Approaches; however, after the construction, it became four Approaches intersection. The aim of this study was to assess the performance of the Simpang Pue Bongo intersection under both conditions.

The analysis was based on the Pedoman Kapasitas Jalan Indonesia (PKJI) 2023 guidelines, or The Guidelines for Road Capacity in Indonesia, and the research method involved conducting a traffic flow survey over a period of seven days for each condition. The data collected revealed that under the three Approaches condition, the highest peak hour occurred on Thursday, January 18, 2024, from 16:30 to 17:30, with a traffic flow of 1,980 vehicles per hour. For the four approaches condition, the highest peak hour occurred on Thursday, March 7, 2024, from 16:30 to 17:30, with a traffic flow of 2,034.4 vehicles per hour.

The analysis showed that for the three Approaches condition, the intersection's capacity (C) was 2,429.2 vehicles per hour, the saturation degree (DS) was 0.82, and the intersection delay (D) was 13.97 seconds. Under the four Approaches condition, the capacity (C) increased to 3,221.7 vehicles per hour, the saturation degree (DS) decreased to 0.63, and the intersection delay (D) reduced to 11.48 seconds.

The performance results indicated a Level of Service (LoS) of category B, with intersection delay (D) ranging from 5 to 15 seconds per vehicle, based on the Regulation of the Minister of Transportation of the Republic of Indonesia No. 96 of 2015.

Keywords: *Traffic Flow, Performance, Intersection, PKJI 2023, Level of Service.*

How to Cite: Reza Rofiz; Arief Setiawan; Ratnasari Ramlan (2025). The Performance of the Pue Bongo Intersection After the Construction of the Pue Bongo Bridge. *International Journal of Innovative Science and Research Technology*, 10(1), 1601-1608. https://doi.org/10.5281/zenodo.14792203

I. INTRODUCTION

A non-signalized intersection is one of the important elements in the road network system, especially in urban areas. A common phenomenon at non-signalized intersections is congestion and long queues, particularly during peak hours, conflicts between vehicles coming from different directions, aggressive driving behavior in finding gaps, and high delay times for vehicles on minor roads. The efficiency, safety, speed, and level of service of the road network depend on the condition of the intersection [7].

In this regard, one non-signalized intersection that needs to be analyzed is the Pue Bongo four-way intersection. The Pue Bongo intersection is located in the Pengawu subdistrict, Tatanga District, Palu City, and connects four roads: to the east, I Gusti Ngurah Rai Street; to the south, Pue Bongo Street; to the west, Padanjakaya Street; and to the north, Pue Bongo Street. The classification of the road status for these four roads is classified as urban roads, functioning as primary local roads in Palu City according to the Palu City Regional Regulation No. 16 of 2011 [5].

Before the construction of the Pue Bongo Bridge, the intersection was a four approaches intersection with three active approaches and one inactive approach. After the Pue Bongo Bridge was built and opened for use, the Pue Bongo intersection became a four approach intersection with relatively heavy traffic. Therefore, it is necessary to analyze

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14792203

the performance at the Pue Bongo intersection before and after the Pue Bongo Bridge was opened. Performance analysis of this intersection can be conducted using various methods. However, in this study, the method used is the PKJI 2023 method.

II. RESULT AND DISCUSSION

A. *Traffic Flow Data*

Traffic flow data collection was based on survey data obtained in the field, conducted at two different time periods: first during the condition when the Pue Bongo intersection had 3 approaches, and then after the Pue Bongo Bridge was completed and opened, when the intersection had 4 approaches. The surveys were conducted for one day each, on January 18, 2024, and March 7, 2024, from 06:30 to 18:30. The traffic volume data can be seen in Table 1 and Table 2 below :

Table 1: Traffic Volume Data for Pue Bongo Intersection with 3 approaches (January 18, 2024)

