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Research paper

Analysis of traffic density onthree-way junction in Jalan Sukabangun 2 using Vissim simulations model

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Abstract

VISSIM is a Simulations model which means a city traffic simulation model. VISSIM is a simulation software used by professionals to create simulations from dynamic traffic scenarios before making real plans. This research was conducted to determine how traffic performance and traffic performance optimization at the junctions between the existing conditions and the Vissim program caused by congestion. An effective method for overcoming non-jammed junctions can be made using the VISSIM method. This study was conducted at THREE-WAY JUNCTION in Jl. Sukabangun 2 (South) - Jl. R.A Abusamah (West) - Jl. Sukabangun 2 (Utara) - Jl. Beringin-Sukabangun 2 (East). In this study, three variations were used, namely the traffic light method, the method of forbidden turning right, and the method of dividing the road and turning signs. The results of PTV Vissim simulation showed that the traffic light method has a quite high queue length, namely 79m compared to the existing condition of 63m, for the vehicle delay in this method is 98.954s. On the method of forbidden turning right from the direction of Jl. BeringinSukabangun 2 (East) has a low queue length of 0.287m compared to the existing condition of 63m. The vehicle delay in this method is 13.307s. The method of dividing the road and turning signs, the queue length is quite low at 1.147m compared to the existing condition of 63m. The vehicle delay in this method is 30,169s. The results of the simulation revealed that the most effective method at THREE-WAY JUNCTION in jalanSukabangun 2 is method of forbidden turning right, dividing the roads and turning signs.

Keywords:*Junction; Vissimsoftware; Vehicle Volume; Queue Length.*

1. Introduction

The development of a city is greatly influenced by the development of the transportation system. A system must be running well all the time. The more the population activity of an area increases, the movement of people, goods and services will also increase, thus the need for transportation services will also increase. The scope of transportation problems includes several things, one of which is the need for movement. The need for movement occurs because of the need to reach places of work, education, and others. Failure to meet the need for this movement will result in congestion, delays, or even traffic accidents [6]. This transportation movement problem often occurs in junction areas.A road junction is an area or place where two or more highways meet or intersect, including road facilities and road sides for traffic movement in that area. The main operational function of a junction is to provide for displacement or change in direction of travel. Road junctions are an important part of the road because most of the efficiency, safety, speed, operating costs and traffic capacity depend on the planning of thejunction[1]. As the case in Palembang City, it occurred at the junction in Jl. SukaBangun 2 - Jl. R.A Abusamah which was an junction with a high level of congestion, because it is the main access to many places. To address the problems occured at the junction of Jalan Jl. Sukabangun 2 - Jl. R.A Abusamah, it is necessary to evaluate the performance of the intersection to get a picture of the current intersection conditions, by examining the traffic volume. Therefore, a solution can be found for solving the problem. In this study, a traffic simulation was used with the PTV Vissim 2020 software, with a primary data collection plan in the form of a survey which was carried out for one working day and one off day.

2. Materials and methods

2.1. Research site

This research took place at the three way junction in Jl. SukaBangun 2 (South) - Jl. R.A Abusamah (West) - Jl. SukaBangun 2 (Utara) - Jl. BeringinSukaBangun 2 (East). The map of the research location and photos of the road situation can be seen in Figure 1.

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Fig. 1: Research Location (Source: Google Maps 2020) and the Three Way Junction Geometric Plan.

2.2. Data collection

a) Types ofSurvey[10]

- Survey of Junction Geometric

This survey was conducted to obtain information about land use conditions and dimensions at junctions that are useful for analyzing data in this study. The survey method used was direct data collection from the field.

- Survey of vehicle volume

This survey was conducted to calculate the volume of the vehicle according to the predetermined classification at each intersection approach. The method used was to record using a camcorder / camera.

- Survey of Vehicle Speed

The survey was conducted to determine the speed of the vehicle when crossing each approach at the junction. This survey was conducted using a GPS Speedometer - Trip Meter.

- Survey of Queue Length

This survey was conducted using Travel Distance software, namely by looking at the length of the queue of vehicles that were waiting or queuing at the junction then tracking the length of the queue of vehicles.

