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Analysis of Signalized Intersection Performance and Road Performance on TB Simatupang Road – Condet Raya Road, East Jakarta Using PKJI 2023

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Abstract— *The TB Simatupang Signalized Intersection is a three-arm signalized intersection connecting Jalan TB Simatupang towards Pasar Rebo and Tanjung Barat with Jalan Raya Condet. The author's observations indicate that this intersection frequently experiences congestion during rush hour due to the high volume of passing vehicles exceeding the existing capacity of Jalan TB Simatupang, resulting in long queues. The purpose of this study is to analyze the performance of the signalized intersection and the performance of Jalan TB Simatupang - Jalan Raya Condet, East Jakarta, and to propose alternative solutions to improve the level of service at this intersection. Using calculations based on the 2023 Indonesian Road Capacity Guidelines (PKJI 2023), the traffic counter technique is the method of analysis used. The research results include the existing saturation level, queue level, average intersection delay and alternative solution to improve intersection level of service.*

Keywords— *Signalized Intersections, Indonesian Road Capacity Guidelines 2023, Degree of Saturation, Queue Length, Delay, Level of Service*

I. INTRODUCTION

Indonesia is one of the most populous countries in the world, ranking fourth globally with a population of approximately 275 million people. This population growth has had a direct impact on the increase in the number of vehicles, which in turn has led to traffic congestion in various major cities across the country, particularly in the Special Capital Region of Jakarta (Isradi et al. 2021).

According to the 2020 Indonesian Population Census, the area with the highest population within DKI Jakarta is East Jakarta Administrative City, with a population of 3,351,114 people, accounting for approximately 27.94% of the total population of DKI Jakarta. Alongside the population growth, transportation activity has also increased, resulting in road overcapacity in the area (BPS-West Java 2020)

The intersection in question is a signalized T-junction that integrates traffic flow from three directions connected to TB Simatupang Street and Condet Main Road (Isradi et al. 2022). Based on the author's observations, this intersection frequently experiences congestion during peak hours due to the high volume of vehicles exceeding the capacity of the roadway on TB Simatupang Street, leading to long queues (Delpiano 2021).

II. RESEARCH METHODOLOGY

A. Research Location

The selected location experiences a high volume of traffic on both the road segment and the intersection, primarily due to the diverse land use in the area, which includes educational institutions, office buildings, public facilities, and residential zones (Firdaus et al. 2021, 2025).

