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Optimization Model of Unsignalized Intersection to Signalized Intersection Using PTV.VISSIM (Study Case: Imogiri Barat and Tritunggal Intersection, Yogyakarta, Indonesia)

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Abstract: Intersections, particularly in an urban area, are the most potentially crowded than other road networks. In Yogyakarta, some intersections have no signal. One of them is at the crossroads between the Imogiri Timur and Wirosaban road in Yogyakarta. This study aims to create the optimization of model of an existing condition (without signal) and with a signalized intersection. The software that used in this study is PTV. VISSIM 9.0. PTV. VISSIM is one of the microsimulation programs from PTV Group. One of the advantages of PTV. VISSIM is the model results from the dynamic simulation. The results of this study obtained the model result on existing conditions obtained average queue length of 17.76 m, maximum queue length 125.57 m, and the level of service is LOS (Level of Service) "D". The models consist of 3 scenarios by giving traffic lights which are (1) without LTOR (Left Turn on Red), (2) with LTOR and (3) combination between LTOR and widening of the road by 2 m on outlet road. The best result shows that the third scenario with the average queue length is 14.99 m, the maximum queue length is 116.43 m, and the service level is LOS "C".

Keywords: Intersection, Model, Optimization, Signal, PTV.VISSIM, Un-signal

1. Introduction

Intersections, particularly in an urban area, are the most potentially crowded than other road networks. Meeting all vehicle volumes from each intersection arm, making queues and delays. Thus, almost traffic congestion occurred in the intersection [4], especially in unsignalized intersection. For drivers, it would make them uncomfortable and stressful; then it will be hard to feel convenient during driving [5].

An unsignalized intersection is one of the important parts of a vehicle meeting that has less volume than a signalized intersection. Unsignalized intersection takes the important role to control the traffic system [1].

At unsignalized intersection, the drivers are free to decide "safe opportunity" passing the intersection. The "gap" in the traffic which closely related to the technique as gap acceptance theory [1]. Based on Hamed et al. [1] gap acceptance is an important factor in evaluating delays, queue lengths, and capacities at unsignalized intersections [2]. On the other hand, it's important to evaluate unsignalized intersection based on safety factor by application of signal, particularly the number of conflict areas and environmental factors.

Therefore, this study tries to approach the evaluation of unsignalized to a signalized intersection. The approach used is to make microsimulations to measure the performance between the existing condition (unsignalized intersection) become signalized intersection with the parameter as delay, queue lengths, and capacities using PTV. VISSIM micro simulation tool. PTV. VISSIM software was used to simulate the case study the evaluation unsignalized

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to signalized intersection because PTV. VISSIM is easy to use, flexible and does not require cumbersome coding [6];[7];[8]. Along with the great issues about sustainable transport systems, PTV. VISSIM can also calculate how many emissions (CO, NOX, VOC) and also can calculate how many fuel consumptions that use in that nodes. Therefore, the evaluation of the unsignalized intersection in Imogiri Barat and Tritunggal, Wirosaban, Yogyakarta using PTV. VISSIM software are needed.

2. Methodology

The data used in this study is based on field survey which then modeled using PTV. VISSIM. 9. Flow chart that explains the methodology can be seen in

Fig. **1**.

2.1 Location of the Study

The study was conducted at unsignalized intersection Imogiri Barat Road with Tritunggal Road. The detailed location of this study is more clearly shown in Fig. 2.

2.2 Period of the Study

The survey was conducted for 2 days are Monday and Saturday for 6 hours from 6:00 am to 12:00 pm. While the survey was conducted, the surveyor recorded the number of vehicles passing through the intersection. The calculation of the number of vehicles was categorized according to the type of vehicle which was light vehicles (LV), heavy vehicles (HV), Motorcycles (MC), and non-motorized vehicles (UM).

Total number of surveyors that conducted in this primary survey was 6 surveyors. The plotting of surveyors can be seen at

Fig. **3**.

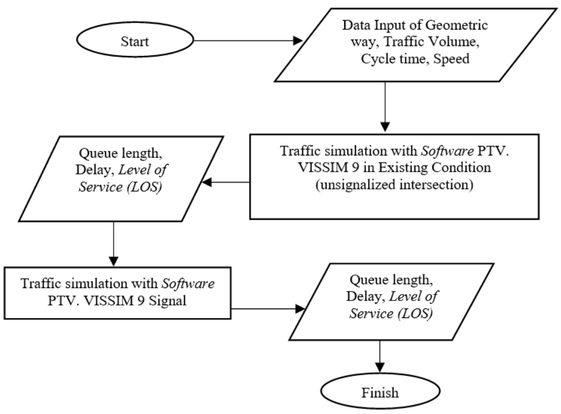

Fig. 1 - Framework Analysis

Fig. 2 - Location of the Study

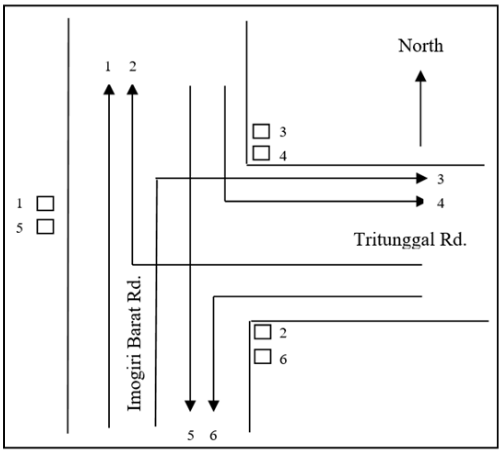

Fig. 3 - The Location of Surveyors

2.3 Data Result

The following are some of the input data used as input for micro simulation program modeling using PTV. VISSIM.