2.3. Time of survey

There were 5 types of surveys in this research. The schedule for carrying out the survey could be detailed as follows:

a) Survey of Junction Geometric wasconducted on January 3, 2021, this survey was to measure the dimensions of each junction approach.
b) Survey of vehicle volume wasconducted for 2 days, namely 1 working day and 1 day off on Sunday, January 3, 2021 and Monday January 4, 2021, from 08: 00-09: 00, 11: 00-12: 00 and 16: 00-17: 00
c) Survey of Vehicle Speed wasconducted on Wednesday, January 6, 2021, carried out for each vehicle passing the junction approach
d) Survey of Queue Lengthwasconducted on Thursday, January 7, 2021, carried out for each junction approach.

2.4. Survey equipment placement

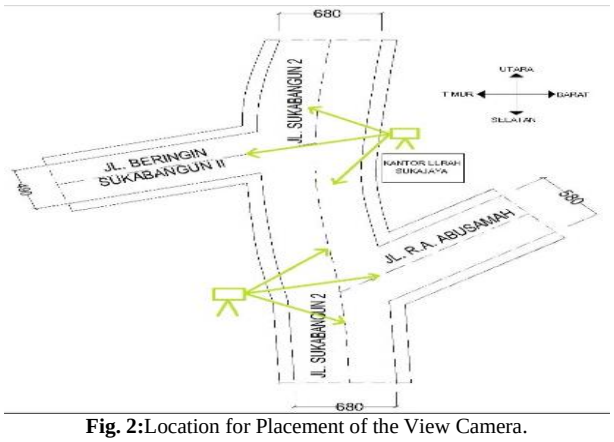


Fig. 2: Location for Placement of the View Camera.

3. Result and discussion

3.1.Characteristics of junction road[11]

a) Geometric of junction

The geometrical data of the junction shows the profile or sections of the junction such as the dimensions of roads and lanes. Based on the results of the survey, data of junction geometric can be seen in Table 1.

Table 1: Geometric Condition at Three Way Junction at Jl. Sukabangun 2 – Jl. R.A Abusamah

Junction names	Road name	Total number Lane	strip	Lane width(m)
Three way junctionJl. Sukabangun 2 – Jl. R.A Abusamah	Jl. Sukabangun 2 (South)	1	2	6,8
	Jl. R.A Abusamah (west)	1	2	5,8
	Jl. Sukabangun 2 (North)	1	2	6,8
	Jl. BeringinSukabangun 2 (East)	1	2	4,9

b) Traffic Circulation System (Direction of Movement) At junctions)[3]

The Traffic Circulation System shows a direction of movement of vehicles that will enter and exit the junction. Sketch of the direction of movement of the junction traffic at three way junction Jl. Sukabangun 2 - Jl. R.A Abusamah can be seen in Figure 3.

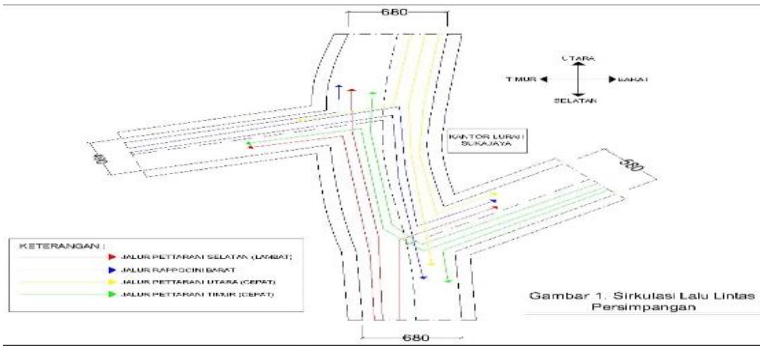


Fig. 3: Traffic Circulation at the Junction.

c) Traffic conflict points at junctions [3]

With the direction of vehicle movement at an intersection, the conflict area of three way junction Jl. Sukabangun 2 - Jl. R.A Abu Samah can be seen in Figure 4.