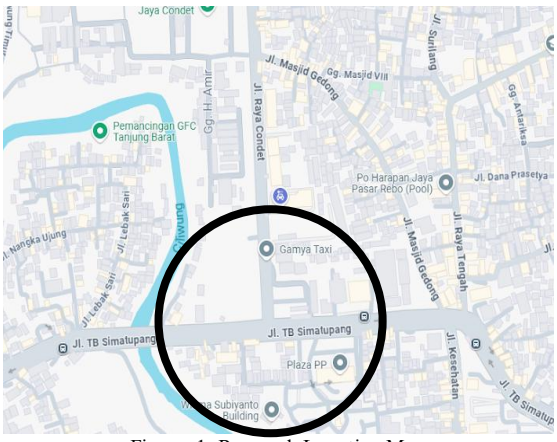

Figure. 1. Research Location Map
Source: Google Maps

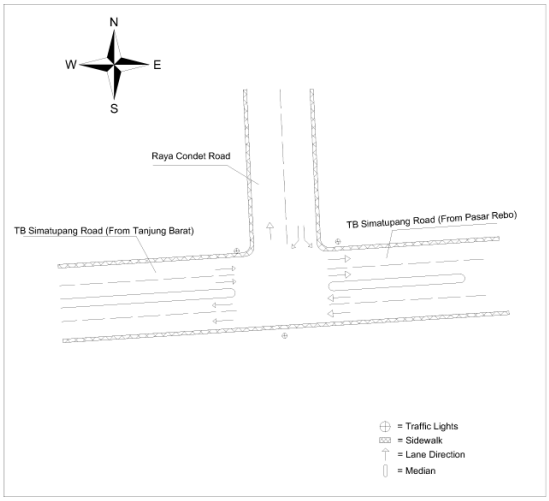

Figure 2. Research Location Sketch
Source: Data Processing by Author

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B. Research Stages

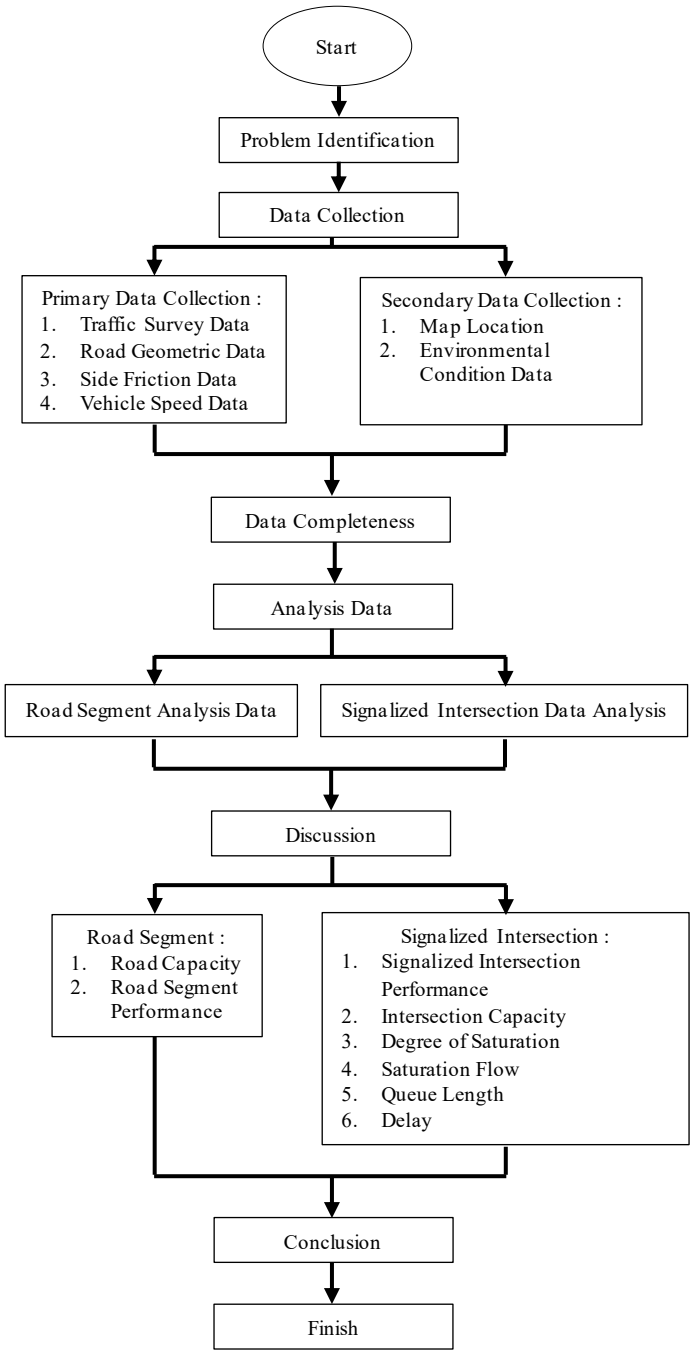

Figure 3. Research Flowchart
Source: Data Processing by Author

Based on the flowchart presented above, it can be stated that the process in this research (Mishra et al. 2023):

1. Start – This stage follows the background preparation, problem formulation, research objectives and benefits, and the collection of all references related to the study.
2. Problem Identification – This stage identify the main problem of traffic congestion on TB Simatupang Road – Raya Condet Road.
3. Primary Data Collection – This stage involves surveying the research site to gather data on traffic volume, road geometry, side friction, and vehicle speed (Schurr et al. 2000).
4. Secondary Data Collection – This stage involves using the internet and Google Maps applications to obtain location data.
5. Data Processing – The analysis of the road segment consist of evaluating road performance, road capacity, and traffic performance (Isradi et al. 2020).
6. Signalized Intersection Analysis – The analysis of the signalized intersection includes assessing intersection performance, intersection capacity, degree of saturation, saturated flow, delays, and queue probability.
7. Conclusion – Afer the analysis is completed, conclusions are drawn based on the findings from the research discussion, along with recommendations that complement the existing study.

III. Results and Discussion

A. Existing Condition

Regional Condition

The geographical coordinates of East Jakarta Administrative City, which is one of the districts in DKI Jakarta Province, are 106°49'35" East Longitude and 06°10'37" South Latitude. About 28.39% of DKI Jakarta's land area is made up of East Jakarta, which is 188.03 km^2. The city is home to 10 subdistrict offices and 65 village offices. The population of East Jakarta is 3,315,114 people. Refer to the table below for the population details of each street.

Land Use Management

The land use at the intersection connecting TB Simatupang Road and Condet Main Road is as follows:

1. The northern leg of the intersection, namely Condet Main Road, is classified as commercial (COM). This is due to the presence of office buildings and an elementary school in the northern area.
2. The eastern leg of the intersection, namely TB Simatupang Road from the direction of Pasar Rebo, is classified as commercial (COM). This is because the eastern area is characterized by office buildings and retail shops.
3. The western leg of the intersection, namely TB Simatupang Road from the direction of Tanjung Barat, is classified as commercial (COM). This is due to the presence of retail stores with direct vehicle access along the western side.

Geometric Intersection

TABLE 1. Geometric Intersection Data

Leg Intersect-ion	Leg Width				
	Width (m)	Entry Width	Left turn lane width for continuous movement	Straight - through lane	Exit Width
North	3,6	3,6	1,1	-	7,2
West	7,2	3,6	3,6	-	7,2
East	7,2	3,6	-	3,6	7,2

Source: Traffic Survey

Traffic Volume

The traffic data in this final project were obtained from field surveys conducted on weekdays (Monday), weekdays/holidays

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(Saturday), and holidays (Sunday) during peak hours by counting the number of vehicles over two-hour intervals, with 15-minute increments in the morning and afternoon.

TABLE 2. Traffic Data Volume (vehicle/hour) Monday

Period (Monday)	Volume (Vehicle/Hour)			
	North	West	East	Total (vehicle/hour)
07.00-08.00	648	4002	4377	9027
07.15-08.15	612	3927	4254	8793
07.30-08.30	605	3997	4132	8734
07.45-08.45	603	3911	4025	8539
08.00-09.00	572	3855	3910	8336
16.00-17.00	941	4823	5894	11658
16.15-17.15	941	5303	5631	11875
16.30-17.30	923	5596	5393	11912
16.45-17.45	917	5834	5396	12147
17.00-18.00	920	5782	5535	12237

Source: Traffic Survey

TABLE 3. Traffic Data Volume (vehicle/hour) Saturday

Period (Saturday)	Volume (Vehicle/Hour)			
	North	West	East	Total (vehicle/hour)
07.00-08.00	329	5223	3090	8642
07.15-08.15	324	5197	2981	8502
07.30-08.30	319	5095	3025	8439
07.45-08.45	321	5027	3064	8411
08.00-09.00	327	5175	2945	8448
16.00-17.00	222	3195	2687	6104
16.15-17.15	207	3088	2769	6064
16.30-17.30	196	2996	2766	5958
16.45-17.45	204	2982	2912	6098
17.00-18.00	210	3009	2944	6163