No.	Time	Traffic Composition			Total Traffic Volume (vehicles/hour)
		MC	LH	HV	
1	06:30-07:30	453.8	818	28.8	1,300.6
2	07:30-08:30	663.8	908	88.2	1,660.0
3	08:30-09:30	524.8	842	113.4	1,480.2
4	09:30-10:30	474.0	835	158.4	1,467.4
5	10:30-11:30	412.6	816	162.0	1,390.6
6	11:30-12:30	665.4	707	169.2	1,541.6
7	12:30-13:30	451.6	782	174.6	1,408.2
8	13:30-14:30	407.0	859	208.8	1,474.8
9	14:30-15:30	491.8	873	196.2	1,561.0
10	15:30-16:30	603.4	878	219.6	1,701.0
11	16:30-17:30	955.2	816	208.8	1,980.0
12	17:30-18:30	590.2	907	167.4	1,664.6
		6,693.6	**10,041.0**	**1,895.4**	**18,362.2**

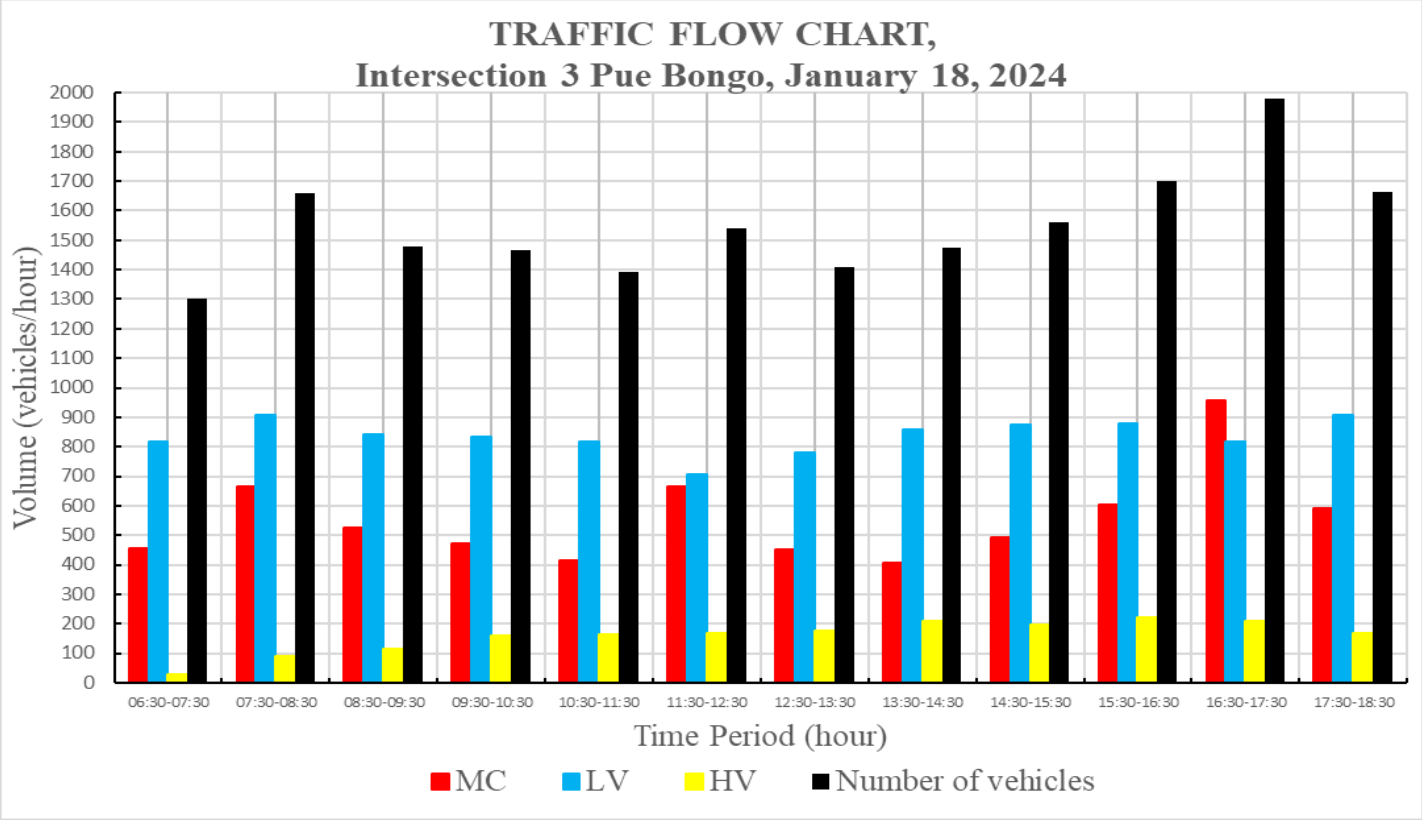

Fig 1: Traffic Volume Graph for Pue Bongo Intersection in the 3 Approaches Condition, January 18, 2024.

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14792203

Table 2: Traffic Volume Data for Pue Bongo Intersection with four approaches (March 7, 2024)

No.	Time	Traffic Composition			Total Traffic Volume (vehicles/hour)
		MC	LH	HV	
1	06:30-07:30	505.8	792	41.4	1,339.2
2	07:30-08:30	687.2	835	99.0	1,621.2
3	08:30-09:30	570.6	776	174.6	1,521.2
4	09:30-10:30	532.6	778	253.8	1,564.4
5	10:30-11:30	480.4	768	262.8	1,511.2
6	11:30-12:30	543.2	830	226.8	1,600.0
7	12:30-13:30	492.0	807	241.2	1,540.2
8	13:30-14:30	469.4	858	273.6	1,601.0
9	14:30-15:30	547.0	852	241.2	1,640.2
10	15:30-16:30	665.8	869	237.6	1,772.4
11	16:30-17:30	809.6	998	226.8	**2,034.4**
12	17:30-18:30	657.0	899	180.0	1,736.0
					19,481.4

