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PERFORMANCE OF THE THREE-ARMED UNSIGNALIZED INTERCHANGE ON JALAN TIPAR CAKUNG, EAST JAKARTA

Andika Setiawan[1], Harwidyo Eko Prasetyo[2], Heru Setiawan[3], Irnanda Satya Soerjatmodjo[4]
[1] Civil Engineering Study Program, University of Muhammadiyah Jakarta, Jl. Cempaka Putih Tengah 27, Indonesia
Correspondence email: andika.setiawan@umj.ac.id
[2] Civil Engineering Study Program, University of Muhammadiyah Jakarta, Jl. Cempaka Putih Tengah 27, Indonesia
Email: harwidyo.eko@umj.ac.id
[3] Civil Engineering Study Program, University of Muhammadiyah Jakarta, Jl. Cempaka Putih Tengah 27, Indonesia
Email: s.heru230699@gmail.com
[4]Civil Engineering Study Program, University of Muhammadiyah Jakarta, Jl. Cempaka Putih Tengah 27, Indonesia
Email: irnanda.satya@umj.ac.id
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ABSTRACT

The growth of the population density greatly affects the level of transportation needs in the city of Jakarta. The increase in the number of vehicles that are lack of balanced with the development of infrastructure It will cause conflicts on the road, especially intersections. Therefore, it is necessary to conduct research on interchange to know the problems that occur. This research was conducted at the Tipar Cakung – Agung Sedayu interchange in East Jakarta with an observation time of 3 days. The method that used in this study is a field survey method, namely by collecting data on traffic. It carried out by recording the number of vehicles that pass through the intersection every 15 minutes. Then from the results of the survey and calculation with the analysis guided by Indonesian Road Capacity Manual (MKJI, 1997). Based on the results of research for interchange performance in existing conditions, the highest traffic flow was obtained at 2831.7 pcu / hour, Degree of Saturation (DS) 1.05, delay on intersection (D) of 22.058 seconds/pcu and queue odds (QP%) in the range of values 44.93%-90.27%.

Keywords: *Intersection three arms, road capacity, Degree of Saturation, MKJI 1997*

1. INTRODUCTION

The rapid development of the cities such as Jakarta has an impact on changes in various systems in urban areas. It is also very demanding to improve transportation facilities and infrastructure in the city of Jakarta. Transportation is one of important aspect that has a role in supporting activities to fulfill human activities. Jakarta is the capital city and the largest city in Indonesia, based on data from the Central Statistics Agency (BPS) in 2021 the Eastern part Jakarta amounted to 3.04 million people. Based on the data and looking at the field conditions, the road intersection is a place for traffic conflicts to occur which is a meeting area of the highway network and also a place where the confluence of vehicles

from various directions and the change of way including the facilities necessary for the movement of traffic. Based on these circumstances, at the Tipar - Cakung road junction, it needs to get enough attention by providing road infrastructure at the intersection so that it can serve traffic flow well with the requirement of degree of saturation > 0.85 (Saturated) and of course avoid the occurrence of conflicts to reduce the number of accidents that occurred at the intersection.

Based on the traffic density problem above, the author will discuss the Performance of the Three-Armed Unsignalized Intersection with A case study of the Tipar Cakung road in East Jakarta, DKI Jakarta.

Formulation of the Problem

What is the degree of saturation (DS) at the three-armed interchange on Jalan Tipar Cakung?

How is the handling of the three-armed intersection on Tipar Cakung Road?

Research Objectives

Analyze the existing condition of the three-armed intersection on Jalan Tipar Cakung Jalan Agung Sedayu, East Jakarta.

Analyze alternatives by closing roads with a ban on turning right on the main route towards Jalan Sukapura towards Agung Sedayu and alternative widening of the main road to improve performance interchange.

2. THEORETICAL FOUNDATIONS

Road Definition

The increase in the number of population in Indonesia continues to grow until now, and from year to year experiencing an increase in the number of people will cause public problems.

According to (Law of the Republic of Indonesia No. 22 of 2009) on road traffic and law No. 38 defines a road is the entire section of the road, including complementary buildings and their equipment which intended for general traffic, which is at ground level, above ground level, below ground or water level, as well as above water level, except rail roads and cable roads.