Source: Traffic Survey

TABLE 4. Traffic Data Volume (vehicle/hour) Sunday

Period (Saturday)	Volume (Vehicle/Hour)			
	North	West	East	Total (vehicle/hour)
07.00-08.00	163	3112	2833	6108
07.15-08.15	148	3075	2738	5960
07.30-08.30	151	2984	2641	5774
07.45-08.45	153	2885	2558	5591
08.00-09.00	145	2766	2463	5374
16.00-17.00	326	5209	2755	8291
16.15-17.15	322	5159	2651	8132
16.30-17.30	316	5070	2706	8092
16.45-17.45	308	4986	2717	8011
17.00-18.00	315	5088	2659	8062

Source: Traffic Survey

Based on the table above, the highest traffic volumes (vehicles/hour) were recorded on Monday during the 17:00–18:00 period, on Saturday during the 07:00–08:00 period, and on Sunday during the 16:00–17:00 period.

Cycle Time

The observation and recording survey of the traffic signal cycle at the intersection of Condet Main Road and TB Simatupang Road was conducted to obtain data and information regarding the operational signal times at the intersection under existing conditions. The data collected include the number of signal phases, duration of the green light, red light, all-red light, inter-green time, yellow light duration, and other relevant information required for analysis (Adipradhana et al. 2024).

TABLE 5. Morning Rush Hour Cycle Time Table

No	Road Name	Light				Cycle Time
		Red	Yellow	Green	All Red	
1	Raya Condet Road (North)	78	3	20	4	105
2	TB Simatupang Road (West)	70	3	32	4	
3	TB Simatupang Road (East)	70	3	32	4	

Source: Traffic Survey

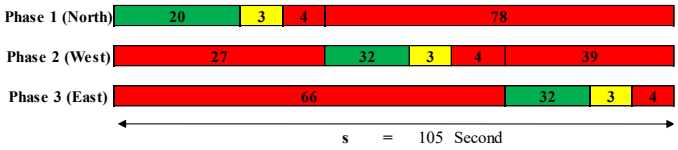


Figure 4. Morning Rush Hour Cycle Time Table

Source: Traffic Survey

TABLE 6. Afternoon Rush Hour Cycle Time Table

No	Road Name	Light				Cycle Time
		Red	Yellow	Green	All Red	
1	Raya Condet Road (North)	78	3	20	4	105
2	TB Simatupang Road (West)	70	3	32	4	
3	TB Simatupang Road (East)	70	3	32	4	

Source: Traffic Survey

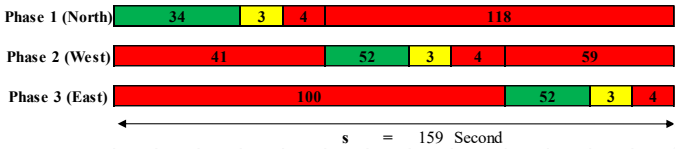
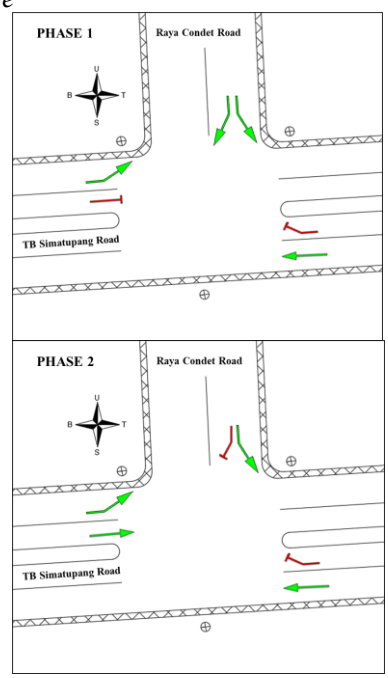


Figure 5. Afternoon Rush Hour Cycle Time Table

Source: Traffic Survey

Traffic Phase



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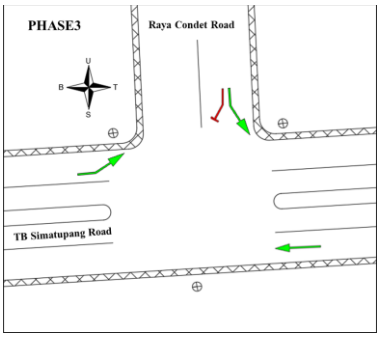

Figure 6. First, Second, and Third Phase of Raya Condet Road – TB Simatupang Road Intersection

Source: Traffic Survey

B. Signalized Intersection Performance

Base Saturation Flow Rate

The base saturation flow at the Raya Condet Road – TB Simatupang Road intersection was estimated based on the number of vehicles crossing the stop line, which were then converted into passenger car unit (smp). At Raya Condet Road (North) and TB Simatupang Road (West), where left-turn movements are allowed without signals (LBKiJT), the effective number of lanes (LE) is calculated using the formula LE = L – LBKiJT. In contrast, at Jl. TB Simatupang (East), where no unsignalized left-turns are present, the effective number of lanes is defined as LE = LM.