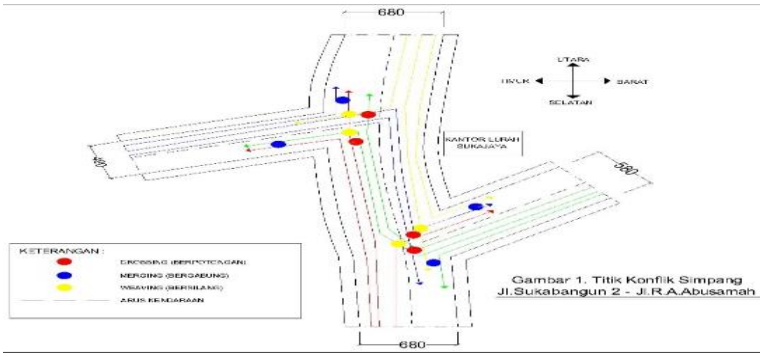


Fig. 4: Point of Conflict at the Junction.

d) Traffic volume[10]

Traffic volume is the number of vehicles passing through the junction under review, and the data is taken from the survey results directly. The data on the volume of vehicles of eachjunction carried out on Sundays and Mondays, starts from 08:00 - 09:00, 11:00 - 12: 00, and 16:00 - 17:00, the data can be seen in Figure 5 - Figure 8.

Figure 5. Graph of vehicle volume on Sunday Jl. Sukabangun 2 (South) shows that the largest volume of vehicles occurs in the straight direction to Jl. Sukabangun 2 (Utara), that is 230 vehicles / hour at 16: 45-17: 00 and the lowest volume is 58 vehicles / hour at 11: 45-12: 00 in the direction of turning left into Jl. BeringinSukabangun 2 (East)

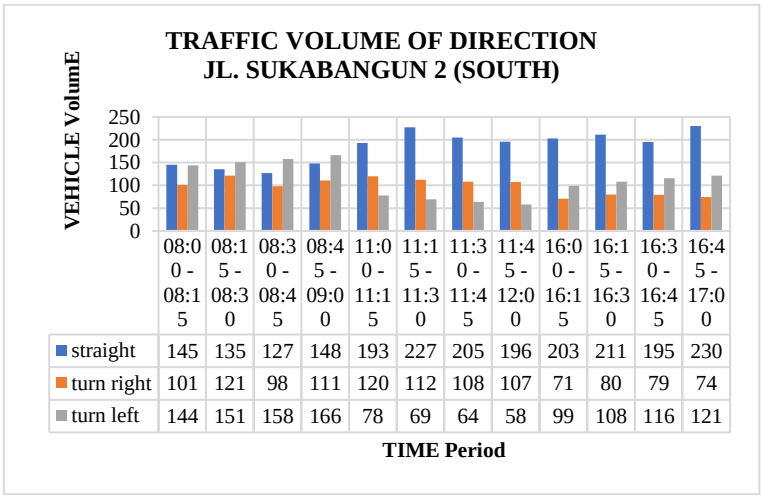
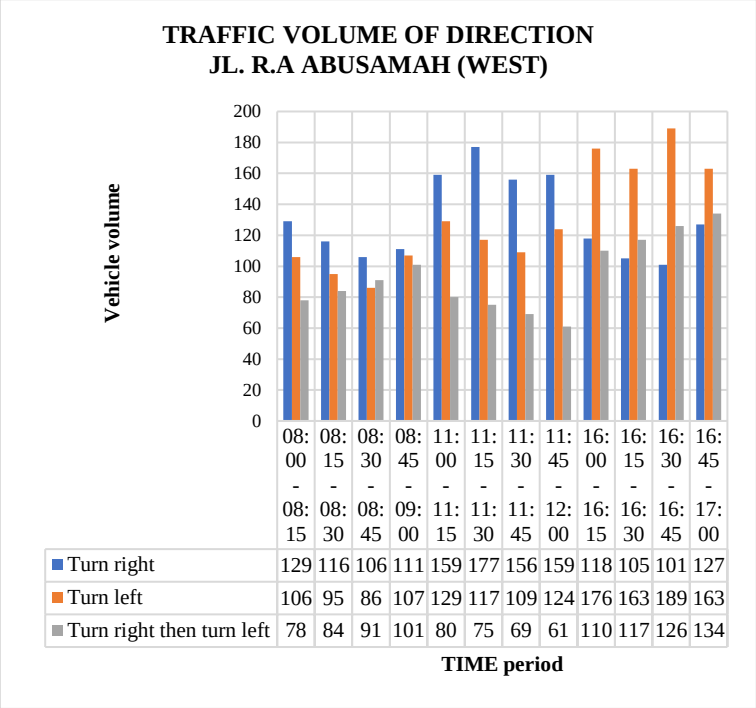


Fig. 5: Graph of Traffic Volume on Sunday at Jl. Sukabangun 2 (South).