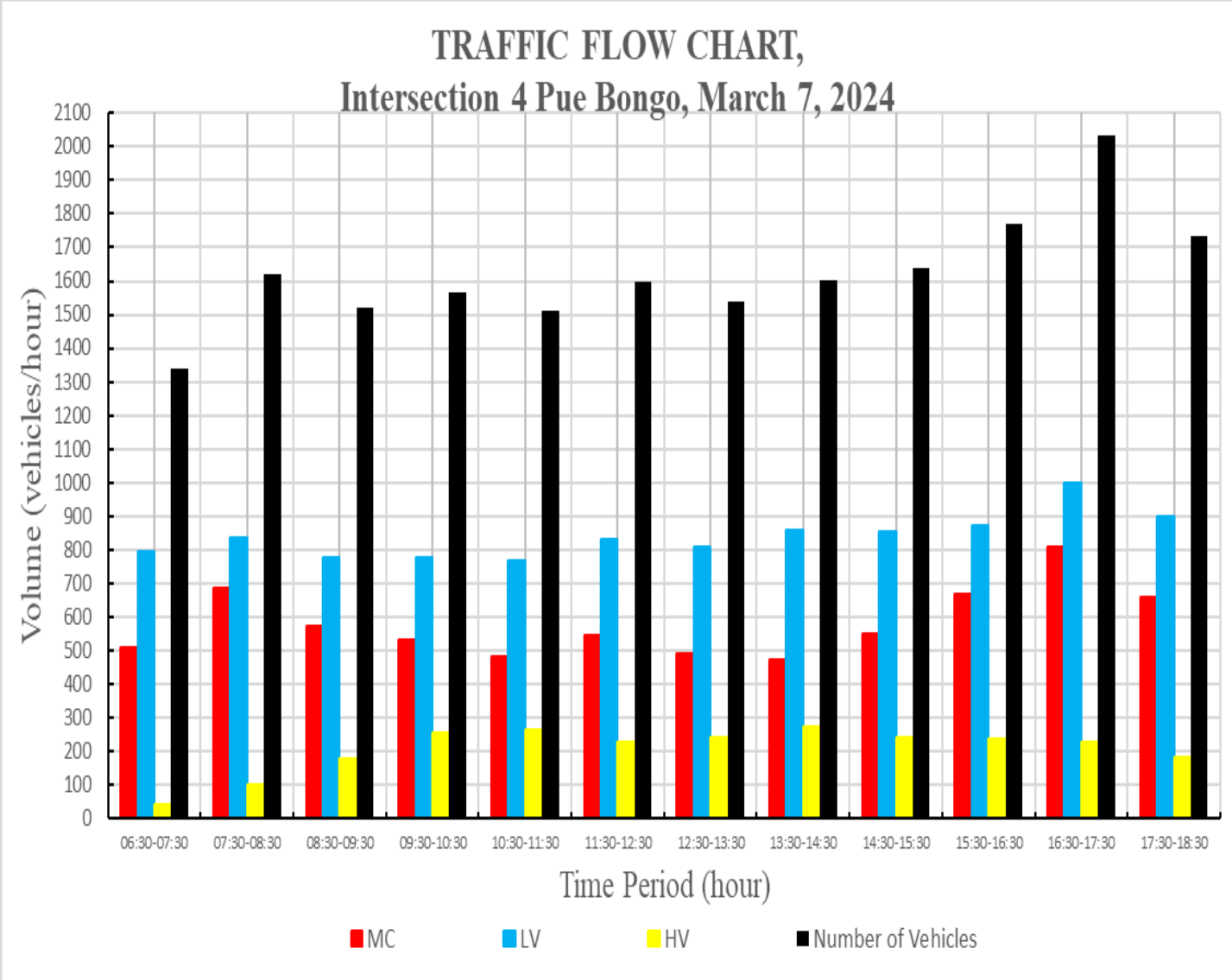

Fig 2: Traffic Volume Graph for Pue Bongo Intersection in the 4 Approaches Condition, March 7, 2024.

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14792203

B. The Data Approach Used

Table 3: The Data Approach Used for Calculating the Performance of Pue Bongo Intersection in the Three Approaches Condition.

Intersection Type	Approach A			Approach B			Approach C			Approach D			Number
	Pue Bongo A St.			I Gusti Ngurah Rai St.			Pue Bongo C St. (Non Active)			Padanjakaya St.			
	L	S	R	L	S	R	L	S	R	L	S	R	
MC	370.2	-	65.0	-	138.4	181.8	-	-	-	62.0	168.4	-	985.8
LV	183.0	-	24.0	-	144.0	276.0	-	-	-	40.0	86.0	-	753.0
HV	28.8	-	3.6	-	79.2	37.8	-	-	-	1.8	90.0		241.2
UM	-	-	-	-	-	-	-	-	-	-	-	-	-
	582.0	-	92.6	-	361.6	495.6	-	-	-	103.8	344.4	-	1,980.0
	674.6			**857.2**			**-**			**448.2**			**1,980.0**
												Q_{TOT} =	**1,980.0**
			674.6										
											Q_{MI} =	**674.6**	
	582.0			-			-			103.8			
											Q_{LT} =	**685.8**	
			92.6			495.6			-			-	
											Q_{RT} =	**588.2**	
						857.2						448.2	