1. Base Saturation Flow (North)
   LE = L – LBKiJT = 3,6 m – 1,1 m = 2,5 m
   Jo = 600 x 2,5 m = 1500 smp / hour (Protected Approach Type)
2. Base Saturation Flow (West)
   LE = L – LBKiJT = 7,2 m – 2,5 m = 4,7 m
   Jo = 600 x 4,7 m = 2820 smp / hour (Protected Approach Type)
3. Base Saturation Flow (East)
   LE = LM = 3,6 m
   Jo = 600 x 3,6 m = 2160 smp / hour (Protected Approach Type)

Determination of Saturation Flow

The adjusted saturation flow rate is calculated using the following formula (Direktorat Jendral Bina Marga 2023):
J = J0 × FHS × FUK × FG × FP × FBKi × FBKa

TABLE 7. Calculation of Saturation Flow Rate on Monday, June 9, 2025 (17:00–18:00)

Approach Code	Green Time in phase -	Vehicle turn ratio			Turn Right Flow		Effective width	Saturation Flow		Traffic Flow
		R_{BKiJT}	R_{BKi}	R_{BKa}	from the observed direction	from the opposite direction	L_E	Base saturation flow J0	Adjusted Saturation Flow J	q
					SMP/hour	SMP/hour	m	SMP/hour	SMP/hour	SMP/hour
(1)	(2)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(17)	(18)
U	1	0,476	0,48	0,52			2,50	1500	1293	161
B	2	0,459	0,459	0,00			4,7	2820	2606	783
T	3	0,000	0,00	0,45			3,6	2160	1904	700

Source : Data Processing by Author

Flow Ratio

The calculation for the North, East, and West approaches during the evening peak hour is as follows:
Rq/J (North) = 161 / 1500 = 0,125
Rq/J (West) = 783 / 2820 = 0,300
Rq/J (East) = 700 / 2160 = 0,368

Based on the above flow ratio results, the Phase Ratio (RF) is obtained as follows:

$$R_F \text{ (North)} = \frac{0,125}{0,125 + 0,300 + 0,368} = \frac{0,125}{0,793} = 0,157$$

$$R_F \text{ (West)} = \frac{0,300}{0,125 + 0,300 + 0,368} = \frac{0,300}{0,793} = 0,379$$

$$R_F \text{ (East)} = \frac{0,368}{0,125 + 0,300 + 0,368} = \frac{0,368}{0,793} = 0,464$$

Capacity and Saturation Degree

The capacity is calculated using the following formula:

$$C \text{ (North)} = 1293\ x\ \frac{34}{159} = 276 \text{ vehicle/hour}$$

$$C \text{ (West)} = 2606\ x\ \frac{52}{159} = 852 \text{ vehicle/hour}$$

$$C \text{ (East)} = 1904\ x\ \frac{52}{159} = 623 \text{ vehicle/hour}$$

The degree of saturation is calculated using the following formula:

$$Dj \text{ (North)} = \frac{161}{276} = 0,583$$

$$Dj \text{ (West)} = \frac{783}{852} = 0,919$$

$$Dj \text{ (East)} = \frac{700}{623} = 1,124$$

Queue Length

The number of remaining passenger car units (smp) in the queue from the previous green phase (NQ1) can be calculated using the following formula:

$$If\ D_J > 0,5\ therefore\ N_{q1} = 0,25 \times s \times \left\{(D_J - 1) + \sqrt{(D_J - 1)^2 + \frac{8 \times (D_J - 0,5)}{s}}\right\}$$

$$If\ D_J \leq 0,5\ therefore\ N_{q1} = 0$$

Using the above formula, the NQ1 value for each approach is obtained as follows :

$$N_{q1(North)} = 0,25 \times 159 \times \left\{(0,583 - 1) + \sqrt{(0,583 - 1)^2 + \frac{8 \times (0,583 - 0,5)}{159}}\right\}$$

$$N_{q1(North)} = 0,198\ smp$$

$$N_{q1(West)} = 0,25 \times 159 \times \left\{(0,919 - 1) + \sqrt{(0,919 - 1)^2 + \frac{8 \times (0,919 - 0,5)}{159}}\right\}$$

$$N_{q1(West)} = 3,383\ smp$$

$$N_{q1(East)} = 0,25 \times 159 \times \left\{(1,124 - 1) + \sqrt{(1,124 - 1)^2 + \frac{8 \times (1,124 - 0,5)}{159}}\right\}$$

$$N_{q1(East)} = 13,555\ smp$$

Subsequently, NQ2 is calculated using the following formula:

$$N_{q2} = s \times \frac{(1 - RH)}{(1 - RH \times DJ)} \times \frac{q}{3600}$$

Based on the above equation, the NQ2 values for each approach are calculated as follows:

$$N_{q2\ (North)} = 159 \times \frac{(1 - 0,327)}{(1 - 0,327 \times 0,583)} \times \frac{161}{3600} = 5,917\ smp$$

$$N_{q2\ (West)} = 159 \times \frac{(1 - 0,5)}{(1 - 0,5 \times 0,919)} \times \frac{783}{3600} = 31,990\ smp$$

$$N_{q2\ (East)} = 159 \times \frac{(1 - 0,5)}{(1 - 0,5 \times 1,124)} \times \frac{700}{3600} = 35,327\ smp$$

Accordingly, the total number of queued vehicles during the evening peak period is determined using the following equation:
N_q (North) = N_{q1} + N_{q2} = 0,198 + 5,917 = 6,114 smp

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N_q (West) = $N_{q1} + N_{q2}$ = 3,383 + 31,99 = 35,374 smp
N_q (East) = $N_{q1} + N_{q2}$ = 13,555 + 35,327 = 48,882 smp
The queue lengths for the North, East, and West approaches during the Monday evening peak hour can be calculated using the following formula:

P_A (North) = $N_q \times \frac{20}{L_M}$ = 6,114 × $\frac{20}{3,6}$ = 33,97 m

P_A (West) = $N_q \times \frac{20}{L_M}$ = 35,374 × $\frac{20}{3,6}$ = 196,52 m

P_A (East) = $N_q \times \frac{20}{L_M}$ = 48,882 × $\frac{20}{3,6}$ = 271,57 m

Stopped Vehicle Ratio

R_{KH} (North) = $0,9 \times \frac{N_q}{q \times s} \times 3600 = 0,9 \times \frac{6,114}{161 \times 159} = 0,773\ stop/smp$