a. Geometric Condition

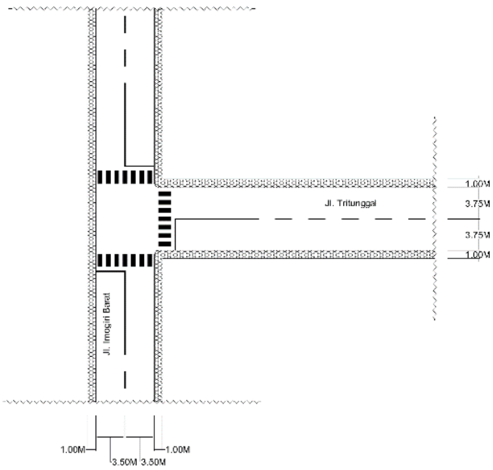

Fig. 4 - Geometric Condition

Table 1 - Data of Road Wide

Name of Road	Direction	Wide of Lane
Imogiri Barat	North	3.50 m
	South	3.50 m
Tritunggal	West	3.65 m
	East	3.65 m

b. Type of Road Environment

Type of road environment can be seen at the table below.

Table 2 - Type of Road Environment

Arm Code	Side Fiction	Median	Type of Road Environment
Imogiri Barat (N)	High	No	Commercial
Tritunggal (E)	Medium	No	Commercial
Imogiri Barat (S)	High	No	Commercial

c. Traffic Volume

Traffic volume survey conducted on Monday, January 12nd, 2016 which represent on weekdays condition.

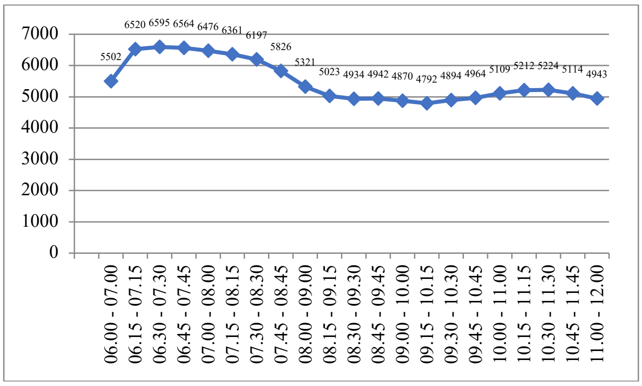

Fig. 5 - Data of Overall Traffic Volume in Peak Seasonal Time

From the data volume above, the peak hour occurred at 06.30 – 07.30 with the total volume is 6595 veh/hour. The peak of this volume is due to market activity in the morning.

Table 2 shows the peak hour that occurs based on the direction of movement of the vehicle from each intersection arm.

Table 3 - Peak Hour Volume (vehicle/hour)

Interval	Direction	HV	LV	MC	UM
06.30 – 07.30	S – E	2	77	726	13
	S – N	4	53	892	48
	N – E	9	114	1453	54
	N – S	6	45	919	34
	E – N	1	65	1231	54
	E – S	12	90	678	15

Note:
S : South
N : North
E : East

Based on the direction and the number of total volumes, it can be seen at Fig. 6. The biggest proportion of this movement is from North to South and also South to North. While the east arm is a minor road, based on the number of volumes.

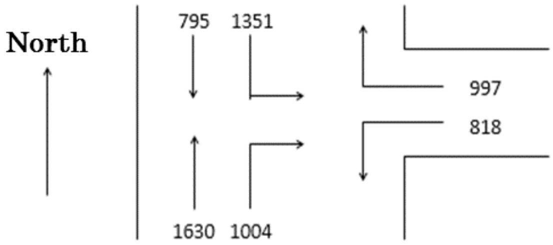

Fig. 6 - Traffic Movement in Intersection

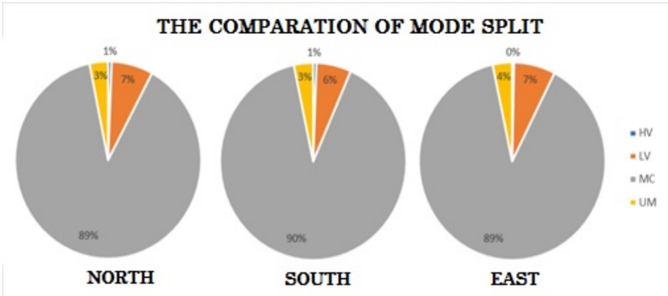

Fig. 7 - Mode Distribution

From the Fig. 7 above, MC (motorcycle) takes the hugest proportion compared with other modes (around 89%-90%) for each arm. The second position is LV (car) with the percentage 6%-7%, then UM (unmotorized / bicycle) and the lowest one is HV (bus/truck).