											Q_{MA} =	**1,305.7**	
													-
											Q_{UM} =	**-**	

Table 4: The Data Approach Used for Calculating the Performance of Pue Bongo Intersection in the Four Approaches Condition.

Intersection Type	Approach A			Approach B			Approach C			Approach D			Number
	Pue Bongo A St.			I Gusti Ngurah Rai St.			Pue Bongo C St.			Padanjakaya St.			
	L	S	R	L	S	R	L	S	R	L	S	R	
MC	118.6	123.2	45.8	11.2	97.0	90.0	41.6	90.8	10.4	47.0	87.2	46.8	809.6
LV	185.0	117.0	47.0	12.0	108.0	153.0	39.0	118.0	9.0	45.0	122.0	43.0	998.0
HV	21.6	25.2	5.4	-	7.2	30.6	61.2	18.0	-	3.6	28.8	25.2	226.8
UM	-	-	-	-	-	-	-	-	-	-	-	-	-
	325.2	265.4	98.2	23.2	212.2	273.6	141.8	226.8	19.4	95.6	238.0	115.0	2,034.4
	688.8			**509.0**			**388.0**			**448.6**			**2,034.4**
												Q_{TOT} =	**2,034.4**
			688.8						388.0				
											Q_{MI} =	**1,076.8**	
	325.2			23.2			141.8			95.6			
											Q_{LT} =	**585.8**	
			98.2			273.6			19.4			115.0	
											Q_{RT} =	**506.2**	
						509.0						448.6	
											Q_{MA} =	**957.6**	
													-
											Q_{UM}	**-**	