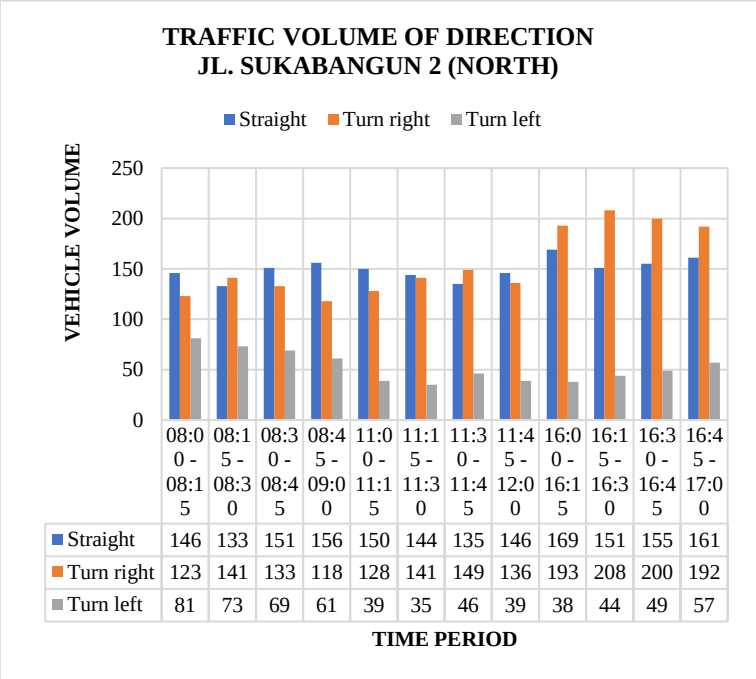
Figure 6. Graph of vehicle volume on Sunday at Jl. R.A Abusamah (West) shows that the largest volume of vehicles occurs in the direction of turning right into Jl. Sukabangun 2 (Utara) which is 189vehicles / hour at 16: 30-16: 45 and the lowest volume is 61 vehicles / hour at 11: 45 - 12:00 in the direction of turning right then turning left into Jl. BeringinSukabangun 2 (East)



	08:00 - 08:15	08:15 - 08:30	08:30 - 08:45	08:45 - 09:00	11:00 - 11:15	11:15 - 11:30	11:30 - 11:45	11:45 - 12:00	16:00 - 16:15	16:15 - 16:30	16:30 - 16:45	16:45 - 17:00
Turn right	129	116	106	111	159	177	156	159	118	105	101	127
Turn left	106	95	86	107	129	117	109	124	176	163	189	163
Turn right then turn left	78	84	91	101	80	75	69	61	110	117	126	134

Fig. 6: Graph of Traffic Volume on Sunday at Jl. R.A Abusamah (West).

Figure 7 Graph of vehicle volume on Sunday at Jl. Sukabangun 2 (Utara) shows that the largest volume of vehicles occurs in the direction of turning left into Jl. R.A Abusamah (West) that is 208 vehicles / hour at 16: 15-16: 30 and the lowest volume is 35 vehicles/ hour at 11: 15-11: 45 in the direction of turning right into Jl. BeringinSukabangun 2 (East).



	08:00 - 08:15	08:15 - 08:30	08:30 - 08:45	08:45 - 09:00	11:00 - 11:15	11:15 - 11:30	11:30 - 11:45	11:45 - 12:00	16:00 - 16:15	16:15 - 16:30	16:30 - 16:45	16:45 - 17:00
Straight	146	133	151	156	150	144	135	146	169	151	155	161
Turn right	123	141	133	118	128	141	149	136	193	208	200	192
Turn left	81	73	69	61	39	35	46	39	38	44	49	57

Fig. 7: Graph of Traffic Volume on Sunday at Jl. Sukabangun 2 (North).

Figure8. Graph of vehicle volume on Sunday at Jl. BeringinSukabangun 2 (East) shows that the largest volume of vehicles occurs in the direction of turning right then turning left into Jl. R.A Abusamah (West) which is 108 vehicles / hour at 16: 15-16:30 and the lowest volume is 14 vehicles / hour at 16: 00-16: 15 in the direction of turning left into Jl. Sukabangun 2 (North).

Based on the results of the vehicle volume dataobtained, it is known that the volume of vehicles passing each period at each junction from 08.00 - 17.00 has a different volume. And based on the total volume of all types of vehicles, it can be concluded that for Sundays the peak hours are 16: 45-17: 00 with 230 vehicles / hour and non-peak hours at 16: 00-16: 15 with 14 vehicles/ hour.