Unsignalized Interchange

According to (MKJI, 1997) in general, interchanges not adjacent to the regulation of the right of way (priority from the left) are used in urban settlement areas and inland areas for inter-road crossings, local with low traffic flow.

Interchange Conditions

There are geometric conditions, depicted in sketches that provide information on road width, road side boundaries, shoulder width, median width and directions, environmental conditions, data adjusted to the data in the field, traffic conditions, traffic data is divided into several types of vehicles, namely LV. HV, MC, and non-motorized vehicles (UM). Traffic conditions can be determined according to the average daily traffic, the annual average (LHRT) with a k factor corresponding to the conversion from LHRT to hourly flow.

Traffic Flow

It is a unique interaction between the driver, the vehicle, and the road. No traffic flow have the same even under similar circumstances. The parameter used are volume, speed, density, degree of saturation, and level of service.

Table 1. EMP values for vehicle types

Vehicle Type	EMP value
Light Vehicles (LV)	1.0
Heavy Vehicles (HV)	1.3
Motorcycles (MC)	0.5

(Source: MKJI 1997)

Capacity (C)

The capacity of a road section is the maximum traffic flow that can pass stably on a cross section of the road under the circumstances (geometric, traffic composition, directional separator, and the environment). Based on (MKJI 1997) the

capacity can be calculated using the following:

C = Co x Fw x FM x Fcs x FRSU x FLT x FRT x FMI

Where:

C = Capacity

Co = Base capacity value (smp/h)

Fw = Approach width factor factor

FM = Main Road median correction factor

Fcs = City size adjustment factor

FRSU = Type adjustment factor road environment, obstacles, side and vehicle unmotorized

FLT = Left turn adjustment factor

FRT = Right turn adjustment factor

FMI = Minor road ratio adjustment factor

Base Capacity (Co)

Table 2. Basic Capacity of co-intersection type (pcu/h)

Kode IT	Jumlah lengan simpang	Jumlah lajur jalan minor	Jumlah lajur jalan utama
322	3	2	2
324	3	2	4
343	3	4	2
422	4	2	2
424	4	2	4

(Source: MKJI 1997)

Approach Width Factor (F_W)

Based on (MKJI 1997), approach width adjustment factor (FW) is an adjustment factor for capacity with respect to the entrance width of the crossroads.

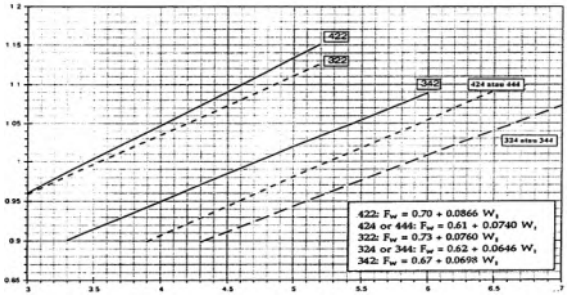

Figure 2.1 Width adjustment factor F_W

(Source: MKJI 1997)

The short width adjustment factor (F_W) is calculated based on the deviation type using the formula :

- 322 ; FW = 0.73 + 0.0760 W1
- 324 ; FW = 0.62 + 0.0646 W1
- 342 ; FW = 0.67 + 0.0698 W1
- 422 ; FW = 0.70 + 0.0698 W1
- 424; FW = 0.61 + 0.0740 W1
-

Main road median correction factor (F_M)

This FM is an adjustment factor for the base capacity with respect to the median type of the main road.

Table 3. Main road median adjustment factors

Uraian	Tipe M	Faktor penyesuaian median (F_M)
Tidak ada median jalan utama	Tidak ada	1,00
Ada median jalan utama, lebar < 3 m	Sempit	1,05
Ada median jalan utama, lebar ≥ 3 m	Lebar	1,20

(Source: MKJI 1997)

City size correction factor (FCS)

The size of the population in a city will affect the behavioral characteristics of road use and the number of vehicles that exist.

