PERFORMANCE ANALYSIS OF SIGNALIZED INTERSECTIONS ON JL. SOEKARNO HATTA, JL. MT. HARYONO, AND JL. MAYJEND PANJAITAN WITH SOFTWARE PTV VISSIM 9 AND MKJI 1997 METHOD

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Abstract: The higher population growth makes the community's need for transportation facilities and infrastructure also higher. One of the intersections that is always crowded with vehicles from various directions, especially during rush hours on weekdays in Malang is the Jl. Soekarno Hatta due to the increase in the volume of vehicles from year to year. In addition, the traffic light at the intersection of Jl. MT. Haryono has been disabled by engineering traffic for motorists going to Jl. Mayjend Panjaitan was required to turn back on Jl. Soekarno Hatta first. This causes vehicle queues, delays, and congestion on Jl. Soekarno Hatta at certain hours which resulted in longer travel times. This study aims to (1) describe the results of the evaluation of the performance of the signalized intersection software PTV Vissim 9 and MKJI 1997, (2) describe the performance of the signalized intersection for the next 5 years, (3) plan alternative solutions to the problems that occur at the signalized intersection in the existing condition. This research method refers to the analysis of MKJI 1997 and PTV Vissim 9 which is used to obtain the existing saturated condition which will later be used as a reference for calculating the prediction of intersection performance in the next 5 years and as a reference in planning alternative solutions that allow to improve the performance of the signalized intersection. Based on the results of the study, it is known that (1) the performance of the existing condition is very saturated where at the intersection of Jl. Soekarno Hatta DS value 0.945, while Jl. Mayjend Panjaitan DS value of 0.945. The average delay is 36.75 sec/pcu category D. Vissim's calculation is 62.58 sec/veh with category E. (2) Prediction of intersection performance in the 5th year obtained a delay value of 37.51 sec/pcu category D for existing conditions. (3) Alternative solutions that allow to improve intersection performance include alternative 2 adding phases, movement, and widening the road with a DS value of 0.872 for all approaches, an average delay of 22.97 sec/pcu category C. Vissim's calculation obtained 72.64 sec/veh with category E. Alternative 4 is the addition of underpass with a DS value of 0.879 for all approaches, the average delay is 22.77 sec/pcu category C. Predicted performance in the 5th year obtained a delay value of 23.32 sec/pcu category C for alternative 2 and 22.90 sec/pcu category C for alternative 4. It is known that alternative 4 solution allows to improve the performance of signaled intersections, this can be seen in the delay obtained.

Keywords: performance of intersection, signalized intersection, MKJI, vissim

1. INTRODUCTION

Transportation is one of the most important aspects for people's lives to support various activities carried out by humans to meet their needs, such as connecting their residence with the workplace, education or place of manufacture of commodities and their customers (Khisty, 2005). The transportation node is formed from the flow of vehicles from several of these approaches meeting and scattering at the intersection. Intersections become the focal point of congestion due to conflicting driver movements involving long queues, time delays, and others (Soedirdjo, 2002).

One of the intersections that is always crowded with vehicles from various directions, especially during rush hours on weekdays in Malang is the Jl. Soekarno Hatta, Jl. MT. Haryono, and Jl. Mayjend Panjaitan. Tanjung (2015), conducted research on the performance of intersections with traffic light conditions on Jl. MT. Haryono is