R_{KH} (West) = $0,9 \times \frac{N_q}{q \times s} \times 3600 = 0,9 \times \frac{35,374}{783 \times 159} = 0,920\ stop/smp$

R_{KH} (East) = $0,9 \times \frac{N_q}{q \times s} \times 3600 = 0,9 \times \frac{48,882}{700 \times 159} = 1,422\ stop/smp$

Total Stopped Vehicle

N_{KH} (N) = $q \times R_{KH} = 161 \times 0,773 = 124,59\ smp/hour$
N_{KH} (W) = $q \times R_{KH} = 783 \times 0,920 = 720,82\ smp/hour$
N_{KH} (E) = $q \times R_{KH} = 700 \times 1,422 = 996,09\ smp/hour$

Total Stopped Vehicle

Average Traffic Delay:

$T_{LL}(North) = s \times \frac{0,5 \times (1-R_H)^2}{(1-R_H \times D_J)} + \frac{N_{q1} \times 3600}{C} = 159 \times \frac{0,5 \times (1-0,327)^2}{(1-0,327 \times 0,583)} + \frac{0,198 \times 3600}{276}$
$T_{LL}(North) = 47,069\ sec/smp$

$T_{LL}(West) = s \times \frac{0,5 \times (1-R_H)^2}{(1-R_H \times D_J)} + \frac{N_{q1} \times 3600}{C} = 159 \times \frac{0,5 \times (1-0,5)^2}{(1-0,5 \times 0,919)} + \frac{3,383 \times 3600}{852}$
$T_{LL}(West) = 51,055\ sec/smp$

$T_{LL}(East) = s \times \frac{0,5 \times (1-R_H)^2}{(1-R_H \times D_J)} + \frac{N_{q1} \times 3600}{C} = 159 \times \frac{0,5 \times (1-0,5)^2}{(1-0,5 \times 1,124)} + \frac{13,555 \times 3600}{623}$
$T_{LL}(East) = 123,753\ sec/smp$

Average Geometric Delay:

$T_G = (1 - R_{KH}) \times P_B \times 6 + (R_{KH} \times 4)$
$T_G(North) = (1 - 0,773) \times 0,52 \times 6 + (0,773 \times 4) = 3,806\ sec/smp$
$T_G(West) = (1 - 0,920) \times 0,459 \times 6 + (0,920 \times 4) = 3,901\ sec/smp$
$T_G(East) = (1 - 1,422) \times 0,45 \times 6 + (1,422 \times 4) = 4,557\ sec/smp$

Average Delay:

T (N) = 47,069 + 3,806 = 50,875 *sec/smp*
T (W) = 51,055 + 3,901 = 54,956 *sec/smp*
T (E) = 123,753 + 4,557 = 128,310 *sec/smp*

Based on the average delay value, the total delay is obtained as follows:

T_{Tot} (N) = 161 x 50,875 = 8195,99 *second*
T_{Tot} (W) = 783 x 54,956 = 43037,39 *second*
T_{Tot} (E) = 700 x 128,310 = 89857,67 *second*

Average Intersection Delay:

$T_I = \frac{\sum(q \times T)}{qTotal} = \frac{141091,05}{1645}$ = 85,79 *sec/smp*

Level Of Service (LOS)

The Level of Service (LOS) at the intersection is determined based on the average delay values observed at each approach and for the intersection as a whole. Based on the calculation results, the average delay is found to be 85.79 seconds per passenger car unit (smp). Referring to the Regulation of the Minister of Transportation of the Republic of Indonesia No. PM 96 of 2015 concerning Guidelines for the Implementation of Traffic Management and Engineering Activities, the Raya Condet Road – TB Simatupang Road intersection is classified as operating at Level of Service F, as the average delay exceeds 60 seconds per vehicle.

C. Road Performance

The performance analysis of the road segment focuses on the eastern approach of TB Simatupang Road. TB Simatupang Road is classified as a type 4/2-T roadway. This route is equipped with pedestrian facilities in the form of sidewalks on both sides. The road passes through a commercial area consisting of office buildings and retail shops along both the right and left sides. The roadside friction along this route is classified as moderate, primarily due to vehicles entering and exiting office areas and public transportation vehicles stopping along the road.

TB Simatupang Road Geometric (East)

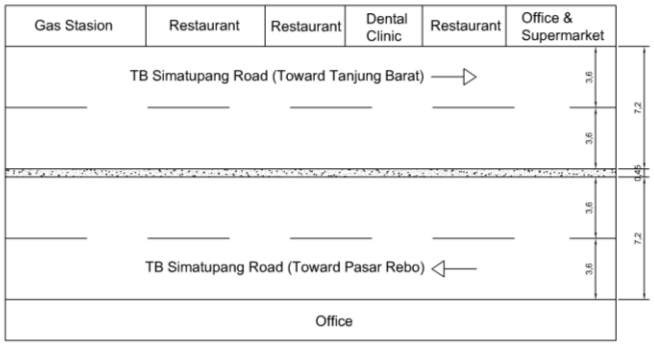

Figure 7. Geometric Layout – Top View of TB Simatupang Road (East)
Source : Survey Result 2025

Traffic Volume Data on TB Simatupang Road (East)

TABLE 8. Traffic Volume (Veh/hour) on TB Simatupang Road (Eastern Approach) Toward Tanjung Barat

Monday, 09 June 2025			
Toward Tanjung Barat (vehicle/hour)			
Period	**MP**	**KS**	**SM**
07.00-08.00	676	19	3667
08.00-09.00	645	17	3231
16.00-17.00	969	16	4891
17.00-18.00	862	6	4650

Source : Traffic Survey

TABLE 9. Traffic Volume (Veh/hour) on TB Simatupang Road (East) Toward Pasar Rebo

