Study on Performance of Intersection Around The Underpass Using Micro Simulation Program

By Joni Arliansyah

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Abstract. In order to overcome the problems of congestion at the major intersections in Palembang City, there have been grade separation constructions in the form of flyover or underpass. One of them is the intersection of Patal Pusri Underpass. The smooth traffic due to the underpass construction needs to be balanced by the arrangement management at the intersections located close to the underpass to get the best network performance since both affect each other performance. The Taman Kenten and Seduduk Putih junctions which are just 569 and 226 meters from the underpass of Patal Pusri has to be analyzed for its needs of management and traffic arrangements to reduce its impact on the performance of the intersection of Patal Pusri or vice versa. Some alternatives of management and traffic arrangements were developed to get the best solutions and the Vissim 8.00 microsimulation program was used to evaluate the performance of intersections in the network where the compared parameters are the value of the queue length and average delay. The results of the analysis and the conducted modeling show that the best solution to optimize the performance of the two junctions are to make geometric changes and diversion of traffic flow at Seduduk Putih Junction and making geometric changes at Taman Kenten Junction.

1. Introduction

Palembang City as a metropolitan city and a capital city of South Sumatra Province is a center of administration, commerce, industry and settlement in South Sumatra. The number of population of Palembang City in 2016 has reached about 1.8 million people that need quite a lot of the existing movement, and traffic congestion is a very serious problem in the city.

One of the solutions of overcoming the traffic congestion at the intersections of the city is by constructing flyovers or underpasses, one of which is the underpass of Patal Pusri

To optimalize the arrangement of traffic at the underpass of Patal Pusri, it requires to perform a traffic management nearby the Underpass of Patal Pusri, that is the Junctions of Taman Kenten and Seduduk Putih whose distances are within 569 and 226 meters from the junction of Patal Pusri.

In analyzing the traffic performance, the Software Vissim was used and several alternative traffic arrangements at the existing junctions were developed in this study.

2. Literature Review

Microsimulation traffic model is a device to simulate the individual vehicle behavior in the road network to estimate possible impacts of traffic pattern change resulted from the traffic flow change or from changes in the physical environment.

Microsimulation model also has a capability of simulating queuing conditions and providing results of density rate and road service. This capability makes this type of model very useful for analyzing traffic operations in urban areas and the city center including interchanges, roundabouts, not signalized and signalized intersections, signal coordinated corridors, and area networks. Microsimulation even reflects relatively small changes in the physical environment such as narrowing lanes, relocating the stop line before the intersection, or optimizing operation of toll booths.

There are two methods of simulation process in Vissim, namely Static Vehicle route and Dynamic Assignment, in which the Dynamic Assignment is more used for simulation at a network because route choice highly depends on the traffic conditions that take place. The writer use VISSIM Manual as a guide to made the model simulation [1].
Several studies successfully applying the Vissim program have been reported. [2, 3, 4, 5, 6]

3. Methodology

The locations of the study were the underpass of Patal junction and two nearby junctions, that is the Junctions of Taman Kenten and Seduduk Putih. The locations are shown in Figure 1.
The methodological procedure is described as follows:

1. Data collection
2. Modelling contained the above three junctions using Vissim program,
3. Calibration and validation models based on GEH Statistic that revealed by F Olga (2012) Formula 1. Shows the GEH Statistic that developed by Olga [7]

$$GEH = \left(\frac{2x(qsimulated - qobserved^2)}{(qsimulated + qobserved)}\right)^{1/2} \quad (1)$$

Table 1. GEH Statistic Criteria

Condition		Remark
GEH ≤ 5,0		Accepted
5,0 ≤ GEH ≤ 10,0	Posibility	some error in model
GEH ≥ 10,00		Rejected

Figure 1. Locations of Study.

4. Evaluation of the existing conditions at the Junctions of Taman Kenten and Seduduk Putih.
5. Development of alternative actions for improvement are as follows:
   - Geometric change, performed both at Taman Kenten Junction and Seduduk Putih Junctions. Figures 2 and 3 show additional widths road to avoid some queue at intersection in congestion condition.
   - The traffic diversion is possibly conducted at Seduduk Putih Junction where the minor traffic flow from Seduduk Street is diverted to other routes.

- The installation of traffic signals can be carried out at the two junctions. The cycle time for each junction is shown at Figure 4 and 5
- Combination of the above alternatives.