Table 4. City size correction factors

Ukuran Kota	Penduduk Juta	Faktor Penyesuaian untuk Ukuran kota (F_{cs})
Sangat kecil	<0,1	0,86
Kecil	0,1 – 0,5	0,90
Sedang	0,5 – 1,0	0,94
Besar	1,0 – 3,0	1,00
Sangat Besar	>3,0	1,04

(Source: MKJI 1997)

Environmental type correction factors, side obstacle classes and non-motorized vehicles (F_{RSU})

Side obstacles are interactions between traffic activities that occur besides the road which results in a reduction in saturated currents in the short.

Table 5. Adjustment factors for environmental types, road environment types, side pests, and non-motorized vehicles.

Kelas tipe lingkungan jalan RE	Kelas hambatan samping SF	Rasio kendaraan tak bermotor p_{UM}					
		0,00	0,05	0,10	0,15	0,20	≥0,25
Komersial	tinggi	0,93	0,88	0,84	0,79	0,74	0,70
	sedang	0,94	0,89	0,85	0,80	0,75	0,70
	rendah	0,95	0,90	0,86	0,81	0,76	0,71
Permukiman	tinggi	0,96	0,91	0,86	0,82	0,77	0,72
	sedang	0,97	0,92	0,87	0,82	0,77	0,73
	rendah	0,98	0,93	0,88	0,83	0,78	0,74
Akses terbatas	tinggi/sedang/rendah	1,00	0,95	0,90	0,85	0,80	0,75

(Source: MKJI 1997)

Right turn correction factor (F_{RT})

Three Armed F_{RT} = 1.9 – 0.922 PRT

Four F_{RT} Arms = 1.0

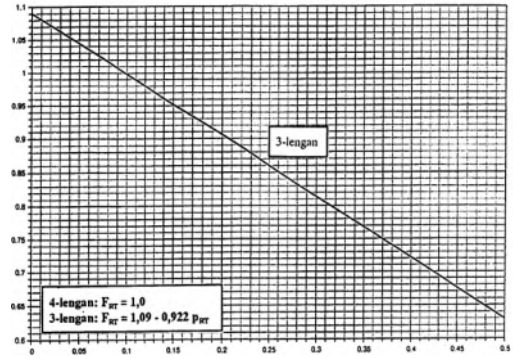

Figure 2.2 Right turn adjustment factor

(Source: MKJI 1997)

Left turn correction factor (F_{LT})

FLT = 0.84 + 1.61 PLT

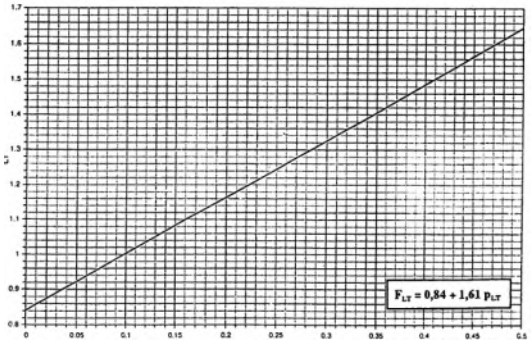

Figure 2.3 Left turn adjustment factor

(Source: MKJI 1997)

Minor road current ratio correction factor (F_{MI})

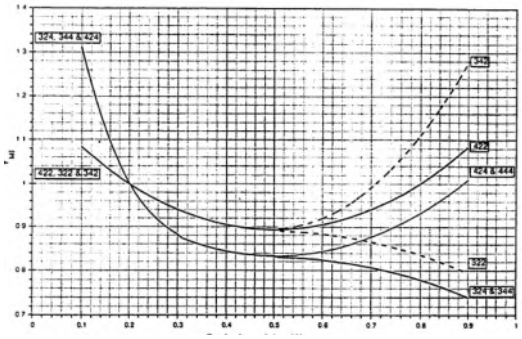

Figure 2.4 Minor road current correction factors

(Source : MKJI 1997)

Degree of Saturation (DS)

The degree of saturation is the ratio of the flow of traffic to the capacity for an approach. The degree of saturation is defined as the ratio of volume (Q) to capacity (C).