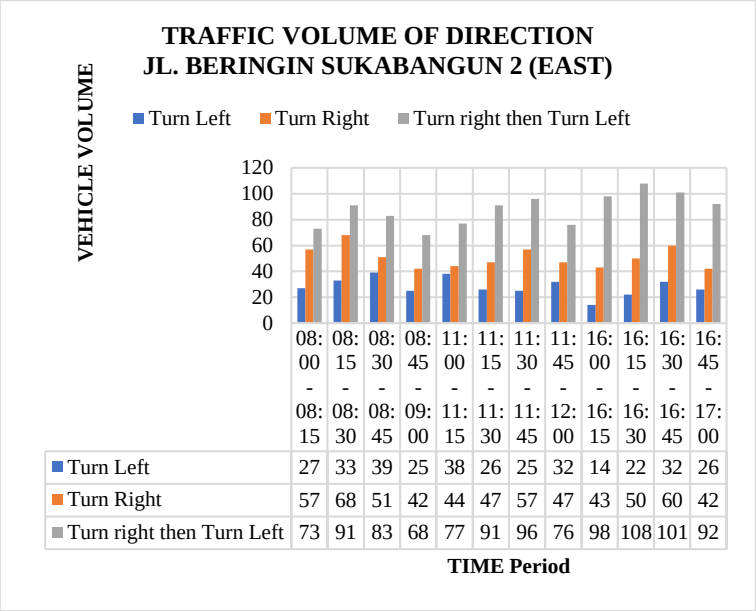


Fig.8: Graph of Traffic Volume on Sunday at Jl. BeringinSukabangun 2 (East)

e) Speed of traffic flow[3]

The results of the vehicle speed survey in the field at each junction of Jl. Sukabangun 2 (South) - Jl. R.A Abusamah (West) - Jl. Sukabangun 2 (North). It is shown in graphic form in Figure 9 - Figure 12.

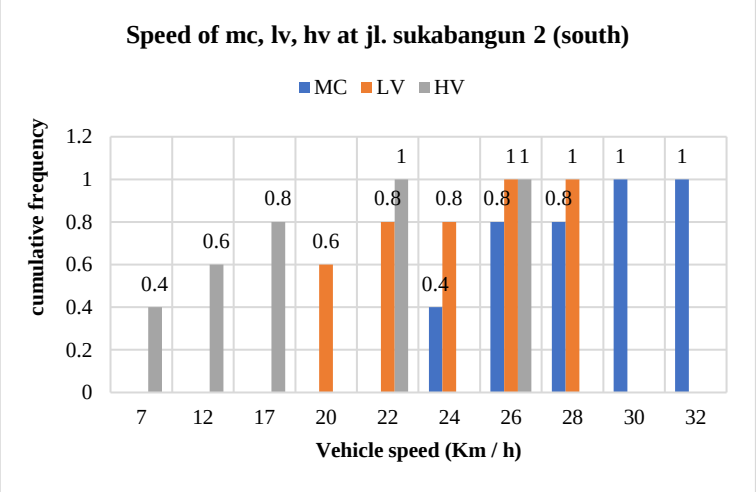


Fig. 9: Graph of Vehicle Speed MC, LV and HV.

Figure 9. Graph shows that the speed of vehicles type MC (motorbikes) has a high speed ranging from 30 km / h - 32 km / h and the lowest speed is vehicles type MC (heavy vehicle) ranges from 7 km / h - 12 km / h at Jl. Sukabangun 2 (South).

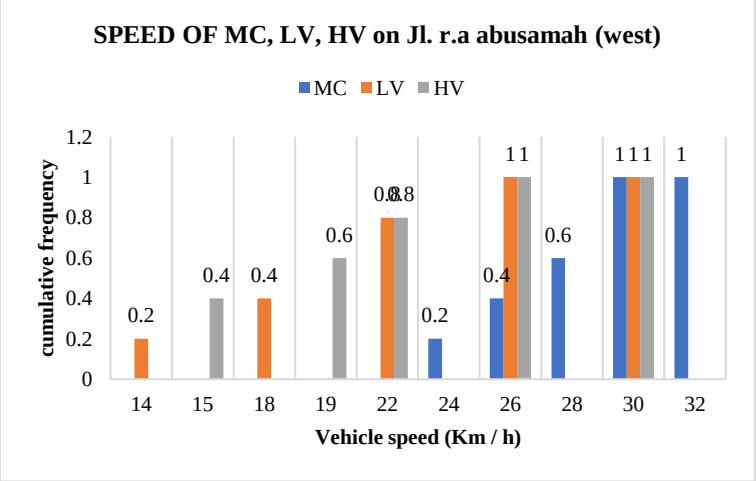


Fig. 10: Graph of Vehicle Speed MC, LV and HV.