6. Evaluation of the junction performance of all alternative improvements is conducted by using Vissim program.

The study location at Underpass Patal Pusri Intersection and other intersections around it include the Seduduk Putih and Taman Kenten junctions located 226 and 569 meters from underpass Patal Pusri. The coordinate location based on UTM at 2°57'00.7"S 104°46'04.4"E. This location known as major intersection in Palembang City, connected R Soekamto Street at west, Residen Abdul Rozak street at east, MP Mangkunegara Street at north, and AKBP Cek Agus at South which is all of the street is line bunding to support of palembang citizen movement. This underpass was constructed in 2014 to increase the level of service at Patal Pusri intersection.

The Seduduk Putih and Taman Kenten junctions got the influence due to the smooth traffic flow at Underpass Patal Pusri. The traffic flow at these junctions needs to manage to get best performance in order to increase the level of service at these junctions and underpass Patal Pusri.

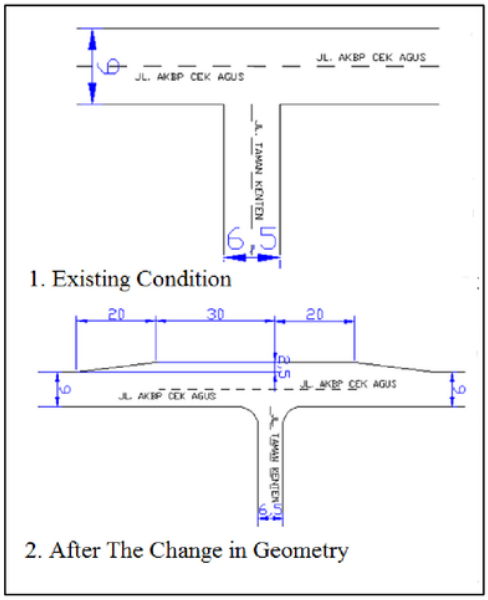

Figure.2. Geometric Change of Taman Kenten Junction

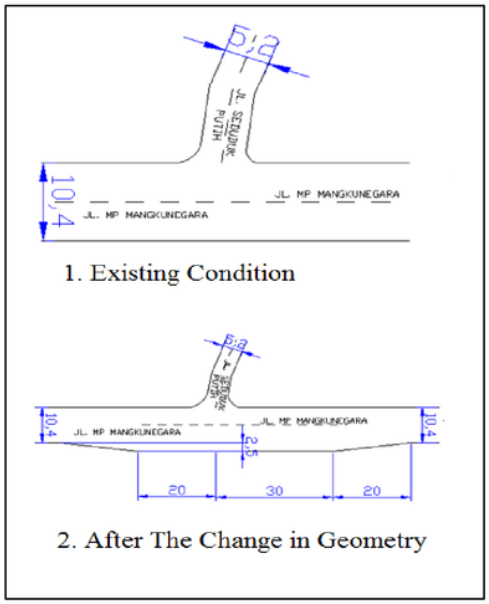

Figure.3 Geometric Change of Seduduk Putih Junction

Both of Figure 2 and Figure 3 ilustrate one alternative development at both junctions providing an additional width of 2.5 m and length of 70 m near the intersection that can be used when some congestion occurs at the intersection so the vehicles can use the additional lane to continue their movement.

Figure.4 Cycle time at Seduduk Putih Junction

Figure 5. Cycle Time at Taman Kenten Junction

4. Data Presentation Analysis and Discussion

This section describes about the data collection, modelling the traffic condition in VISSIM 8.00 Program, calibration of the model based on GEH Statistic, and analysis of the traffic performance of the solution alternatives at both junctions around underpass Patal Pusri. The best alternative was selected among the alternatives developed.

4.1. Data Collection

The data need to be collected for analysis in this study are traffic volume, free flow speed and existing road geometric.

4.2. Calibration of theModel

Traffic flow data collected at analyzed intersections were used to calibrate microsimulation models parameters in order to reach reliable and realistic outputs. In the calibration process, traffic volume in peak hour was compared with the results of traffic volume from VISSIM program. GEH statistic that mention in formula 1 was used.