$DS = Q_{TOT} / C$

Where

DS = Degree of saturation

Q_{TOT} = Traffic flow (smp/hr)

C = Capacity (smp/h)

Snooze (D)

1) Interchange Traffic Delay (DT_I)

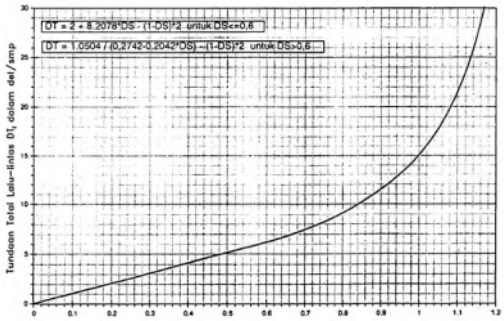

Figure 2.5 Interchange Traffic Delay - Degree of Saturation

(Source: MKJI 1997)

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

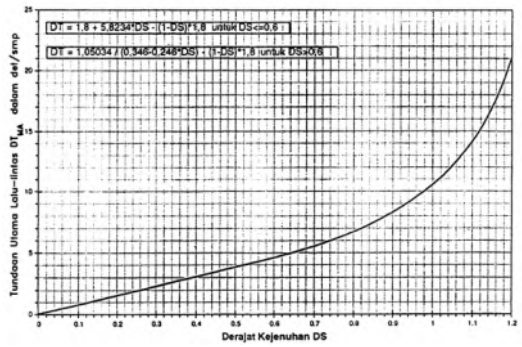

Figure 2.6 Main Road Traffic Delay – Degree of Saturation
(Source: MKJI 1997)

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

$DT_{MI} = (Q_{TOT} \times DT_I - QM_A \times DT_{MA}) / QM_I$

Where:

DT_{MI} = Minor road traffic delays
Q_{TOT} = Total current
DT_I = Interchange traffic delay
QM_A = Total main road current
DT_{MA} = Delay of main road traffic
QM_I = Total flow of minor roads

4) Geometric Delay of Junction (DG)

- DG = (1 - DS) x (W_T x 6+ (1 - PT) x 3) + DS x 4 (DS < 1.0)
- DG = 4 (DS > 1.0)

Where:

DG = Geometric delay of intersection
DS = Degree of saturation
P_T = Total turn ratio

5) Interchange delay (D)

D = DG + DTI (det/smp)

Where:

DG= Geometric delay of intersection
DT= Delayed traffic intersections

Queue Opportunity

The range of queue opportunity is determined from the empirical relationship between queue opportunity and the degree of saturation.

$QP\% = 9.02 \times DS + 20.66 \times DS^2 + 10.49 \times DS^3$ (lower limit)

$QP\% = 47.71 \times DS + 24.68 \times DS^2 + 10.49 \times DS^3$ (upper limit)

Where:

QP% = Queue opportunity
DS = Degree of saturation

3. RESEARCH METHODOLOGY

Flowchart

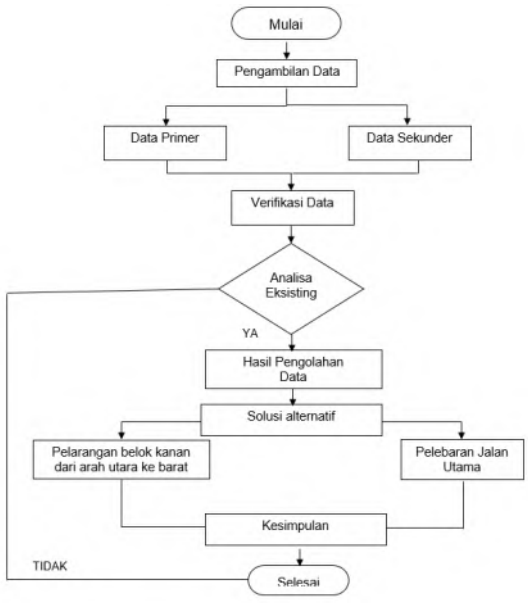

Figure 3.1 Flowchart

Data Collection

The location of this study was carried out at the unsignalized intersection of Jalan Tipar Cakung, East Jakarta. The study was conducted on Wednesdays, Thursdays, and Saturdays in the morning at 06.00-09.00, noon 11.00-15.00 and afternoon 16.00-20.0 WIB, because these hours represent the working day and holidays during rush hour. Data collection was carried out by calculating the capacity of intersections, delays, and queue opportunities using the 1997 Indonesian Road Capacity Manual method, using primary and secondary data collection techniques.