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14792203

The PKJI 2023 Formula Used [2] :

(1) Minor Road Flow Ratio (P_{MI})

$P_{MI} = Q_{MI} / Q_{TOT}$

(2) Total Turning Movement Ratio (P_T)

$P_T = P_{LT} + P_{RT}$

(3) Left Turn Movement Ratio (P_{LT})

$P_{LT} = Q_{LT} / Q_{TOT}$

(4) Right Turn Movement Ratio (P_{RT})

$P_{RT} = Q_{RT} / Q_{TOT}$

(5) Calculation of the ratio between the flow of non-motorized and motorized vehicles (P_{UM})

$P_{UM} = Q_{UM} / Q_{TOT}$

Table 5: Number of Lanes and Average approaches Widths for Minor and Major Approach

Average Width of the Major Approach (W_{AB}) and Minor (W_C)	Number of Lane (Total for both directions)
$W_A = (a/2)/2 < 5,5$	2
$\geq 5,5$	4
$W_{BD} = (b/2+d/2)/2 < 5,5$	2
$\geq 5,5$	4

Source: PKJI 2023 [2]

(6) Approach Width (W_I)

$$W_I = \frac{W_{BD} + W_A}{2}$$

Table 6: Basic Capacity by Intersection Type

Intersection Type	Basic Capacity (vehicle/hour)
322	2,700
342	2,900
324 or 344	3,200
422	2,900
424 or 444	3,400

Source: PKJI 2023 [2]

(7) Approach Width Correction Factor (F_W)

$F_W = 0,73 + 0,0760\ W_i$

Table 7: Main Road Median Correction Factor

Description	Type Median	Median Correction Factor (F_M)
No main road median	None	1,00
A main road median, width < 3 m	Narrow	1,05
A main road median, width > 3 m	Width	1,20

Source: PKJI 2023 [2]

(8) City Size Correction Factor (F_{CS})

Table 8 : City Size Correction Factor (F_{CS})

City Size (CS)	Population (million)	City Size Correction Factor (F_{CS})
Very Small	< 0,1	0,82
Small	0,1 – 0,5	0,88
Medium	0,5 – 1,0	0,94
Large	1,0 – 3,0	1,00
Very Large	> 3,0	1,05

Source: PKJI 2023 [2]

(9) Correction Factor for Road Environment Type, Lateral Obstacles, and Non-Motorized Vehicles (F_{RSU})

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14792203

Table 9 : Correction Factor for Road Environment Type, Lateral Obstacles, and Non-Motorized Vehicles (F_{RSU})

Road Environment Type Class (RE)	Roadside Obstacles Class (SF)	Non-Motorized Vehicle Ratio (P_{UM})					
		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
	Medium	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
	Medium	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
Akses terbatas	High/Medium/Low	1,00	0,95	0,90	0,85	0,80	0,075

Source: PKJI 2023 [2]

(10) Left Turn Correction Factor (F_{LT})

$F_{LT} = 0,84 + 1,61\ P_{LT}$

(11) The Right Turn Correction Factor is a correction factor for the percentage of all traffic movements that make a right turn at the intersection.