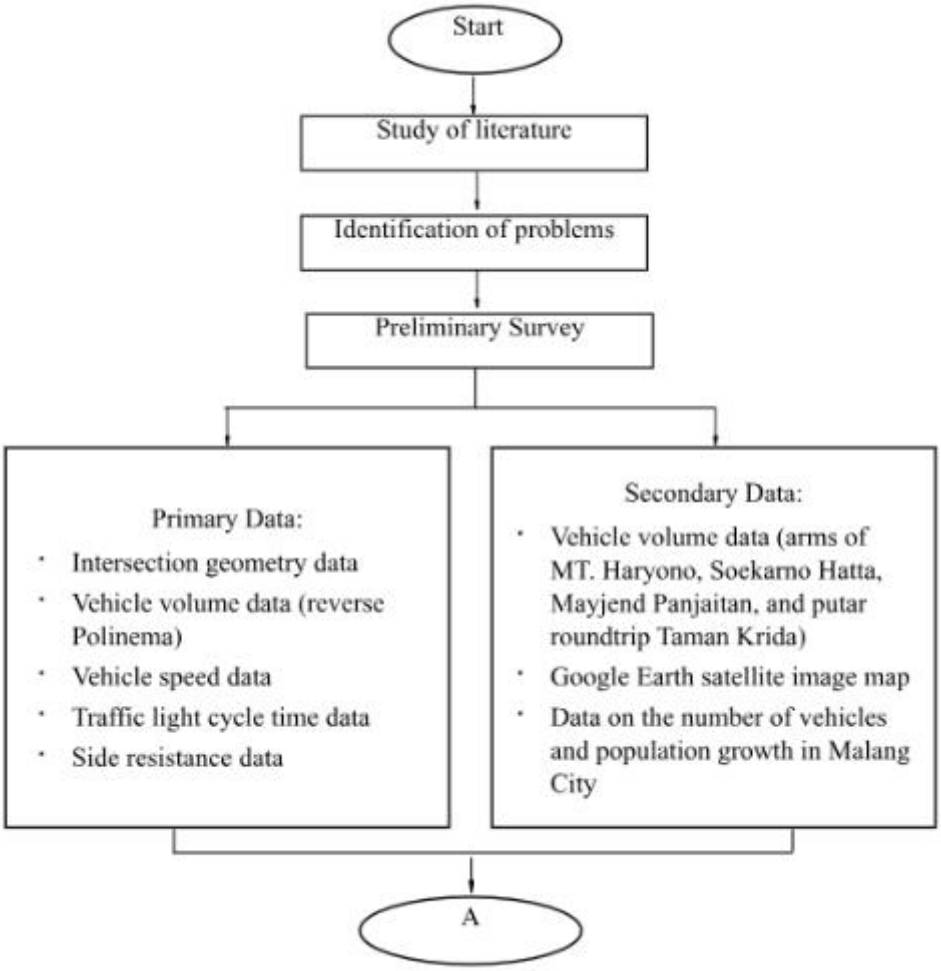
still functioning. In this study, the results of the degree of saturation (DS) 0.94 with a service level of D in the existing condition. Then an alternative geometry improvement and cycle time optimization were carried out from 81 seconds to 99 seconds. With the alternative, the obtained DS 0.77 with a service level of C.

Based on current real conditions, namely the traffic light at the intersection of Jl. MT. Haryono has been disabled by traffic engineering. Traffic engineering carried out is traffic flow from Jl. MT. Haryono to Jl. Soekarno Hatta applies Left Turn On Red (LTOR) and towards Jl. Mayjend Panjaitan applies a ban on straight roads. So that drivers who are going to Jl. Mayjend Panjaitan was required to turn back on Jl. Soekarno Hatta first. This causes vehicle queues, delays, and congestion on Jl. Soekarno Hatta at certain hours which resulted in longer travel times. This intersection is also not supported by good geometric conditions, where there is a bridge not far from the intersection.

Based on the problems above, the researchers will conduct research with "***Performance Analysis Of Signalized Intersections on Jl. Soekarno Hatta, Jl. MT. Haryono, and Jl. Mayjend Panjaitan with Software PTV Vissim 9 and MKJI 1997 Method***".

2. METHODS

The research method used in this study can be seen in the flow chart as shown in Figure 1 below.


Start
Study of literature
Identification of problems
Preliminary Survey
Primary Data:
Intersection geometry data
Vehicle volume data (reverse Polinema)
Vehicle speed data
Traffic light cycle time data
Side resistance data
Secondary Data:
Vehicle volume data (arms of MT. Haryono, Soekarno Hatta, Mayjend Panjaitan, and putar roundtrip Taman Krida)
Google Earth satellite image map
Data on the number of vehicles and population growth in Malang City
A