2.4 The Input Parameter of PTV. VISSIM

a. Road Network

The first input process carried out on Vissim modelling is the road network. This stage is the process for making road networks based on existing geometric conditions, including the width of each lane.

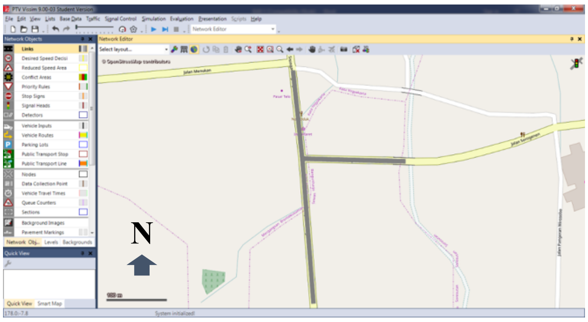

Fig. 8 - Road networking in PTV. VISSIM

The Fig. 8 shows the road network depiction based on the link and connector on the non-signalized intersection. The function of the link is as the main road, while the connector functions to connect each link.

b. Conflict Area and Priority

Conflict area and priority can be seen in this following figure.

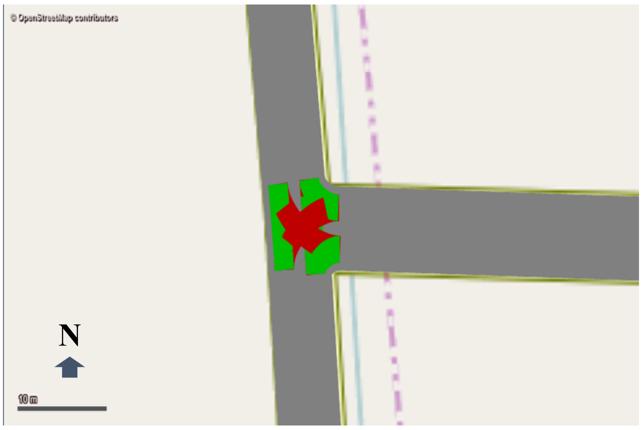

Fig. 9 - Conflict Area and Priority

Red and green is a display to show priority. Green indicates that the movement has a higher priority than the movement in red. So, in Fig. 8 above, the North-South lane has a higher priority than the East arm.

c. Vehicle Route

Vehicle route determines the direction where vehicle will go. It can be seen in this following figure.

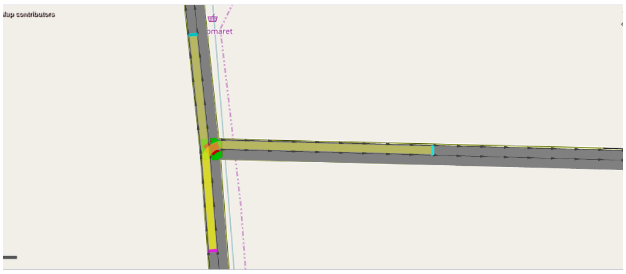

Fig. 10 - Vehicle Route

d. Vehicle Type and Volume

Vehicle type that can be used in this software are based on [3] as the following description:

1) Heavy vehicle (bus, truck, trailer)
2) Light vehicle (car, minibus)
3) Motorcycle
4) Unmotorized (bicycle)

Vehicle input process in PTV. VISSIM can be seen in the following table.

Table 4 - Vehicle Input

Count 16	No	Name	Link	Volume (0)	VehComp(0)
1	1		7: Jl. Imogiri barat U	2611.0	4: MC
2	2		7: Jl. Imogiri barat U	174.0	2: LV
3	3		7: Jl. Imogiri barat U	24.0	3: HV
4	4		7: Jl. Imogiri barat U	88.0	5: UM
5	5		5: Jl Sorogenen B	1419.0	4: MC
6	6		5: Jl Sorogenen B	138.0	2: LV
7	7		5: Jl Sorogenen B	7.0	3: HV
8	8		5: Jl Sorogenen B	45.0	5: UM
9	9		10: Jl. Imogiri Barat	1729.0	4: MC
10	10		10: Jl. Imogiri Barat	166.0	2: LV
11	11		10: Jl. Imogiri Barat	10.0	3: HV
12	12		10: Jl. Imogiri Barat	65.0	5: UM

e. Side Friction

Types of side friction are like parking places on the shoulder of the road as shown below. Making this parking area is based on the actual conditions in the field on each arm and also the area used for parking.