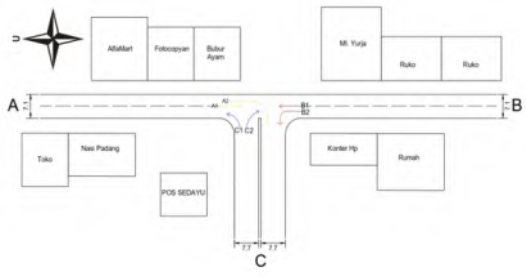

Figure 3.2 Survey Point and Surveyor Location

This intersection has three arms, the width is 7.1 meters while the minor road is 7.7 meters.

Obtained from the data collection on Wednesday, October 7, 2021, representing that three days are the peak points of vehicle volume. Data collection is divided into three parts by representing during peak hours, namely 06.00-09.00, 11.00-15.00, 16.00-20.00 WIB.

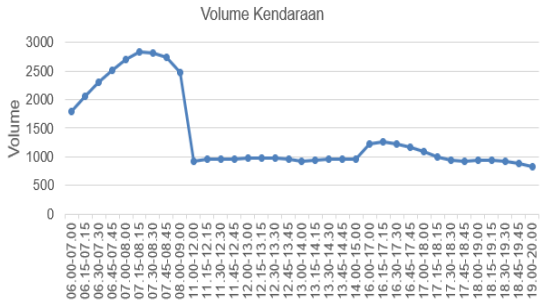

Figure 3.3 Cumulative Graph of vehicle survey from Jl Tipar Cakung to Jl. Sukapura, and to Jl. Agung Sedayu.

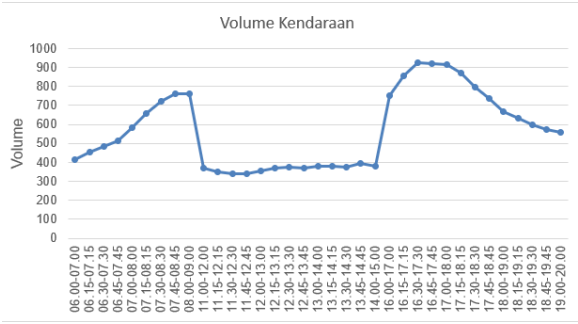

Figure 3.4 Cumulative Graph of vehicle surveys from Jl. Sukapura to Jl. Tipar Cakung, and to Jl. Agung Sedayu.

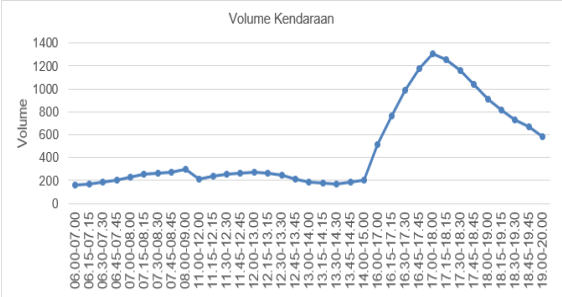

Figure 3.5 Cumulative Graph of vehicle survey from Jl. Agung Sedayu to Jl. Sukapura, and to Jl. Tipar Cakung.

4. DISCUSSION

Data Description

This research was carried out on unsignalized interchange at Jl. Tipar Cakung is a meeting from Jl. Tipar Cakung – Jl. Sukapura and Jl. Agung Sedayu. For the analysis of this study, it was used by taking several data , including Motor vehicles Motorcycle (MC), light vehicle Light vehicles (LV), and heavy vehicles Heavy vehicles (HV). This data collection is carried out simultaneously on each road section at each intersection location, the data collection time starts from the morning on 06.00-09.00 WIB, noon 11.00-15.00 WIB, and afternoon 16.00-20.00 WIB. The data used from the calculation of surveys in the field used the highest vehicle volume, namely vehicle volume data on October 07, 2021, on Wednesday, the morning peak hour, on 07.15– 08.15 WIB where many motor vehicle transportations passed by. From the results of research in the field, vehicles that pass through a large part consist of two-wheeled vehicles, that is motorcycles.