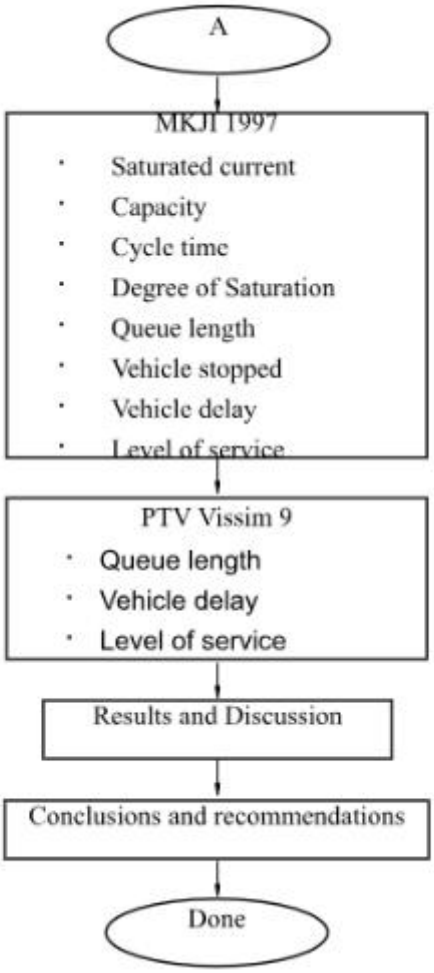


Figure 1. Research Flowchart

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NB: penulisan diagram alir penelitian harus sesuai dengan format aturan penulisan flowchart, berbeda dengan penulisan alur penelitian/konsep berpikir.

2.1. **Research variable**

The variables in this study are the level of performance of signalized intersections, alternative solutions of signalized intersections, and predictions of traffic growth. The performance level variables for signalized intersections are capacity, current saturation, degree of saturation, queue length, delay, and level of service. The alternative solution variable for signalized intersections is in the form of several alternatives that are raised to increase the ability of signalized intersections. The predictive variable for traffic growth is in the form of predicting the ability of signalized intersections for the next 5 years based on existing conditions and selected alternatives.

2.2. **Data analysis**

The data analysis procedure that will be carried out on the existing condition of the intersection will be processed using the 1997 Indonesian Road Capacity Manual method and the PTV Vissim 9 program which will produce signalized intersection performance.

2.3. **Performance of Signalized Intersections for the Next 5 Years**

Traffic growth projections are estimates of future traffic growth calculations that can be calculated using the geometric method. The geometric method itself uses the

assumption that the amount of each data will increase geometrically from year x to the next year (year x). The formula that will be used is like Equation 1 below.

$$Pn=Po1+rn \qquad \text{Equation. 1}$$

Pn = Vehicle volume in year-n
Po = Volume of vehicles in the first year
r = Percentage of growth per year
n = year-n

3. RESULT AND DISCUSSION

The results and discussion of the research that has been carried out are as follows.

3.1. Traffic Volume at Peak Hours

Based on a survey of vehicle volume carried out for 3 days, the peak hour daily traffic volume occurs on Saturday, October 2, 2021 at 17.45-18.45 WIB with detailed data in Table 1.

Table 1. Traffic Volume at Peak Hour Saturday, October 2, 2021

Time	Traffic Volume at Peak Hour (pcu/hr)						
	LV		HV		MC		Amount
	LTOR/ STOR	RT	LTOR STOR	RT	LTOR/ STOR	RT	
17.45-18.45	North Approach						
	414	744	0	5,2	232,2	460	1855,4
	East Approach						
	164	686	0	0	69	291,8	1210,8
	West Approach						
	976	-	5,2	-	585,4	-	1566,6

Source: Field Results

Based on Table 1, it is known that on the North approach there are LV 414 junior high school/hour turning left and 744 junior high school/hour turning right, HV 5.2 junior high school/hour turning right, and MC 232.2 junior high school/hour turning left and 460 junior high school/hour turning left. right. On the East approach, there are LV 164 pcu/hr straight and 686 pcu/hr turning right, and MC 69 pcu/hr going straight and 291.8 pcu/hr turning right. On the West approach, there are LV 979 pcu/hr turning left, HV 5.2 pcu/hr turning left, and MC 585.4 pcu/hr turning left.

3.2. Existing Condition

The results of the calculation of the existing conditions using the 1997 MKJI analysis obtained the recapitulation results in Table 2.