Table 5. Parking Space Input

Count: 3	No	Name	Lane	Link	Pos	Lenght	Type	Capacity	DesSpeedDistrDef
1	1		17-1	17	2.493	18.451	Real Parking Spaces	3	5:5 km/h
2	2		20-1	20: Parking	1.106	17.054	Real Parking Spaces	2	5:5 km/h
2	2		21-1	20: Parking	2.295	45.978	Real Parking Spaces	7	5:5 km/h

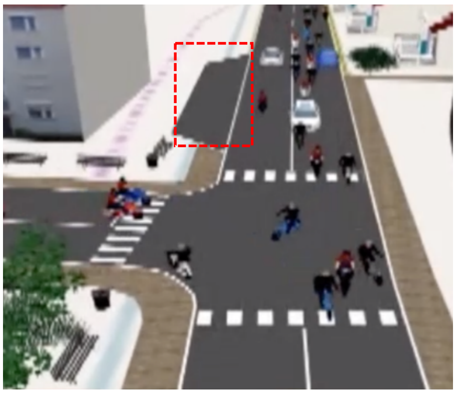

Fig. 11 - Drawing Parking Space (Red Dotted Line Box)

The weaknesses of PTV. VISSIM is at this stage. In the real condition, a lot of vehicles park on the road and it makes road capacity decrease. Whereas in this software, VISSIM just can only provide specific parking space. It means that if there are vehicles use the shoulder of the road as a parking lot, passing vehicles will crash into the parking lot on the road.

This is indeed quite different, because VISSIM was created in Germany (Karlsruhe) wheares have good parking conditions and traffic volume is not higher than Asia. While some countries in Southeast Asia, there is still very much parking on road side and it will reduce the capacity of the road that can occur the traffic congestion.

f. Driving behavior

Driving behavior in PTV. VISSIM based on the behavior of the road user who drives in the free line and free side to overtake. Driving behavior settings can regulate how close the distance between vehicles is, how the vehicle will overtake the vehicle in front of it, how to drive (left or right hand side), and others.

Table 6 - Driving Behavior Input

Count 5	No	Name	ObsrvdVehs	StanDistIsFix	StandDist	CarFollowModType	W74bxAdd	W74bxAdd	LnChgRule	AdvMerg	DesLatPos	OvtLDef	OvtRDef	LatDistDrivDef	LatDistStandDef
1	1	Urban (Motorized)	4		0.5	Wiedemann 74	2.0	3.0	Slow lane rule	/	Right	/	/	1.0	0.2
2	2	Ride – side rule (Motorized)	2		0.5	Wiedemann 99	2.0	3.0	Free lane selection	/	Left	/	/	1.0	0.2
3	3	Freeway (Free lane selection)	2		0.5	Wiedemann 99	2.0	3.0	Free lane selection	/	Middle of lane	/	/	1.0	0.2
4	4	Footpath (No interaction)	2		0.5	No interaction	2.0	3.0	Slow lane rule	/	Left	/	/	1.0	0.2
5	5	Cycle – track (Free overtaking)	2		0.5	Wiedemann 99	2.0	3.0	Slow lane rule	/	Left	/	/	0.3	0.1

g. Evaluation Configuration

Configuration to set the result's evaluation based on the nodes of the existing condition and the license of the software.

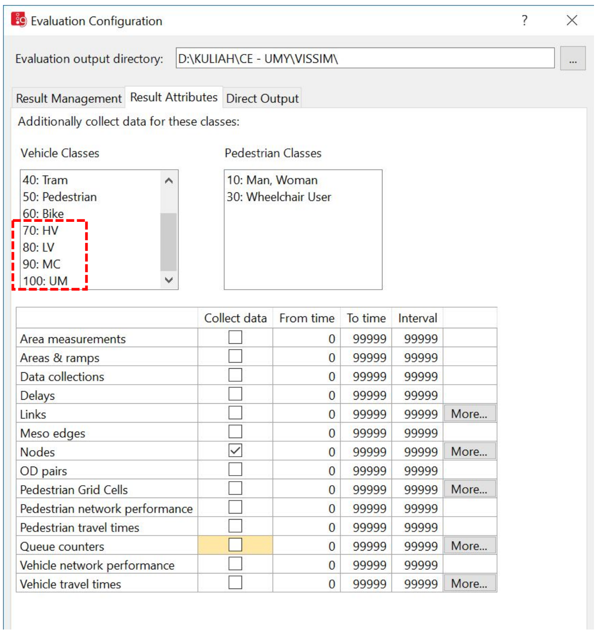

Fig. 12 - Evaluation Configuration Based on Classification Vehicle (Red Dotted Line Box)

h. Data Validation

For the process of calibrating and validating the data at this stage, we compare the results of the traffic volume that was captured during the volume survey recorded in the modelling. The analysis used is linear regression. The following are the results.

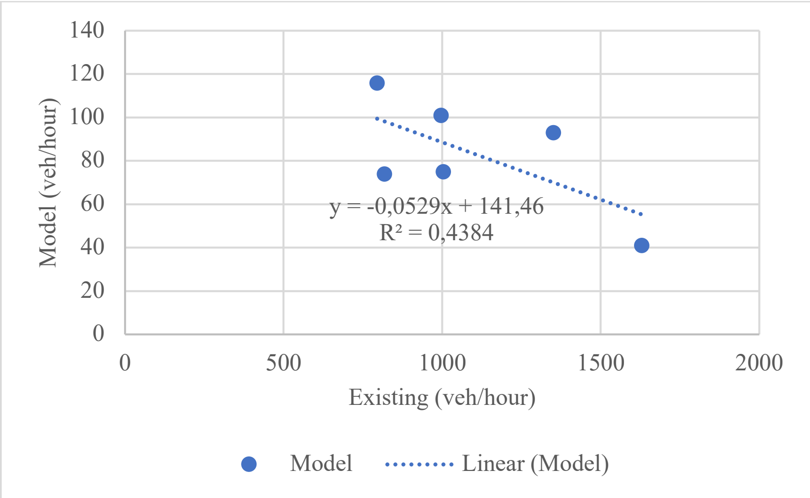

Fig. 13 – Data Validation Based On Traffic Volume

From the results of the regression analysis above, it is obtained that the value of R^2 (correlation coefficient) has a value of 0.4384. This result gives a sign that the model is still acceptable, it's because $R^2 > 0.3$.