$F_{RT} = 1,09 – 0,922\ P_{RT}$

(12) Minor Road Flow Ratio Correction Factor (F_{MI})

Table 10 : Minor Road Flow Ratio Correction Factor (F_{MI})

Intersection Type	F_{MI}	P_{MI}
422	$1,19 \times R_{mi}^2 – 1,19 \times R_{mi} + 1,19$	0,1 – 0,9
424 dan 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
	$1,11 \times R_{mi}^2 – 1,11 \times R_{mi} + 1,11$	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 dan 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: PKJI 2023 [2]

$F_{MI} = 1,19 \times P_{MI}^2 - 1,19 \times P_{MI} + 1,19$

(13) Capacity (C)

$C = C_O \times F_W \times F_M \times F_{CS} \times F_{RSU} \times F_{LT} \times F_{RT} \times F_{MI}$

(14) Degree of Saturation (DS)

$DS = Q_{TOT}$ (vehicles/hour) / C (vehicles/hour)

(15) Intersection Delay (D)

(15.1) Intersection Traffic Delay (D_{TI})

$DT_I = 2 + 8,2078 \times DS – (1 – DS) \times 2$, if DS < 0,6, or

$DT_I = (1,0504 / (0,2742-(0,2042 \times DS)) – ((1-DS) \times 2)$, if DS > 0,6

(15.2) Main Road Traffic Delay (DT_{MA})

$DT_{MA} = 1,8 + 5,8234 \times DS - (1 – DS) \times 1,8$ if DS <, 0,6

$DT_{MA} = 1,05034 / (0,346-0,246 \times DS) - (1-DS) \times 1,8$ if DS > 0,6

(15.3) Minor Road Traffic Delay (DT_{MI})

$DT_{MI} = ((Q_{TOT} \times DT_I) – (Q_{MA} \times DT_{MA})) / Q_{MI}$

(16) Geometric Delay at the Intersection (DG)

If DS ≥ 1,0, then DG = 4 s/vehicles

If DS ≤1,0, then DG Calculated based on the formula :

$DG = ((1-DS) \times ((P_T \times 6) + (1 - P_T) + 3)) + (DS \times 4)$

(17) Intersection Delay (D)

$D = DG + DT_I$

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14792203

(18) Queueing Probability

(18.1) Upper limit
QP% = (47,71 x DS) – (24,68 x DS^2) + (56,47 x DS^3)

(18.2) Lower limit
QP% = (9,02 x DS) + (20,66 x DS^2) + (10,49 x DS^3)

C. Approach Width and Intersection Type

The approach width for the minor and major roads is obtained from field surveys. The intersection type indicates the number of approaches of the intersection and the number of approaches on the major and minor roads. The approach width and intersection type can be seen in Table 11, Figure 3 and Figure 4.

Table 11 : Approaches Width and Intersection Type

Number of Approach	Approach Width							Number of Lanes		Intersection Type
	Minor Street			Mayor Street			Average Approach Width	Minor Street	Street Mayor	
	WA	WC	WAC/2	WB	WD	WBD/2				
3	2.5	-	-	5	3.75	4.375	3.43	2	2	322
4	5	3.75	4.375	5	5	5	4.69	2	2	422