Figure 10. Graph shows that the speed of vehicles type MC (motorbikes) has a high speed ranging from 30 km / hour - 32 km / hour and the lowest speed is the HV type (heavy vehicle) ranging from 15 km / hour - 19 km / hour at Jl. R.A Abusamah (West).
Figure 11. Graph shows that the speed of vehicles type MC (motorbikes) has a high speed ranging from 32 km / hour - 36 km / hour and the lowest speed is the HV type (heavy vehicle) ranging from 8 km / hour - 11 km / hour at Jl. Sukabangun 2 (North).

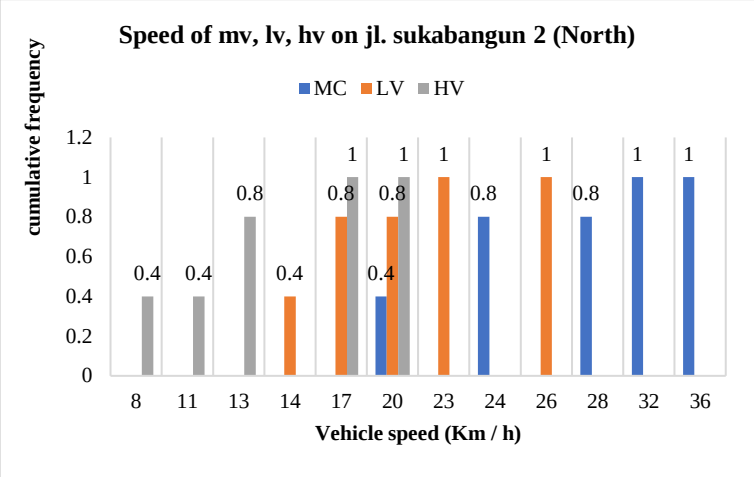


Fig. 11: Graph of Vehicle Speed of MC, LV and HV.

Figure 12. Graph shows that the speed of vehicles type MC (motorbikes) has a high speed ranging from 25 km / h - 27 km / h and the lowest speed is the HV type (heavy vehicle) ranging from 11 km / h - 13 km / h at Jl. BeringinSukabangun 2 (East).

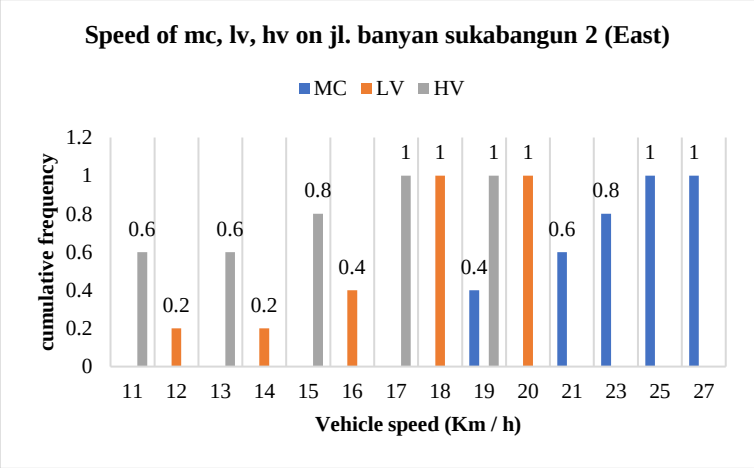


Fig. 12: Graph of Vehicle Speed ofMC, LV and HV.

f) Traffic Queue Length[3]

The results of the survey of the queue length at each junction at Jl. Sukabangun 2 (South) - Jl. R.A Abusamah (West) - Jl. Sukabangun 2 (Utara) - Jl. BeringinSukabangun 2 (East) is shown in graphic form in Figure 13.