3. The Result and Discussion

3.1 The Result of Traffic Modelling with PTV.VISSIM in Existing Condition

The parameters input of traffic simulation model of the existing conditions was made as closely as possible with the real conditions in the field. The results obtained can be seen in **Table 8.**

3.2 The Result of Traffic Modelling with PTV.VISSIM with Giving Signal

Based [10] on, he provided a reference for the provision of the signal by connecting the number of vehicle currents on the major road and the minor direction. For more details can be seen in

Fig. 14.

Dividing the needs of the intersection setting requirement is important. Setting requirement in 3 sections for low-volume vehicles with sufficient priority beam (in yellow area chart), for medium-volume intersections should be given signal or roundabout (in gray area charts), and for high-volume intersections, a cross-sectional intersection should be made (in red graphs) [10].

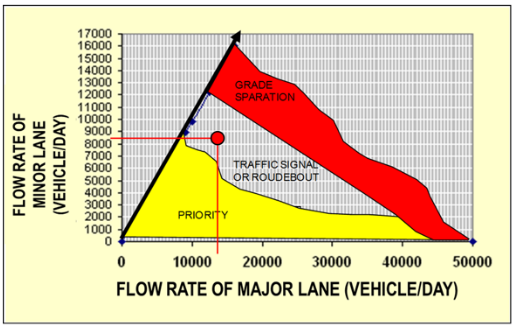

Fig. 14 - Determination of the type of intersection [10]

Based on the primary data, it can be known that major rate volume is 13206 veh/day and a minor rate volume is 8800 veh/day. It means, according to [10] the intersection requires Traffic Signal or Roundabout. In this study use giving signal scenario as a minimum effort which is compared with roundabout.

After giving signal scenario, the next phase is determining of time cycle of signal and the number of phases as well. Traffic signal setting that authors use is based on manual calculation by determining turning ratio [9]. Here the analysis about traffic signal setting.

a. The Time Setting of Traffic Signal

At the intersection, signaling is made using 3 phase signals. The model of that phase is shown in the following figures:

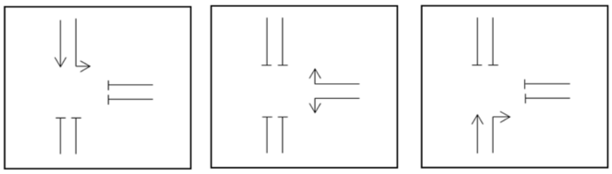

Fig. 15 - The Number of Time Cycles

The cycle time and green time calculations for each arm is shown in Vehicle volume values are derived from the summary of vehicle volumes in Fig. 5 and converted to units of PCU (Passenger Car Unit).

Table 7 - Volume and Road Capacity

Parameters	North	East	South
Volume (Q) (pcu/hour)	1126,4	946,8	1364,5
Capacity (S) (pcu/hour)	2100	2190	2100
Y (Q/S)	0,536	0,432	0,650
Ymax		1,618	

Since the value of Ymax is more than 1, the IFR value is used 0.9. Here the time setting of signalized intersection.

- Amber time : 2 seconds
- Allred time : 2 seconds
- Total lost time (L) : 12 seconds

Cycle time (Co) : $\frac{1,5.L+5}{1-IFR} = \frac{1,5.12+5}{1-0,9}$
: 230 seconds

Based on Marga, [3] explained that the normal cycle time value limit for intersection 4 is 130 seconds and intersection 3 is 100 seconds. From the trial and error process, the ideal cycle time for the intersection is 121 seconds, with the following calculation.

- Green time calculation (g)
  North : Y_north / IFR x (Co-L)
  : 0,536 / 1,618 x (121-12)
  : 36 seconds

  East : Y_east / IFR x (Co-L)
  : 0.432 / 1.618 x (121-12)
  : 29 seconds

  South east : Y_south / IFR x (Co-L)
  : 0.650 / 1.618 x (121-12)
  : 44 seconds

- South to the north: north + south + amber + allred
  : 36 + 44 + 2 + 2
  : 84 seconds

The picture of the phase diagram is shown in the following figure.