Table 2. Calibration Analysis of Seduduk Putih Junction

No	Section	Number of Vehicle Observed	Number of Vehicle based on Simulation	GEH Value	Remark
1	MP Mangku Negara (to Patal)	1810	1785	0.589	accepted
2	Seduduk Putih	330	345	0.816	accepted
3	MP Mangku Negara (to Kenten)	2075	2002	1.617	accepted
Average GEH Value				1.008	accepted

Table 3. Calibration Analysis of Seduduk Putih Junction

No	Section	Number of Vehicle Observed	Number of Vehicle based on Simulation	GEH Value	Remark
1	AKBP Cek Agus (To Patal)	2037	1993	0.980	accepted
2	Taman Kenten	367	384	0.877	accepted
3	AKBP Cek Agus (To M Isa)	1947	1902	1.026	accepted
Average GEH Value				0.961	accepted

Based on Table 2 and Table 3, it is found that the traffic flow resulted in VISSIM model simulation can be accepted so the simulation model is ready to be used to analyze the scenario developed.

4.3. Seduduk Putih Junction

Seduduk Putih Junction located 226 m at north Underpass Patal Pusri intersection and the traffic volume at this junction shown in Table 2. At this junction, six solution alternatives were developed to solve traffic problems. Table. 4 shows the developed alternatives combined with the performance of Seduduk Putih Junction.

Table 4. Performance of Seduduk Putih Junction

No	Alternative	Street	Queue Lenght (m)	Delay (s/veh)
1	Existing	MP Mangkunegara (to patal)	180.58	184.68
		Seduduk Putih	112.74	
		MP Mangkunegara (to kenten)	211.18	
2	Geometric Change	MP Mangkunegara (to patal)	117.86	110.89
		Seduduk Putih	75.2	
		MP Mangkunegara (to kenten)	191.68	
3	Geometric Change Combine with Diversion Traffic Flow	MP Mangkunegara (to patal)	26.75	76.4
		Seduduk Putih	0	
		MP Mangkunegara (to kenten)	190.46	
4	Installation of traffic light	MP Mangkunegara (to patal)	175.94	80.27
		Seduduk Putih	73.27	
		MP Mangkunegara (to kenten)	221.23	
5	Geometric change combine with installation traffic light	MP Mangkunegara (to patal)	125	78.26
		Seduduk Putih	71.21	
		MP Mangkunegara (to kenten)	191.23	
6	Geometric change combine with installation traffic light and diversion traffic flow	MP Mangkunegara (to patal)	125.91	91.64
		Seduduk Putih	0	
		MP Mangkunegara (to kenten)	190.24	

Based on Table 4, it is found that the third alternative is the best scenario among the scenarios developed because it has the shortest queue length while the delay is 76.4 second. The zero value of flow at seduduk putih street happen because the vehicle flow is diversed to use other route.

4.4. Taman Kenten Junction

Taman Kenten Junction located 569 m at south Underpass Patal Pusri intersection. Total traffic volume at this junction is 896 vehicle at peak hour. At this junction four solution alternatives was developed to handle traffic problems. Table 5 shows the developed alternatives combined with the performance of Taman Kenten Junction.

Table 5. Performance of Taman Kenten Junction

No	Alternative	Street	Queue Lenght (m)	Delay (s/vehicle)
1	Existing	AKBP Cek Agus (to patal)	504.72	135.77
		Taman Kenten	131.05	
		AKBP Cek Agus (to M Isa)	256.08	
2	Geometric Change	AKBP Cek Agus (to patal)	504.72	76.15
		Taman Kenten	78.21	
		AKBP Cek Agus (to M Isa)	196.71	
3	Installation of traffic light	AKBP Cek Agus (to patal)	504.38	89.02
		Taman Kenten	74.81	
		AKBP Cek Agus (to M Isa)	211.71	
4	Geometric change combine with installation traffic light	AKBP Cek Agus (to patal)	530.22	86.41
		Taman Kenten	117.85	
		AKBP Cek Agus (to M Isa)	235.84	

Based on Table 5, we can see that the second alternative is the best scenario among the other alternatives developed, because it has the shortest queue length while the delay is 76.15 second.

Based on the above cases, all solution alternatives can improve the service performance of the junctions however the geometric changes and traffic flow diversion are the best alternative among the alternatives developed.

5. Conclusion

In order to improve the service performance of the junctions studied, several improvement alternatives which are geometric changes, traffic flow diversion, traffic light installments and their combinations was developed. The result indicated that the performance of Seduduk Putih Junction can be improved by using combination of geometric changes and traffic flow diversion. Geometric changes is recommended alternative to improve the performance of Taman Kenten Junction.

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