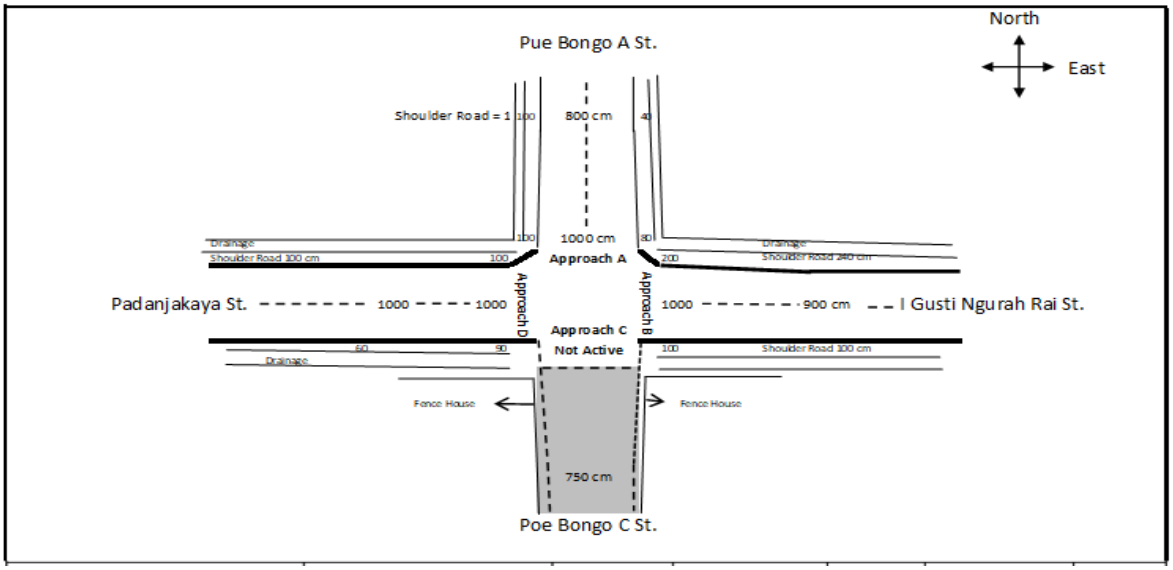

Fig 3: Intersection of Pue Bongo with an active 3 approaches condition (Intersection Type 322)

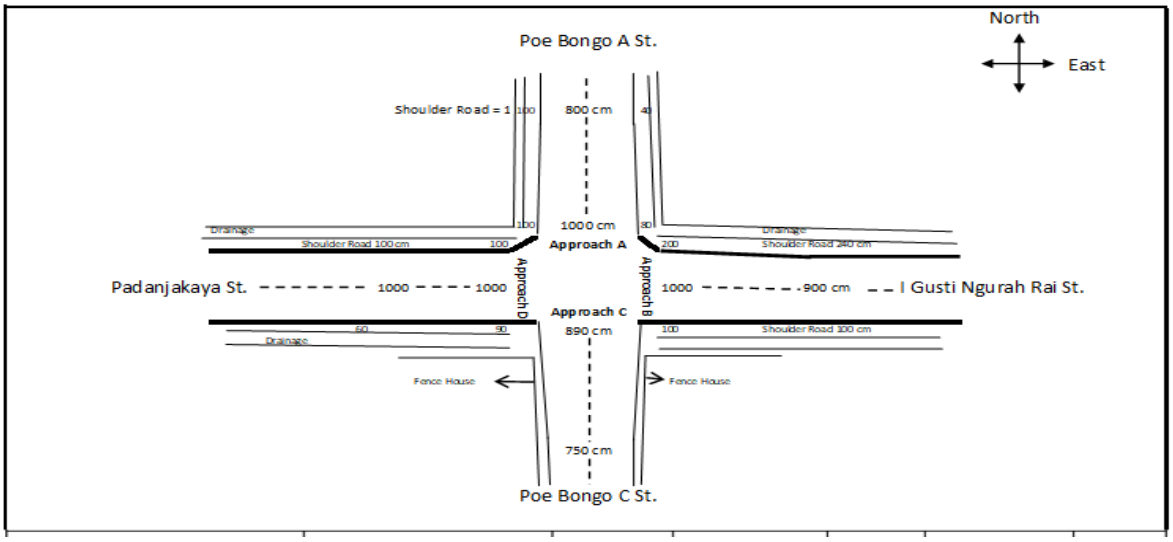

Fig 4: Intersection of Pue Bongo with an active 4 approaches condition (Intersection Type 422)

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14792203

D. Intersection Capacity and Correction Factor

The following is a summary of the intersection capacity and correction factors in Table 12.

Table 12 : Intersection Capacity

Day, Date	Number of Approach	C_O (vehicles/ hour)	F_W	F_M	F_{CS}	F_{RSU}	F_{LT}	F_{RT}	F_{MI}	C (vehicles /hour)
Thursday, 18/01/2024	3	2,700	0.991	1.00	0.88	0.98	1.40	0.82	0.92	2,429.2
Thursday, 07/03/2024	4	2,900	1.106	1.00	0.88	0.98	1.30	1.00	0.89	3,221.7

E. Performance of Unsignalized Intersection

The following is a summary of the data presented in Table 13.