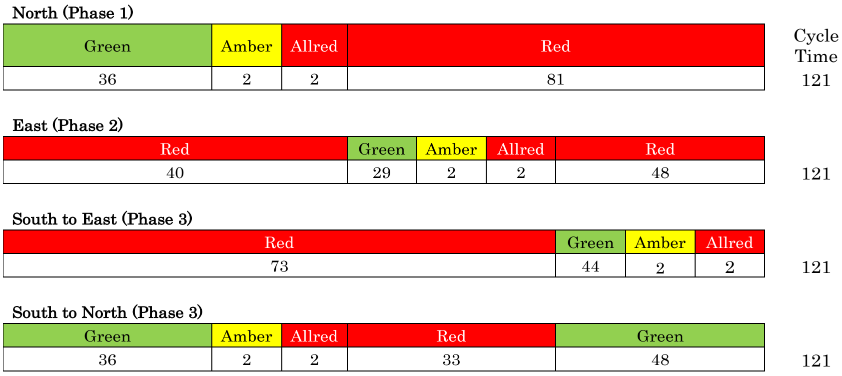

Fig. 16 - Diagram of 3 Phase Setting

b. The Result Model of The Signal Addition

In modeling with the addition of signal, the researchers used several scenarios as a comparison to get a good modeling result. Some of these scenarios are:

i. Scenario 1 - Signaling 3 phase without LTOR (Left Turn on Red)

In this scenario, any drivers who want to pass through left have to wait for the green light signal. In this condition, data processing result is shown in Table 9.

ii. Scenario 2 - Signaling 3 phases with LTOR (Left Turn on Red)

In this scenario, each driver can pass easily left without waiting for the signal light to turn green. The condition of the road network is compatible with a 3 phases scenario without LTOR, so it is the same as in the existing conditions.

The signaling phase used in this scenario is shown in the following figure.

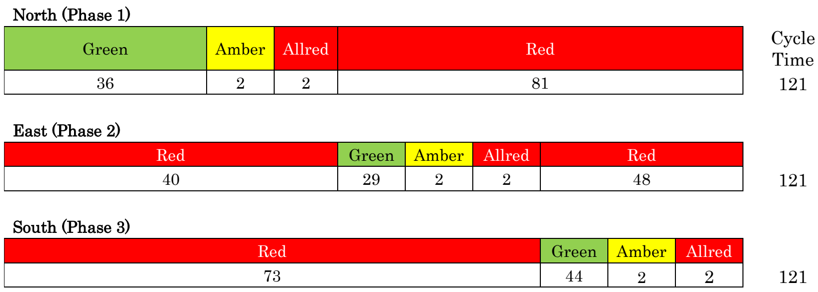

Fig. 17 - Diagram of 3 Phase Setting (Scenario 2)

The results of data processing in scenario 2 can be seen in Table 10.

iii. Scenario 3 - Signaling 3 Phases with LTOR and Road Widening

In this scenario, it is similar to the 3 phases scenario with LTOR, but there is the addition of 1 lane specific to the LTOR path.

The widening is 2 meters for the North and South and 1.8 meters for the Eastern segment. The widening length is used 50 meters for each road segment. The widening sketch image is shown in Fig. 18 and the results of data processing can be seen in Table 11.

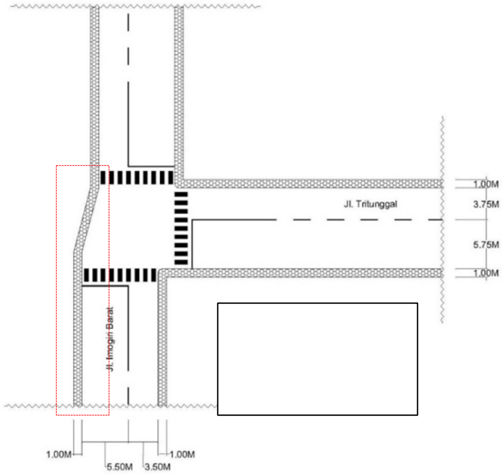

Fig. 18 - Geometric Changes in Intersections with Road Widening (Red Dotted Line Box)

The following is the appearance of each scenario from the results of traffic simulation modeling with PTV. VISSIM.

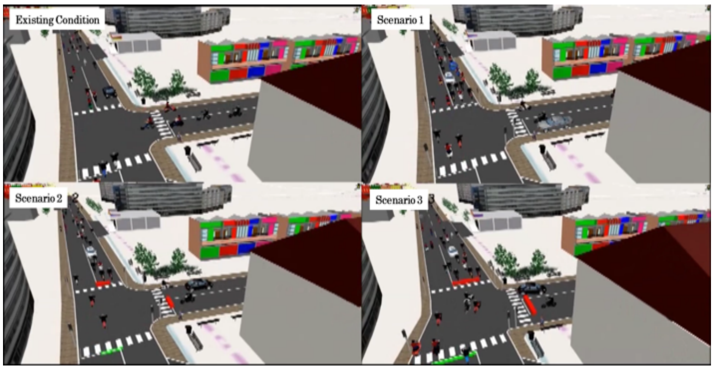

Fig. 19 - 3D Model of PTV. VISSIM (1)