Analysis of Existing Condition

In analyzing of the existing conditions at the intersection jl. Tipar Cakung – Jl. Agung Sedayu gets the volume of vehicles obtained from the results of this research divided into two, which are the total current volume (QTOT) and the major road current volume (QMA) and the current volume minor roads (QMI). The total volume of light vehicle

traffic flow (LV) is 1545 pcu/hour, the total volume of heavy vehicle (HV) traffic flow is 7.8 pcu/hour, the total volume of motor vehicle (MC) traffic flow is 3583 pcu/hour, the total volume of the flow of motor vehicles (MC) is 3583 pcu/hour, the total volume of flow of motor vehicle (MC) traffic flow is 3583 pcu/hour, the total volume of flow is on main road (QMA) 3832.8 pcu/h, total volume of traffic flow on minor road (QMI) 1303 pcu/h.

Table 6. The results of the calculation of traffic flow of the three-stroke interchange turning ratio.

Hari Rabu, 07 Oktober 2021											
Volume Kendaraan											
Kode Pendekat	Arah	LV		HV		MC		Total Kendaraan		
		kend/ jam	emp = 1,0 smp/jam	kend/ jam	emp = 1,3 smp/jam	kend/ jam	emp = 0,5 smp/jam	kend/ jam	smp/ jam	Rasio Belok
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Jl. Minor Barat (Jl. Agung Sedayu)	LT	301	301	0	0	630	315	931	616	0.47276
	RT	335	335	0	0	704	352	1039	687	0.52724
	Total	636	636	0	0	1334	667	1970	1303	
Jl. Mayor Selatan (Jl. Tipar Cakung)	LT	347	347	3	3.9	3025	1512.5	3375	1863.4	0.65775
	ST	156	156	2	2.6	1622	811	1780	969.6	0.34225
	Total	503	503	5	6.5	4647	2323.5	5155	2833	
Jl. Mayor Utara	ST	258	258	1	1.3	720	360	979	619.3	0.61942
	RT	148	148	0	0	465	232.5	613	380.5	0.38058
	Total	406	406	1	1.3	1185	592.5	1592	999.8	
Jl. Mayor Total Selatan +Utara		909	909	6	7.8	5832	2916	6747	3832.8	
Utama+Minor	LT	648	648	3	3.9	3655	1827.5	4306	2479.4	0.482777
	ST	414	414	3	3.9	2342	1171	2759	1588.9	
	RT	483	483	0	0	1.169	585	1.652	1.068	0.21
Utama+ Minor Total		1545	1545	6	7.8	7166	3583	8717	5135.8	0,003785
				Rasio Jl. Minor / (Jl. Mayor+Minor) total					0.253709	UM/MV

(Source: Analysis,2021)

Next, the data that is needed is secondary data in the form of the number of residents obtained from related agencies, namely the Central Statistics Agency (BPS) of East Jakarta City in 2021 the total population of 3.04 million people.

Approach Width and Interchange Type

The main approach width is the average width of the Jl. Tipar Cakung – Jl. Sukapura.

W_{AB} = (W_A + W_B) / 2

W_{AB} = (7.1+7.1)/2

= 7.1 m

W_{AB} is the geometric width of the main road A-B is 7.1 meters

The width of the minor short is the average width of the Agung Sedayu road.

W_{CD} = WC/ 2

W_{CD} = 7.7/2

= 3.85 m

W_{CD} is the geometric width of the minor road is 3.85 meters

The overall total average width of the main and minor roads.

WI= (WA + WB + WC) / number of arms

WI= (7.1+7,17,7)/3

WI= 7.3 m

WI is the minor and main geometric mean width.