Table 13 : Capacity of Unsignalized Intersection

Day, Date	Q (vehicles/ hour)	DS Qtot/C	D_{Ti} (second)	DT_{MA} second	DT_{MI} (second)	DG (Second/ vehicle)	D (Second/ vehicle)	QP (%)
Thursday, 18/01/2024	1,980.0	0.82	9.38	6.89	14.2	4.59	13.97	26.76 – 53.07
Thursday, 07/03/2024	2,034.4	0.63	6.49	4.85	7.96	4.99	11,48	16.58 - 34.51

Based on the calculations for the unsignalized intersection above, the Degree of Saturation (Ds) value is 0.82 for the intersection with 3 approaches and 0.63 for the intersection with 4 approaches. Based on these results, the value of DS meets the requirements of PKJI 2023 for unsignalized intersections [2], both for the 3-approaches and 4-approaches conditions, where DS < 0.85

III. CONCLUSION

Based on the results of the research, the performance of the Pue Bongo Unsignalized Intersection when the 3-lanes condition before the Pue Bongo bridge was built, obtained a Capacity value (C) of 2,429.2 vehicles/hour, Degree of Saturation (DS) 0.82 and Delay Time (D) 13.97 seconds/vehicle, so that it entered the Level of Service (LoS) category B, and the Performance of the Pue Bongo Unsignalized Intersection when the 4-lanes condition after the Pue Bongo bridge was built and used, obtained a Capacity value (C) 3,221.7 vehicles/hour, Degree of Saturation (DS) 0.63 and Delay Time (D) 11.48 seconds/vehicle, so that it enters Level of Service (LoS) category B, namely Delay Time (D) between 5 - 15 seconds/vehicles based on the Regulation of the Minister of Transportation of the Republic of Indonesia No. 96 of 2015 [6].

REFERENCES

[1]. Abdul Malik Jayazi, dkk. (2022). Analisis Kinerja Simpang Tak Bersinyal (Studi Kasus Simpang 4 Paok Motong Kabupaten Lombok Timur). Mataram, Universitas Islam Al Azhar Mataram Indonesia.Bina Jalan Kota, Jakarta.

[2]. Direktorat Jenderal Bina Marga. (2023). Pedoman Kapasitas Jalan Indonesia (PKJI).Jakarta, Direktorat Bina Jalan Kota, Jakarta. pp. 129 – 152.

[3]. Dwi Bussaina Ghassani, dkk. (2021). Analisa Kinerja Simpang Tak Bersinyal Akibat Hambatan Samping (Studi Kasus: Simpang Tiga Tak Bersinyal Jalan Kyai H. Asyari - Jalan Raya Boja Kaliwungu). Kendal, Universitas Selamat Sri.

[4]. Milawaty Waris. (2018). Analisis Kinerja Simpang Tak Bersinyal Metode Pedoman Kapasitas Jalan Indonesia 2014. Majene, Universitas Sulawesi Barat.

[5]. Peraturan Daerah Kota Palu No. 16. (2011). Tentang Rencana Tata Ruang Wilayah Kota Palu tahun 2010 - 2030. Palu, Walikota Palu. pp. 13 – 14.

[6]. Peraturan Menteri Perhubungan Republik Indonesia Nomor PM 96 (2015), Pedoman Pelaksanaan Kegiatan Manajemen dan Rekayasa Lalu Lintas. Jakarta, Kementerian Perhubungan Republik Indonesia. pp.17.

[7]. Tamin. (2000). Perencanaan dan Pemodelan Transportasi. Edisi Kedua. Bandung: ITB.

[8]. Yuni Rizna. (2020). Evaluasi Kinerja Lalu Lintas Pada Simpang Tiga Kreongan Jember. Jember, Universitas Muhammadiyah Jember.