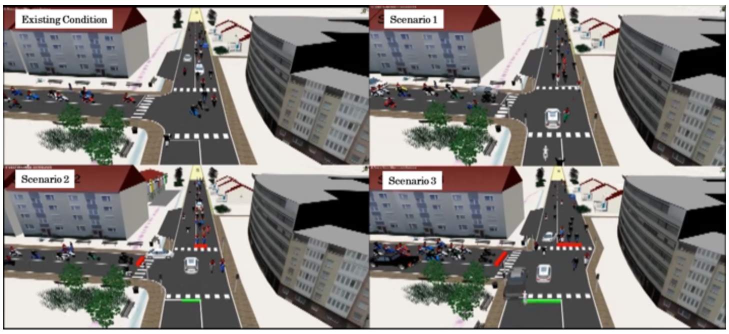

Fig. 20 - 3D Model of PTV. VISSIM (2)

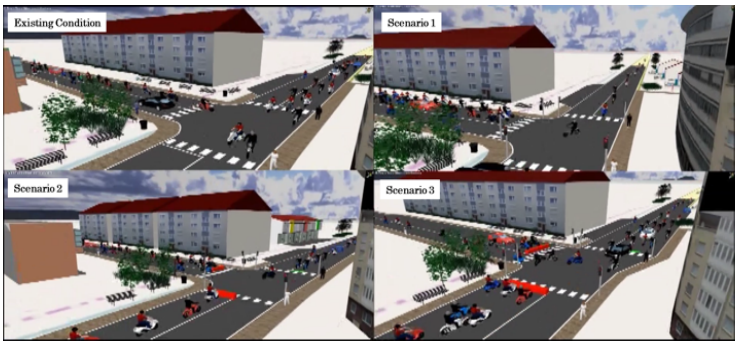

Fig. 21 - 3D Model of PTV. VISSIM (3)

And these following tables (Table 8, 9, 10 and 11) show the node result of PTV. VISSIM for 4 conditions.

Table 8 - Node Result Evaluation of Existing Condition with PTV. VISSIM Model

TIME INT	MOVEMENT	QLEN (m)	QLEN MAX (m)	VEHS (ALL) (unit)	PERS (ALL) (pers)	LOS (ALL)	LOS VAL (ALL)	VEH DELAY (ALL) (sec)	PERS DELAY (ALL) (sec)	STOP DELAY (ALL) (sec)	STOPS (ALL) (unit)	EMIS-SIONS CO (gram)	EMIS-SIONS NOX (gram)	EMIS-SIONS VOC (gram)	FUEL CONSUMP TION (US Galoon)
0-3600	Imogiri Barat (N) – Imogiri Barat (N)	5.72	33.98	120	125	LOS_A	1	6.79	7.11	0.34	0.17	61.514	11.968	14.257	0.88
0-3600	Imogiri Barat (N) – Tritunggal (E)	49.48	109.08	106	111	LOS_E	5	48.33	48.33	11.56	5.21	233.124	45.357	54.029	3.335
0-3600	Tritunggal (W) – Imogiri Barat (N)	71.6	125.57	88	90	LOS_F	6	100.41	100.7	39.72	12.83	415.033	80.75	96.188	5.938
0-3600	Tritunggal (W) – Imogiri Barat (S)	11.43	35.14	72	75	LOS_A	1	7.09	7.27	1.64	0.22	39.323	7.651	9.113	0.563
0-3600	Imogiri Barat (S) – Imogiri Barat (S)	0.33	20.81	101	105	LOS_A	1	8.59	9.12	0.28	0.28	67.295	13.093	15.596	0.963
0-3600	Imogiri Barat (S) – Tritunggal (E)	0.65	17.37	192	206	LOS_A	1	9.33	9.51	0.11	0.13	127.027	24.715	29.44	1.817
0-3600	**Average**	**17.76**	**125.57**	**696**	**729**	**LOS_D**	**4**	**25.78**	**25.76**	**7.08**	**2.54**	**926.42**	**180.248**	**214.707**	**13.254**

Table 9 - Node Result Evaluation of Scenario 1 with PTV. VISSIM Model

TIME INT	MOVEMENT	QLEN (m)	QLEN MAX (m)	VEHS (ALL) (unit)	PERS (ALL) (pers)	LOS (ALL)	LOS VAL (ALL)	VEH DELAY (ALL) (sec)	PERS DELAY (ALL) (sec)	STOP DELAY (ALL) (sec)	STOPS (ALL) (unit)	EMIS-SIONS CO (gram)	EMIS-SIONS NOX (gram)	EMIS SIONS VOC (gram)	FUEL CONSUMP TION (US Galoon)
0-3600	Imogiri Barat (N) – Imogiri Barat (N)	23.25	103.95	116	121	LOS_B	2	16.28	16.92	8.7	0.79	87.398	17.004	20.255	1.25
0-3600	Imogiri Barat (N) – Tritunggal (E)	56.23	106.53	93	98	LOS_E	5	60.22	60.34	50.46	1.15	140.13	27.264	32.477	2.005
0-3600	Tritunggal (W) – Imogiri Barat (N)	68.05	120.63	101	105	LOS_F	6	83.59	84.23	72.2	1.65	196.166	38.167	45.463	2.806
0-3600	Tritunggal (W) – Imogiri Barat (S)	64.4	120.76	74	80	LOS_F	6	86.39	86.15	72.9	1.62	149.312	29.051	34.605	2.136
0-3600	Imogiri Barat (S) – Imogiri Barat (S)	43.96	151.52	41	45	LOS_F	6	97.28	99.48	80.46	2.61	100.11	19.478	23.202	1.432
0-3600	Imogiri Barat (S) – Tritunggal (E)	111.8	153.4	75	83	LOS_F	6	133.53	132.92	108.46	4.17	245.119	47.691	56.809	3.507
0-3600	**Average**	**46.33**	**153.4**	**517**	**549**	**LOS_E**	**5**	**70.27**	**71.41**	**57.68**	**1.75**	**917.572**	**178.526**	**212.656**	**13.127**