Monday, 09 June 2025			
Toward Pasar Rebo (vehicle/hour)			
Period	**MP**	**KS**	**SM**
07.00-08.00	472	39	2038
08.00-09.00	444	34	1992
16.00-17.00	451	16	2906
17.00-18.00	381	14	3534

Source : Traffic Survey

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TABLE 10. TB Simatupang Road (East) Peak Hour Traffic Volume

Monday, 09 June 25			
Toward Tanjung Barat (vehicle/hour)			
Periode	**MP**	**KS**	**SM**
16.00-17.00	969	16	4891
Toward Pasar Rebo (vehicle/hour)			
16.00-17.00	451	16	2906

Source : Traffic Survey

Based on the data above, the Passenger Car Equivalents (PCE) are assigned as follows: Motorcycle (MC) = 1.0, Light Vehicle (LV) = 1.2, and Heavy Vehicle (HV) = 0.25, as the traffic volume per lane exceeds 1,050 vehicles per hour.

TABLE 11. Traffic Volume (Veh/hour) on TB Simatupang Road (East)

smp/hour

Vehicle Type	MP		KS		SM		QTOT		
EMP Toward Tanjung Barat	1		1,2		0,25		3407,774		
EMP Toward Pasar Rebo	1		1,2		0,25				
Direction	vehicle/hour	SMP/hour	vehicle/hour	SMP/hour	vehicle/hour	SMP/hour	Direction,%	vehicle/hour	SMP/hour
[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Toward Tj.Barat	969	969,21	16	19,2	4891	1222,6748	65%	5875,91	2211,08475
Toward Ps.Rebo	451	451,04928	16	19,2	2906	726,44044	35%	3372,81	1196,68972
Total	1420,26	1420,2593	32	38,4	7796,5	1949,1152	100%	9248,72	3407,77447
Separation, PA=q1/(q1+q2)							65%		
SMP Factor, FSMP									0,36845904

Source : Analysis Result by Author 2025

According to the statistics presented above, the traffic flow on TB Simatupang Road during the evening peak hour (17:00–18:00) in the direction of Tanjung Barat is 2211,08 smp/hour. Meanwhile, the traffic flow on TB Simatupang Road in the direction of Pasar Rebo during the same period is 1196,69 smp/hour.

Free Flow Speed

VB toward Tanjung Barat
= (57 + 0) x 0,81 x 1,03 = 47,5551 km/hour
VB Arah Pasar Rebo
= (57 + 0) x 0,81 x 1,03 = 47,5551 km/hour

TABLE 12. Free Flow Speed Recap Table

Direction	Base Free Flow Speed V_{BD} (km/hour)	Faktor Penyesuaian			Free Flow Speed MP $V_{B,MP}$ ((2)+(3))x(4)x(5) (km/hour)
		Lane Width V_{BL} (km/hour)	Side Friction FV_{BHS}	City Population Size FV_{BUK}	
[1]	[2]	[3]	[4]	[5]	[6]
Toward Tj. Barat	57	0	0,81	1,03	47,5551
Toward Ps. Rebo	57	0	0,81	1,03	47,5551

Source : Analysis Result by Author 2025

Capacity

C (Toward Tanjung Barat)
= 3400 x 1 x 1 x 0,94 x 1,03 = 3292 smp/hour
C (Toward Pasar Rebo)
= 3400 x 1 x 1 x 0,94 x 1,03 = 3292 smp/hour

TABLE 13. Capacity Calculation Table

Direction	Base Capacity C_0 SMP/jam	Faktor penyesuaian untuk kapasitas				Capacity C (8) x (9) x (10) x (11) x (12) SMP/hour
		Lane width FC_{LJ}	Median Divider FC_{PA}	Side Friction FC_{HS}	City Population Size FC_{UK}	
[7]	[8]	[9]	[10]	[11]	[12]	[13]
Toward Tj. Barat	3400	1	1	0,94	1,03	3292
Toward Ps. Rebo	3400	1	1	0,94	1,03	3292

Source : Analysis Result by Author 2025

Saturation Degree

Dj (Toward Tanjung Barat) = $\frac{2211}{3292}$ = 0,67
Dj (Toward Pasar Rebo) = $\frac{1446}{3292}$ = 0,45

Travel Speed

TABLE 14. Average Speed on TB Simatupang Road Toward Tanjung Barat and Pasar Rebo

Period	Toward Tanjung Barat	Toward Pasar Rebo
	Speed Average	
07.00-07.15	22,44	31,56
07.15-07.30	22,13	31,44
07.30-07.45	22,94	31,9
07.45-08.00	22,85	32,15
Speed Avg./hour	**22,59**	**31,7625**
16.00-16.15	17,52	28,44
16.15-16.30	17,56	28,71
16.30-16,45	17,72	28,79
16.45-17.00	17,66	28,51
Speed Avg./hour	**17,615**	**28,6125**

Source : Survey Result 2025

The average speed obtained from the table above during the 17:00–18:00 time period is 17,615 km/h in the direction of Tanjung Barat and 28,6125 km/h in the direction of Pasar Rebo.