Table 2. MKJI 1997 Calculation Results Existing Condition

Approach	Saturated current *(S)*	Traffic flow *(Q)*	Saturated current ratio	Capacity *(C)* (pcu/hr)	Degree of saturation *(DS)*	Queue length *(QL)*	Vehicle stopped (N_{SV})	Vehicle delay (D_I)	Level of service

	(pcu/hr)	(pcu/hr)	*(FR)*				(pcu/hr)	(sec/pcu)	
North	2194,98	1076	0,49	1138,32	0,945	402,29	1040		
East	2132,82	877	0,41	927,92	0,945	364,61	879	36,75	D
West									

Source: Computer Data Processing

Based on Table 2 shows that the DS value obtained is 0.945 for the North and East approaches. According to MKJI 1997, the intersection will be in a saturated condition causing long queues at peak traffic conditions. The delay value is 36.75 sec/pcu, the service level is D. The average total delay time experienced by the vehicle when passing through the intersection is 36.75 seconds with a cycle time of 173 seconds. According to the Regulation of the Minister of Transportation Number KM 14 of 2006, this shows that traffic conditions are approaching unstable, a relatively large decrease in speed due to the volume of vehicles and obstacles that arise as well as increasingly limited freedom of movement, but this condition can still be tolerated for a short time.

Based on the results of the calculation of the survey data above, a recapitulation table of the results of the 1997 MKJI and Vissim is obtained which can be seen in Table 3.

Table 3. Results of the 1997 MKJI and Vissim Calculation Recapitulation

Time Period	Reference	Analysis Results	
		Parameter	**Score**
17.45–18.45 WIB	MKJI 1997	DS	0,945
		Queue length (m)	383,45
		D (det/pcu)	36,75
	Vissim	*LOS*	E
		QLen (m)	117,59
		VehDelay (det/kend)	62,58

Source: Computer Data Processing

Based on the results of the Vissim simulation, the delay value is 62.58 seconds / drive with a service level of F. This causes traffic flow to be stuck with high traffic density and long vehicle queues, causing congestion.

According to Table 3, the results of the 1997 Indonesian Road Capacity Manual (MKJI) and PTV Vissim methods are different due to the following factors.

a. For the 1997 MKJI method, peak hour performance was analyzed by converting the passenger car equivalent value (emp) for LV, HV, and MC while the Vissim method used vehicle volume veh/hour without any unit conversion to pcu/hour.
b. The researcher uses PTV Vissim 9-05 student version which can only simulate the program for 10 minutes or 10 cars, by evaluating in per unit vehicle/hour in the 1997 MKJI.
c. The influencing results are also based on the Vissim PTV program which simulates field conditions of vehicles and can make adjustments to driver behavior/Driving Behaviors so that the simulation results can be different from field conditions.

3.3. Traffic Growth Prediction for the Next 5 Years

The results of the calculation of the prediction of the ability of the intersection for the next 5 years are shown in Table 4.

Tabel 4. Prediction of Intersection Ability in the Next 5 Years Existing Condition

Year	Year	Capacity *(C)* (pcu/hour)		Degree of saturation *(DS)*		Vehicle delay *(D_I)* (sec/pcu)	Level of service
		North	East	North	East		
0	2021	1138	928	0,95	0,95	36,75	D
1	2022	1138	928	0,96	0,96	36,87	D
2	2023	1138	928	0,97	0,97	37,00	D
3	2024	1138	928	0,99	0,99	37,15	D
4	2025	1138	928	1,00	1,00	37,31	D
5	2026	1138	928	1,02	1,02	37,51	D

Source: Computer Data Processing

Based on Table 4, it shows that in the 5th year for the North approach, the capacity value is 1138 pcu/hour and the DS is 1.02. For the Eastern approach, the capacity value is 928 pcu/hour and the DS is 1.02. The delay is 37.51 sec/pcu and the service level is D. It is concluded that the intersection in the existing condition of the 5th year will be in a saturated condition which causes long queues in peak traffic conditions because the degree of saturation is greater than 0.85. According to the Regulation of the Minister of Transportation Number KM 14 of 2006, this shows that traffic conditions are approaching unstable, there is a decrease in speed due to the increasing volume of vehicles and obstacles, so that freedom of movement is increasingly limited..

3.4. Alternative Solution 1

Alternative 1 is the addition of traffic lights and the addition of traffic phases and movements on the Western approach. The addition of traffic signals on the West approach causes the 2-phase rule at the intersection to change to 3 phases. Alternative 1 calculation results in Table 5.