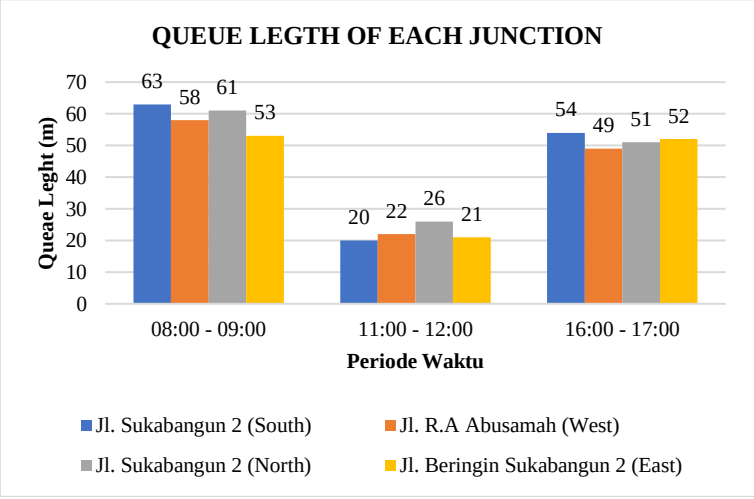


Fig. 13: Queue Length at Each Junction.

Figure 13. Graph shows that the highest peak queue length is 63 meters at Jl. Sukabangun 2 (South) around 08:00 - 09:00, and the lowest queue is 20 meters at Jl. Sukabangun 2 (South) around 11:00 - 12:00.

3.2. Junction Simulation Modelling[3]

Simulation modelling with Vissim software is carried out as in the simulation modelling steps previously discussed, that is by inputting processed data. The data entered is in accordance with the observation data, data are the vehicle model used, the distribution of vehicle speed, the route of travel, the composition of the vehicle, the number of vehicles per road section. After all data has been inputted, the simulation is run.

3.3. Calibration and validation of simulation model[8]

a) Calibration of Simulation Model

To produce an output that matches the reality in the field, a calibration is carried out by changing the parameters of the driver's behaviour (driving behaviour) through trial and error by referring to the parameter values in previous studies.Based on the parameters in the Vissim software, then the calibration process is carried out on the vehicles volume during peak hours and non-peak hours in the morning, afternoon and evening. The parameters and calibration values for each peak and non-peak hour period are shown in Table 2.

Table 2: Calibration Value of Junction

Parameter	Period		
	08:00 – 09:00	11:00 – 12:00	16:00 – 17:00
Average Standstill Distance	0.6	0.4	0.6
Add. Part of Desired Safety Distance	0.6	0.4	0.6
Mul. Part of Desired Safety Distance	1	1	1
No. of Observed Vehicle	8	4	8
Lane Change Rule	Free Lane Selection	Free Lane Selection	Free LaneSelection
Desired Lateral Position	any	any	any
Lateral Distance Driving	0.4	0.2	0.4
Lateral Distance Standing	0.2	0.2	0.2
Safety Distance Reduction Factor	0.6	0.6	0.6
Minimum Headway	0.5	0.5	0.5

Table 2.showssome parameters and their calibration values, the calibration results above indicate that several parameters have the same value for each period, while the parameters for Average Standstill Distance, Lateral Distance Driving and Lateral Distance Standing have different values depended on the simulation time period. The results of the analysis after calibration with the GEH test on vehicle volume based on the parameter values are shown in Table 3.

As seen at Table 3., the results of the calibration with the GEH test for all roads in each period have met the requirements, when the value obtained is <5, it means that the simulation model has been accepted or has been calibrated

Table 3: Calibration Results with Geoffrey E. Havers Test on Traffic Volume

Result	Road names	Period		
		08:00 – 09:00	11:00 – 12:00	16:00 – 17:00
Model	Jl. Sukabangun 2 (South)	855	1166	1041
	Jl. R.A Abusamah (West)	746	1025	1040
	Jl. Sukabangun 2 (North)	1000	1026	1321
	Jl. BeringinSukabangun 2 (East)	268	246	219
Observation	Jl. Sukabangun 2 (South)	986	1268	1143
	Jl. R.A Abusamah (West))	856	1130	1142
	Jl. Sukabangun 2 (North	1101	1129	1429
	Jl. BeringinSukabangun 2 (East)	342	316	289
GEH test	Jl. Sukabangun 2 (South)	4,31	2,92	3,08
	Jl. R.A Abusamah (West))	3,88	3,19	3,08
	Jl. Sukabangun 2 (North	3,11	3,13	3,91
	Jl. BeringinSukabangun 2 (East)	4,23	4,17	4,39
Conclusion		Accepted	Accepted	Accepted

Figure 14.shows a visual display on the Vissim software before and after the calibration, before calibration the traffic flow of vehicles is very regular and in their respective lanes, the distance between the vehicles is so tenuous. After calibration, the flow of vehicles is irregular, and overtaking occurs, the distance between the vehicles is also very tight. This shows that the driver's behaviour in heterogeneous traffic is in accordance with the conditions in the field, thus the simulation model can be accepted.