Base capacity (Co)

For type 324 intersections, a basic capacity of 3200 pcu/hour is obtained in accordance with the provisions of the 1997 MKJI

Approach width adjustment factor (F_W)

FW = 0.70 + 0.0698 x WI

= 0.70 + 0.0698 x 7.3

= 1,092 m

Left turn factor **(FLT)**

FLT = 0.84 + 1.61 x PLT

= 0.84 + 1.61 x 0.199

= 1.16

Capacity (C)

C = CO x FW x FM x FCS x FRSU x FLT x FRT x FMI

= 3200 x 1.092 x 1.05 x 1.05 x 0.94 x 1.62 x 0.90 x 0.92

C = 4848.88 pcu/hour

Table 7. Calculation Results of Capacity Adjustment

Hari	Kapasitas Dasar (CO) SMP/JAM	Faktor Penyesuaian Kapasitas (F)							Kapasitas (C) SMP/JAM
		Lebar Pendekat Rata - Rata (FW)	Median Jalan (FM)	Ukuran Kota (FCS)	Hambatan Samping (FRSU)	Belok Kiri (FLT)	Belok Kanan (FRT)	Rasio Arus Minor (FMI)	
RABU	Tabel 2.8	Gambar 2.1	Tabel 2.10	Tabel 2.11	Tabel 2.15	Gambar 2.3	Gambar 2.2	Gambar 2.4	Rumus 2.2
	3200	1.092	1.05	1.05	0.94	1.62	0.90	0.92	4848.88

(Source: Analysis,2021)

Degree of Saturation (DS

DS = QTOT/C

= 5135.8/4848.88

= 1.06

Interchange Traffic Delay **(DT_I)**

DTI = 1.0504 / (0.2742 – 0.2042 x DS) – (1

– DS) x 2
= 1.0504 / (0.2742 – 0.2042 x 1.06) – (1 – 1.36) x 2
= 18.25 sec/pcu

Delay Time Major Road (DT_{MA})

DTM A = 1.0504 / (0.346 – 0.246 x DS) – (1 – DS) x 1.8
= 1.0504 / (0.346 – 0.246 x 1.06) – (1 – 1.06) x 1.8
= 12,399 sec/pcu

Delay Time Minor Road (DT_{MI})

DTMI = (QTOT x DTI - QMA x DTMA) / QMI
=(5135.8x18.255–3832.8 x 12.399) /1303
= 93715.9 sec/pcu

Interchange Geometric Delay (DG)

Based on MKJI 1997, if the DS value > 1 then the value (DG) = 4

Snooze Interchange

D = DG x DTI
= 4 + 18,255
= 22.25 sec/pcu

Queue Opportunity (QP%)

QP% Lower Limit
= 9.02 x DS + 20.66 x DS^2 + 10.49 x DS^3
= 9.02 x 1.06 + 20.66 x 1.12 + 10.49 x 1.178
= 45.20 %

QP% Upper Limit
= 47.71 x DS – 24.68 x DS^2 + 10.49 x DS^3
= 47.71x1.06+24.68x1.12 + 10.49 x 1.178
= 90.68 %

Table 8. Hof Traffic Behavior Calculations

RABU									
HARI	Arus Lalu Lintas (Q) smp/jam	Derajat Kejenuhan DS= Q/C	Sasaran	Tundaan Lalu Lintas Simpang (DTI) det/smp	Tundaan Jalan Mayor (DTMA) det/smp	Tundaan Jalan Minor (DTMI) det/smp	Tundaan Geometrik (DG) det/smp	Tundaan Simpang (D) det/smp	Peluang Antrian (QP%)
		Rumus 2.6		Gambar 2.5	Gambar 2.6	Rumus 2.7	Rumus 2.9	Rumus 2.8	Gambar 2.7
Rabu	5135.8	1.06	DS > 0.85	18.25	12.40	93715.89	4	22.25	45-91

(Source: Analysis,2021)

5. CONCLUSION

From the results of this research on the three-armed unsignalized intersection of Jl. Tipar Cakung East Jakarta, the following conclusions can be drawn:

1. The total volume at the three-stroke intersectio on Jl. Tipar Cakung East Jakarta of 8748 vehicles with a DS value of 1.06
2. For delays on road geometrics in existing conditions of 22.25 sec / pcu.
3. The queue opportunity that occurs at the intersection is 90.68%.

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