Tabel 5. Alternative Calculation Results 1

Approach	*S* (pcu/green hour)	*Q* (pcu/hour)	*FR* *(Q/S)*	*PR* *(FR/IFR)*
North	2292,95	1076	0,47	0,42
East	2132,82	877	0,41	0,37
West	1621,87	386	0,24	0,21
		IFR =	1,12	

Source: Computer Data Processing

Based on Table 5, the IFR value is 1.12. According to MKJI 1997, the maximum IFR value that can be used in calculating the cycle time before adjustment is 0.96. Then the calculation of Form SIG-IV cannot be continued because it will result in a negative value of cycle time before adjustment.

3.5. Alternative Solution 2

Alternative 2 is the addition of traffic lights and the addition of phases and traffic movements on the West approach and road widening on the East and West approaches. The width of the East approach road for the direct left turn (W_{LTOR}) is 4 m and the entrance width (W_{ENTER}) is 6 m with the approach width (W_A) being 10 m. While the

width of the West approach road for the direct left turn (W_{LTOR}) is 4 m and the entrance width (W_{ENTER}) is 6.6 m with the approach width (W_A) being 10.6 m. Alternative 2 calculation results in Table 6.

Tabel 6. Alternative Calculation Results 2

Approach	Saturated current *(S)* (pcu/ hour hijau)	Traffic flow *(Q)* (pcu/hour)	Rasio Saturated current *(FR)*	Capacity *(C)* (pcu/hour)	Degree of saturation *(DS)*	Queue length *(QL)*	Vehicle stopped (N_{sv}) (pcu/hour)	Vehicle delay (D_i) (sec/pcu)	Level of service
North	2292,95	1076	0,47	1233,71	0,872	138,97	986		
East	3877,85	877	0,23	1005,68	0,872	76,80	898	22,97	C
West	3568,11	386	0,11	442,90	0,872	34,91	477		

Source: Computer Data Processing

Based on Table 6 shows that the DS value obtained is 0.872 for the North, East, and West approaches. According to MKJI 1997, the intersection will be in a saturated condition causing long queues at peak traffic conditions. The delay value is 22.97 sec/pcu, the service level is C. The average total delay time experienced by the vehicle when passing through the intersection is 22.97 seconds with a cycle time of 64 seconds. According to the Regulation of the Minister of Transportation Number KM 14 of 2006, this shows that traffic conditions are within stable limits but the speed and movement of vehicles are limited by other vehicles, the obstacles are getting bigger, and the driver has limitations to overtake and choose the speed.

The results of the calculation of the prediction of the ability of the intersection in the next 5 years for alternative 2, the results are shown in Table 7.

Tabel 7. Prediction of Intersection Ability in the Next 5 Years Alternative Conditions 2

Tahun Ke-	Tahun	Capacity *(C)* (pcu/hour)			Degree of saturation *(DS)*			Vehicle delay (D_i) (sec/pcu)	Level of service
		North	East	West	North	East	West		
0	2021	1234	1006	443	0,87	0,87	0,87	22,97	C
1	2022	1234	1006	443	0,89	0,89	0,89	23,03	C
2	2023	1234	1006	443	0,90	0,90	0,90	23,10	C
3	2024	1234	1006	443	0,91	0,91	0,91	23,17	C
4	2025	1234	1006	443	0,93	0,93	0,93	23,24	C
5	2026	1234	1006	443	0,94	0,94	0,94	23,32	C

Source: Computer Data Processing

Based on Table 7 shows that in the 5th year for the North approach, the capacity value is 1234 pcu/hour and DS is 0.94. For the Eastern approach, the capacity value is 1006 pcu/hour and DS is 0.94. While the Western approach, the capacity value is 443 pcu/hour and DS is 0.94. The delay is 23.32 sec/pcu and the service level is C. According to the Regulation of the Minister of Transportation Number KM 14 of 2006, this shows that traffic conditions are within stable limits but the speed and movement of vehicles are limited by other vehicles, the obstacles are getting bigger, and the driver has limitations for overtaking and selecting speed. The results of the degree of saturation and delay in the alternative conditions of the 5th 2nd year are still better than the existing conditions.

3.6. Alternative Solution 3

Alternative 3 is widening the road on the East approach. The width of the East approach road for a direct left turn (WLTOR) is 3 m and the entrance width (WMASUK) is 4 m with the approach width (WA) being 7 m. Alternative 3 calculation results in Table 8.