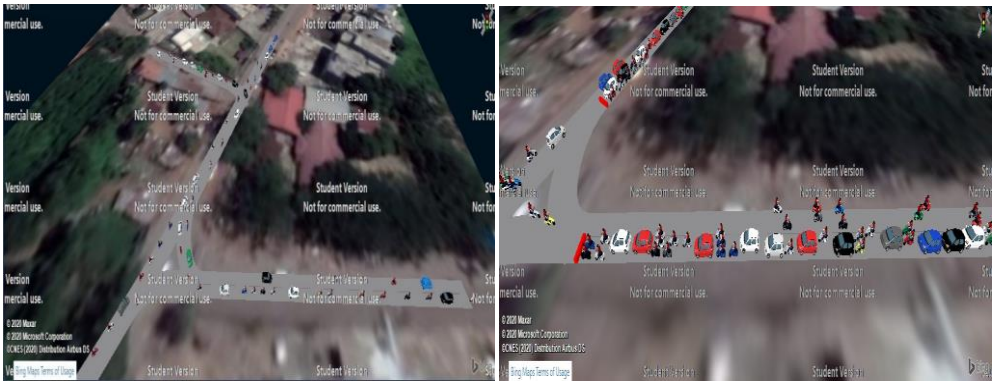


Fig. 14: Before and After Calibration.

b) Validation of Simulation Model[13]

- Traffic Light Method

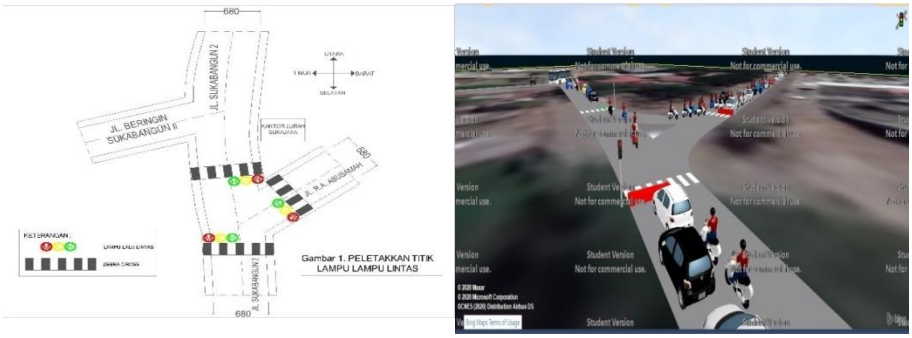


Fig. 18: Positioning of Traffic Light Point and Vissim Simulation Modeling.

4. Conclusion

1) Driving behaviour parameter values such as, Average Standstill Distance, Lateral Distance Driving and Lateral Distance Standing are the benchmarks for whether the model is accepted or not. In the period 08:00 - 09:00. 11:00 - 12:00, 16:00 - 17:00 respectively has an Average Standstill Distance value of 0.6 m; 0.4 m; 0.6 m; and a Lateral Distance Driving value of 0.4 m; 0.2 m; 0.4 m; while value Lateral Distance Standing were 0.2 m; 0.2 m; 0.2 m.
2) The results of the Vissim simulation modelling showed that the largest queue length value in the first method was 79.460 m from the direction of Jl. Sukabangun 2 (Utara) - Jl. BeringinSukabangun 2 (East). In the second method, the value was 0.287 m from Jl. Sukabangun 2 (North). In the third method, the value was 1.147 m from the direction of Jl. Sukabangun 2 (North).
3) The results of the Vissim simulation modelling showed that the largest value of vehicle delay in the first method was 98.954 s from the direction of Jl. BeringinSukabangun 2 (East). In the second method, the value was 13.307 s from the direction of Jl. R.A Abusamah (West). In the third method, it was 30.169 s from the direction of Jl. R.A Abusamah (West).

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