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Table 10 - Node Result Evaluation of Scenario 2 with PTV. VISSIM Model

TIME INT	MOVEMENT	QLEN (m)	QLEN MAX (m)	VEHS (ALL) (unit)	PERS (ALL) (pers)	LOS (ALL)	LOS VAL (ALL)	VEH DELAY (ALL) (sec)	PERS DELAY (ALL) (sec)	STOP DELAY (ALL) (sec)	STOPS (ALL) (unit)	EMIS-SIONS CO (gram)	EMIS-SIONS NOX (gram)	EMIS-SIONS VOC (gram)	FUEL CONSUMP TION (US Galoon)
0-3600	Imogiri Barat (N) – Imogiri Barat (N)	4.51	34.01	102	107	LOS_B	2	10.69	11.08	1.1	0.42	63.178	12.292	14.642	0.904
0-3600	Imogiri Barat (N) – Tritunggal (E)	62.61	112.7	74	79	LOS_F	6	83.24	82.75	65.9	2.11	151.953	29.564	35.216	2.174
0-3600	Tritunggal (W) – Imogiri Barat (N)	73.94	122.87	83	86	LOS_F	6	100.66	101.74	84.08	2.25	193.99	37.743	44.959	2.775
0-3600	Tritunggal (W) – Imogiri Barat (S)	11.68	35.13	69	73	LOS_A	1	7.37	8.46	2.16	0.22	38.01	7.395	8.809	0.544
0-3600	Imogiri Barat (S) – Imogiri Barat (S)	31.6	119.96	80	82	LOS_D	4	54.95	54.96	39.98	1.42	125.159	24.351	29.007	1.791
0-3600	Imogiri Barat (S) – Tritunggal (E)	2	51.13	185	200	LOS_A	1	9.93	10.24	0.16	0.22	128.027	24.909	29.671	1.832
0-3600	**Average**	23.66	122.87	610	644	LOS_D	4	36.63	36.71	25.15	0.91	703.081	136.794	162.946	10.058

Table 11 - Node Result Evaluation of Scenario 3 with PTV. VISSIM Model

TIME INT	MOVEMENT	QLEN (m)	QLEN MAX (m)	VEHS (ALL) (unit)	PERS (ALL) (pers)	LOS (ALL)	LOS VAL (ALL)	VEH DELAY (ALL) (sec)	PERS DELAY (ALL) (sec)	STOP DELAY (ALL) (sec)	STOPS (ALL) (unit)	EMIS-SIONS CO (gram)	EMIS-SIONS NOX (gram)	EMIS-SIONS VOC (gram)	FUEL CONSUMP TION (US Galoon)
0-3600	Imogiri Barat (N) – Imogiri Barat (N)	3.88	21.89	128	133	LOS_A	1	8.03	8.62	0.82	0.33	75.038	14.6	17.391	1.074
0-3600	Imogiri Barat (N) – Tritunggal (E)	60.63	113.17	90	97	LOS_E	5	74.57	75.71	54.52	2.13	175.492	34.144	40.672	2.511
0-3600	Tritunggal (W) – Imogiri Barat (N)	58.28	116.43	103	107	LOS_F	6	94.76	96.23	76.02	2.61	242.204	47.124	56.133	3.465
0-3600	Tritunggal (W) – Imogiri Barat (S)	3.27	19.78	85	92	LOS_B	2	11.76	13.88	1.09	0.39	58.239	11.331	13.497	0.833
0-3600	Imogiri Barat (S) – Imogiri Barat (S)	18.59	108.79	80	82	LOS_D	4	40.94	41.19	29.6	1.23	108.606	21.131	25.171	1.554
0-3600	Imogiri Barat (S) – Tritunggal (E)	0.55	29	178	193	LOS_B	2	11.25	11.82	0.27	0.31	132.872	25.852	30.794	1.901
0-3600	**Average**	14.99	116.43	699	739	LOS_C	3	34.02	34.81	21.96	0.99	798.953	155.447	185.165	11.43

4. Summary

Based on the modeling results in all four conditions, the third scenario is the best model. Scenarios with a combination of traffic signals, enforcement of LTOR and arm widening can improve intersection performance and improve traffic safety. The parameters that can be used in the analysis of this study are (1) the fewer number of conflict points, due to signaling that can regulate movement, (2) greater intersection capacity, because more vehicles can be accommodated, (3) level of service (LOS) from the value of the delay is getting smaller. Thus, efforts to increase safety with the application of signalized intersections can be easy with the existence of micro simulation programs using PTV. VISSIM.

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