Tabel 8. Alternative Calculation Results 3

Approach	Saturated current *(S)* (pcu/hour hijau)	Traffic flow *(Q)* (pcu/hour)	Rasio Saturated current *(FR)*	Capacity *(C)* (pcu/hour)	Degree of saturation *(DS)*	Queue length *(QL)*	Vehicle stopped *(N_{SV})* (pcu/hour)	Vehicle delay *(D_I)* (sec/pcu)	Level of service
North	2194,98	1076	0,49	1186,02	0,907	234,06	999	23,08	C
East	2520,61	877	0,35	966,80	0,907	217,21	871		
West									

Source: Computer Data Processing

Based on Table 8 shows that the DS value obtained is 0.907 for the North and East approaches. According to MKJI 1997, the intersection will be in a saturated condition causing long queues at peak traffic conditions. The delay value is 23.08 sec/pcu, the service level is C. The average total delay time experienced by the vehicle when passing through the intersection is 23.08 seconds with a cycle time of 105 seconds. According to the Regulation of the Minister of Transportation Number KM 14 of 2006, this shows that traffic conditions are within stable limits but the speed and movement of vehicles are limited by other vehicles, the obstacles are getting bigger, and the driver has limitations to overtake and choose the speed.

The results of the calculation of the prediction of the ability of the intersection in the next 5 years for alternative 3, the results are shown in Table 9.

Tabel 9. Prediction of Intersection Ability in the Next 5 Years Alternative Conditions 3

Tahun Ke-	Tahun	Capacity *(C)* (pcu/hour)		Degree of saturation *(DS)*		Vehicle delay *(D_I)* (sec/pcu)	Level of service
		North	East	North	East		
0	2021	1186	967	0,91	0,91	23,08	C
1	2022	1186	967	0,92	0,92	23,13	C
2	2023	1186	967	0,94	0,94	23,18	C
3	2024	1186	967	0,95	0,95	23,23	C
4	2025	1186	967	0,96	0,96	23,30	C
5	2026	1186	967	0,98	0,98	23,37	C

Source: Computer Data Processing

Based on Table 9 shows that in the 5th year for the North approach, the capacity value is 1186 pcu/hour and DS is 0.98. For the Eastern approach, the capacity value is 967 pcu/hour and DS is 0.98. The delay is 23.37 sec/pcu and the service level is C. According to the Regulation of the Minister of Transportation Number KM 14 of 2006, this shows that traffic conditions are within stable limits but the speed and movement of vehicles are limited by other vehicles, the obstacles are getting bigger, and the driver has limitations to overtake and choose speed.

3.7. Alternative Solution 4

Alternative 4 is the addition of an underpass. The underpass connects the West and East approaches. For drivers from the West approach who want to enter the East approach or vice versa, they can pass the underpass. Meanwhile, drivers from the east to north approach or vice versa continue to use traffic signal lights. Alternative 4 calculation results in Table 10.

Tabel 10. Alternative Calculation Results 4

Approach	Saturated current *(S)* (pcu/hour hijau)	Traffic flow *(Q)* (pcu/hour)	Rasio Saturated current *(FR)*	Capacity *(C)* (pcu/hour)	Degree of saturation *(DS)*	Queue length *(QL)*	Vehicle stopped *(N_{SV})* (pcu/hour)	Vehicle delay *(D_I)* (sec/pcu)	Level of service
North	2292,95	1076	0,47	1223,77	0,879	182,86	969		
East	2700,43	877	0,32	997,58	0,879	140,80	855	22,77	C
West									

Source: Computer Data Processing

Based on Table 10 shows that the DS value obtained is 0.879 for the North and East approaches. According to MKJI 1997, the intersection will be in a saturated condition causing long queues at peak traffic conditions. The delay value is 22.77 sec/pcu, the service level is C. The average total delay time experienced by the vehicle when passing through the intersection is 22.77 seconds with a cycle time of 83 seconds. According to the Regulation of the Minister of Transportation Number KM 14 of 2006, this shows that traffic conditions are within stable limits but the speed and movement of vehicles are limited by other vehicles, the obstacles are getting bigger, and the driver has limitations to overtake and choose the speed.