WT (Toward Tanjung Barat) = $\frac{0,3}{17,615}$ = 0,02 jam
WT (Toward Pasar Rebo) = $\frac{0,3}{28,6125}$ = 0,01 jam

Level Of Service (LOS)

The level of service (LOS) can be determined by calculating the ratio between traffic volume and the basic road capacity (q/C). By performing this calculation, the LOS value can be obtained, which is then used to classify the road segment or assess its level of service. The following presents the LOS calculation results for the busiest day:

TABLE 15. Level of Service (LOS) Analysis Results on TB Simatupang Road

Road Section	Directon	Capacity (smp/hour)	Traffic Flow (smp/hour)	Degree Saturation	Travel Speed (km/jam)	Segment Length (Km)	LOS
Eksisting (2025)							
TB Simatupang Road	Toward Tanjung Barat	3292	2211	0,67	17,615	0,3	C
	Toward Pasar Rebo	3292	1197	0,45	28,6125	0,3	C

Source : Analysis Result by Author 2025

D. Solutions and Alternative Measures

In this alternative solution, the northbound approach phase is converted to serve only left-turn movements. A U-turn facility is subsequently provided on the eastern leg, located 300 meters from the intersection. For illustration purposes, the analysis is conducted during the peak traffic period, specifically on Monday from 17:00 to 18:00.

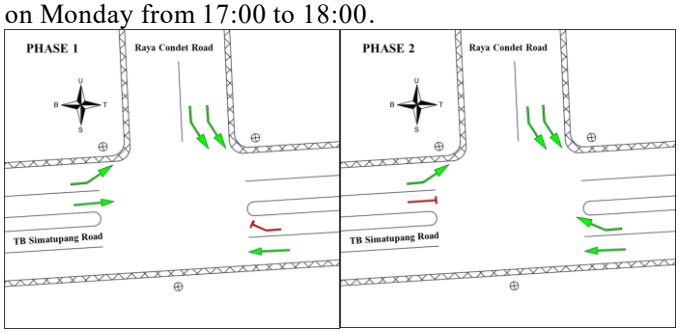

Figure 8. Signal Phases at Jl. Raya Condet – Jl. TB Simatupang Intersection (Alternative)

Source : Analysis Result by Author 2025

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Flow Ratio and Phase Ratio (R_F)

$R_{q/J}$ (West) = 783 / 2606 = 0,300

$R_{q/J}$ (East) = 422 / 1901 = 0,222

Based on the traffic flow ratio results above, the Phase Ratio (R_F) is obtained as follows :

R_F (West) $= \frac{0,300}{0,300+0,222} = \frac{0,300}{0,522} = 0,575$

R_F (East) $= \frac{0,222}{0,300+0,222} = \frac{0,222}{0,522} = 0,425$

TABLE 16. Calculation of Flow Ratio and Phase Ratio (All-Left-Turn Alternative)

Approach Code	Green time in phase -	Saturation Flow: Adjusted Saturation Flow J SMP/hour	Traffic Flow: q SMP/hour	Flow Ratio: R_q/J (18)/(17)	Phase Ratio: R_F (19)/R_{AS}
(1)	(2)	(17)	(18)	(19)	(20)
North	1	0	0	0,000	0,000
West	2	2606	783	0,300	0,575
East	3	1901	422	0,222	0,425

Source : Analysis Result by Author 2025

Green Signal Time (W_{Hi})

1. $W_{HH} = W_{MS} + W_A$
   $W_{HH} = 8 + 6 = 14$ second/cycle
2. Pre-Adjusmtent Cycle Time (S_{bp})
   $S_{bp} = \frac{(1,5\ x\ 14+5)}{(1-0,575)} = 61$ second
3. Green Time Calculation (W_{Hi})
   w_{Hi} (B) = (61 − 14) × 0,575 = 27 detik
   w_{Hi} (T) = (61 − 14) × 0,425 = 20 detik

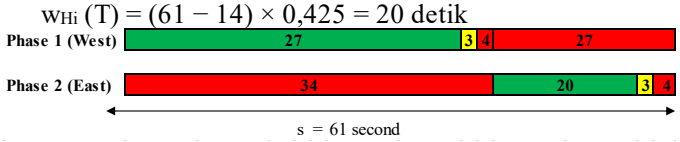

Figure 9. Alternative Cycle Time

Source : Analysis Result by Author 2025

Capacity and Saturation Degree

The capacity is calculated using the following formula:

C (West) $= 2606\ x\ \frac{27}{61} = 1150$ smp/hour

C (East) $= 1901\ x\ \frac{20}{61} = 621$ smp/hour

The degree of saturation is calculated using the following formula:

Dj (East) $= \frac{783}{1150} = 0,681$

Dj (West) $= \frac{422}{621} = 0,679$

Queue Length

$$N_{q1(West)} = 0,25 \times 61 \times \left\{(0,681-1) + \sqrt{(0,681-1)^2 + \frac{8 \times (0,681-0,5)}{61}}\right\}$$

$$N_{q1(West)} = 0,529\ smp$$

$$N_{q1(East)} = 0,25 \times 61 \times \left\{(0,679-1) + \sqrt{(0,679-1)^2 + \frac{8 \times (0,679-0,5)}{61}}\right\}$$

$$N_{q1(East)} = 0,520\ smp$$

Subsequently, NQ2 is calculated using the following formula:

$$N_{q2} = s \times \frac{(1-RH)}{(1-RH \times DJ)} \times \frac{q}{3600}$$

Based on the above equation, the NQ2 values for each approach are calculated as follows:

$$N_{q2\ (West)} = 61 \times \frac{(1-0,5)}{(1-0,574 \times 0,681)} \times \frac{783}{3600} = 7,145\ smp$$

$$N_{q2\ (East)} = 61 \times \frac{(1-0,5)}{(1-0,426 \times 0,679)} \times \frac{422}{3600} = 4,447\ smp$$

Accordingly, the total number of queued vehicles during the evening peak period is determined using the following equation:

N_q (West) = N_{q1} + N_{q2} = 0,529 + 7,145 = 7,675 smp

N_q (East) = N_{q1} + N_{q2} = 0,520 + 4,447 = 4,967 smp

The queue lengths for the North, East, and West approaches during the Monday evening peak hour can be calculated using the following formula:

P_A (West) $= N_q \times \frac{20}{L_M} = 7,675 \times \frac{20}{4,7} = 42,64$ m

P_A (East) $= N_q \times \frac{20}{L_M} = 4,447 \times \frac{20}{3,6} = 27,59$ m

Stopped Vehicle Ratio

$$R_{KH}\ (West) = 0,9 \times \frac{N_q}{q \times s} \times 3600 = 0,9 \times \frac{7,675}{783 \times 61} = 0,676\ stop/smp$$

$$R_{KH}\ (East) = 0,9 \times \frac{N_q}{q \times s} \times 3600 = 0,9 \times \frac{4,967}{422 \times 61} = 0,812\ stop/smp$$

Total Stopped Vehicle

N_{KH} (West) $= q \times R_{KH} = 783 \times 0,676 = 529,06\ smp/hour$

N_{KH} (East) $= q \times R_{KH} = 422 \times 0,812 = 342,40\ smp/hour$

Total Stopped Vehicle

Average Traffic Delay:

$$T_{LL}(West) = s \times \frac{0,5 \times (1-R_H)^2}{(1-R_H \times D_J)} + \frac{N_{q1} \times 3600}{C} = 61 \times \frac{0,5 \times (1-0,574)^2}{(1-0,574 \times 0,681)} + \frac{0,529 \times 3600}{1150}$$

$$T_{LL}(West) = 8,645\ sec/smp$$

$$T_{LL}(East) = s \times \frac{0,5 \times (1-R_H)^2}{(1-R_H \times D_J)} + \frac{N_{q1} \times 3600}{C} = 61 \times \frac{0,5 \times (1-0,426)^2}{(1-0,426 \times 0,679)} + \frac{0,520 \times 3600}{621}$$

$$T_{LL}(East) = 13,918\ sec/smp$$

Average Geometric Delay:

$$T_G = (1-R_{KH}) \times P_B \times 6 + (R_{KH} \times 4)$$

$$T_G(West) = (1-0,676) \times 0,459 \times 6 + (0,676 \times 4) = 3,596\ sec/smp$$

$$T_G(East) = (1-0,812) \times 0,45 \times 6 + (0,812 \times 4) = 3,759\ sec/smp$$

Average Delay:

T (West) = 8,645 + 3,596 = 12,242 *sec/smp*

T (East) = 13,918 + 3,759 = 17,677 *sec/smp*

Based on the average delay value, the total delay is obtained as follows:

T_{Tot} (West) = 783 x 12,242 = 7454,173 *second*

T_{Tot} (East) = 422 x 17,677 = 9586,662 *second*

Average Intersection Delay:

$T_I = \frac{\sum(q\,X\,T)}{qTotal} = \frac{17040,84}{1205} = 14,14\ sec/smp$

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The level of service (LOS) of the intersection based on the analysis of the alternative solution on Friday from 17:00 to 18:00 shows an improvement, with an average intersection delay (TI) of 14.14 seconds/smp. This corresponds to LOS 'B' for all approaches, indicating that the signalized intersection alternative results in a better delay performance.

IV. Conclusion And Suggestions

Based on the results of the analysis and discussion, the following conclusions can be drawn:

1. The peak hour traffic flow at the intersection of Jalan Raya Condet and Jalan TB Simatupang is as follows:
   a. Monday, 17:00-18:00 :
      North Approach = 308 smp/hour
      West Approach = 1448 smp/hour
      East Approach = 1568 smp/hour
   b. Monday, 17:00-18:00 :
      North Approach = 112 smp/hour
      West Approach = 1422 smp/hour
      East Approach = 990 smp/hour
   c. Monday, 17:00-18:00 :
      North Approach = 111 smp/hour
      West Approach = 930 smp/hour
      East Approach = 1416 smp/hour
2. The performance results of the intersection and road segment at Jl. Raya Condet – Jl. TB Simatupang are as follows:
   a. The performance of the signalized intersection (APILL) at Raya Condet Road –TB Simatupang Road shows the following results:
      – North leg capacity: 276 smp/hour
      – West leg capacity: 852 smp/hour
      – East leg capacity: 623 smp/hour
      – Degree of saturation (North): 0.583
      – Degree of saturation (West): 0.919
      – Degree of saturation (East): 1.124
      – Average intersection delay: 85.79 seconds
      – Level of service (LOS): “F”
   b. The performance of the road segment along Raya Condet Road – TB Simatupang Road shows :
      – Capacity in both directions (Tanjung Barat and Pasar Rebo): 3,292 smp/hour
      – Degree of saturation (Tanjung Barat direction): 0.67
      – Degree of saturation (Pasar Rebo direction): 0.45
      – Road segment level of service (LOS): “C”.
3. The proposed solution and alternative for the performance analysis of the signalized intersection (APILL) at Raya Condet Road and TB Simatupang Road involves modifying the northbound approach phase to allow only left-turn movements. A U-turn facility is provided 300 meters from the intersection on the eastern leg. Under this alternative, the following results were obtained:
   a. East leg capacity: 1,150 smp/hour
   b. West leg capacity: 621 smp/hour
   c. Degree of saturation (West): 0.681
   d. Degree of saturation (East): 0.679
   e. Average intersection delay: 14.14 seconds
   f. Level of service (LOS): “B”.

   It is concluded that this alternative design significantly improves the level of service from “F” to “B”.

1.1 Suggestions

After conducting research and coming to conclusions, the author suggests several things.

1) To reduce congestion during peak hours, it is recommended to temporarily close the right-turn movement from Raya Condet Road (north) using water barriers or traffic cones, thereby converting it to a left-turn-only movement.
2) For future researchers, it is recommended to analyze this signalized intersection using traffic simulation software such as PTV VISSIM and VISUM to obtain comparisons and explore alternative solutions.

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