The results of the calculation of the prediction of the ability of the intersection in the next 5 years for alternative 4, the results are shown in Table 11.

Tabel 11. Prediction of Intersection Ability in the Next 5 Years Alternative Conditions 4

Tahun Ke-	Tahun	Capacity *(C)* (pcu/hour)		Degree of saturation *(DS)*		Vehicle delay *(D_I)* (sec/pcu)	Level of service
		North	East	North	East		
0	2021	1224	998	0,88	0,88	22,77	C
1	2022	1224	998	0,89	0,89	22,79	C
2	2023	1224	998	0,91	0,91	22,81	C
3	2024	1224	998	0,92	0,92	22,83	C
4	2025	1224	998	0,93	0,93	22,86	C
5	2026	1224	998	0,95	0,95	22,90	C

Source: Computer Data Processing

Based on Table 11, it shows that in the 5th year for the North approach, the capacity value is 1224 pcu/hour and the DS is 0.95. For the Eastern approach, the capacity value is 998 pcu/hour and DS is 0.95. The delay is 22.90 sec/pcu and the service level is C. According to the Regulation of the Minister of Transportation Number KM 14 of 2006, this shows that traffic conditions are within stable limits but

the speed and movement of vehicles are limited by other vehicles, the obstacles are getting bigger, and the driver has limitations to overtake and choose speed.

Based on the results of calculations on alternative conditions, alternative 4 obtains better results than alternatives 2 and 3. In the calculation of predictions for the next 5 years, alternative 4 is also very possible to be used as a long-term alternative. Alternative 4 is expected to improve intersection performance.

4. CONCLUSION

1. The results of the performance of the signalized intersection using the 1997 MKJI obtained a degree of saturation of 0.945 for all approaches, the value of the queue length for the North approach is 402.29 m and 364.61 m for the East approach. The average intersection delay (DI) value is 36.75 sec/pcu, so it is included in the service level category D with a cycle time of 173 seconds. The results of the Vissim calculation produce a delay value (VehDelay) of 62.58 seconds / drive with the Level of Service (LoS) E category.
2. The results of the analysis of predictive performance of intersections in existing conditions for the next 5 years, the delay value is 37.51 sec/pcu with service level category D.
3. Alternatives that can be done to improve performance at the Soekarno-Hatta signalized intersection are alternative 4. Alternative 4 is to add an underpass. The results obtained are the value of the degree of saturation of 0.879 for all approaches, the value of the queue length for the North approach is 182.86 m, and 140.80 m for the East approach, the average intersection delay (DI) is 22.77 sec/pcu so that it enters the service level category C with a cycle time of 83 seconds. Prediction for the 5th year for alternative 4 obtained a delay rate (DI) of 22.90 sec/pcu with service level category C.

5. REFERENCES

Direktorat Jenderal Bina Marga Departemen Pekerjaan Umum. (1997). Manual Kapasitas Jalan Indonesia (MKJI) 1997. Bandung: Dirjen Bina Marga.

Menteri Perhubungan. (2006). Peraturan Menteri Perhubungan Nomor: KM 14 Tahun 2006 Tentang Manajemen dan Rekayasa Lalu Lintas di Jalan. Jakarta: Direktorat Jenderal Perhubungan Darat.

Hakim, L. (2016). Pedoman Penggunaan dan Pengenalan Program PTV Vissim. Bekasi: Sekolah Tinggi Transportasi Darat.

Khisty, C.J. & Lall, B.K. (2005). Dasar-Dasar Rekayasa Transportasi (Jilid 1) 3rd ed. Jakarta: Erlangga.

Soedirdjo, & Liliani, T. (2002). Rekayasa Lalu Lintas. Jakarta: Direktorat Jenderal Pendidikan Tinggi.

Badan Pusat Statistik. (2010). Pedoman Penghitungan Proyeksi Penduduk dan Angkatan Kerja. Jakarta: Sub Direktorat Statistik Mobilitas Penduduk dan Tenaga Kerja.

Tanjung, A.F. (2015). Kenerja Simpang Terhubung Bersinyal Pada 3 Titik Ruas Jalan (Jl. M.T. Hryono, Jl. Mayjen Panjaitan, dan Jl. Soekarno Hatta) Kota Malang. Skripsi tidak diterbitkan. Malang: Universitas Negeri Malang.