Evaluation of Service at the Demang Lebar Daun Intersection in Palembang City

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Abstract. Intersections are a part of the road that becomes the center of conflict points from various directions of traffic flow. The Demang Lebar Daun intersection is a meeting of four roads that have different geometric conditions. At the observation location, traffic flow conditions during peak hours cause long queues of vehicles that cause congestion. This research aims to evaluate the level of service at the intersection location. Data collection is carried out by making initial measurements in the form of geometric data and cycle time. Traffic flow volume data is taken for three days, namely two weekdays and one weekend from 07.00 to 18.00 local time. In this research, the analysis of intersection performance will be compared both in existing and design conditions, referring to MKJI 1997. Based on the analysis, the level of service for the referred method is in E (Webster) and D (MKJI). This service category needs to be improved so the quality of traffic movement is relatively stable in speed. The brief alternative solutions that are recommended by this research are speeding up the red light and slowing down the green light in traffic light management, as well as the parking prohibition on the side of the road at least 50 meters from the intersection by installing the traffic sign.

Keywords: Degree of saturated, intersection, level of service, peak hour, signalized, webster.

1 Introduction

As part of the road network system, intersections retain control over determining smooth movement. The movement is controlled by a regulatory system so that traffic flow can be controlled. If traffic flow is not controlled, then intersections as critical points can cause problems. Problems such as delays for a long time will certainly cause traffic jams. In the city of Palembang itself, one of the intersections is very dense and often delayed, namely the Demang Lebar Daun intersection. This intersection connects arterial roads and collector roads as well as locally in the form of signaled intersections that function at one armpoint only.

Demang Lebar Daun Interchange is divided into 4 directions, namely, east, which leads to Ogan street; west, which leads to Parameswara street; north, which leads to Siti Khadijah Hospital; and south, which leads to Jalan Srijaya Negara. Simpang Demang

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Lebar Daun has traffic lights that function to regulate the movement of each vehicle so that it can move alternately so as not to interfere with the existing flow. At the observation location, the intersection is quite dense during peak hours because the location of the intersection is close to shopping centers in the form of shopping houses, markets, and schools. High uncontrolled traffic flow during peak hours can result in intersections no longer being able to provide good service through traffic signaling devices (trafic signs) [6]. The malfunction of traffic lights at the intersection will cause obstacles at the signaled intersection. Long waiting times during rush hour and long queues of vehicles at intersections are obstacles that are often encountered. Uncontrolled and repeated accumulations of conditions will result in traffic jams. This condition is an indication of the saturation of intersection capacity in peak current conditions where current road infrastructure facilities are unable to keep up with the load of the number of existing vehicles.

Seeing the importance of this intersection as access to traffic flow, it is felt that there is a need for an evaluation to assess the performance of the Demang Lebar Daun road intersection so that it can provide follow-up handling if needed. The evaluation of intersection performance is carried out based on the methods in the Indonesian Road Capacity Manual (MKJI). This manual serves as a guideline for calculating traffic capacity and behavior across road segments and road networks. The results obtained based on the guidelines will later be compared with existing conditions. Traffic engineering predictions accompanied by improvement recommendations as additional output to the study will increase the effectiveness of travel time.

2 Theoritical Foundation

2.1 Literature Review

Studies related to how to expand the performance of signaling intersections with several methods have been carried out by previous researchers. Based on the results of the analysis [2] [6] [7] and [8], The performance of service levels at observation locations spread across several Indonesian city areas such as Aceh, Jakarta, Surabaya, Aceh, and Kendari shows that the current condition of existing intersections is unable to accommodate existing traffic capacity. The level of service as an indicator of quality varies in value from C to F. The level indicates that the intersection has approached saturation. Therefore, recommendations on efforts to improve intersection performance need to be proposed. Some efforts to improve performance include setting signaled lights and the surrounding environment, widening roads on shortages, and installing signs and markings.

2.2 Traffic Movement

In traffic movement, intersections as meeting points of two or more road sections are the most frequent points of conflict. Generally, conflicts that occur are caused by high volumes of traffic at intersections, geometric designs that do not fulfill service functions, the behavior of each driver, a lack of careful arrangement of street lights, and a

lack of availability of traffic signs. The size of the intersection has functioned according to its service capacity, which can be measured and seen from several variables, such as the delay value and the remaining capacity of the intersection [4].

The delay value describes the condition of traffic saturation. The degree of saturation is the ratio between traffic volume and road capacity. If the saturation degree value reaches more than 0,75, it can be said that the traffic flow is in an unstable flow zone. The value of the degree of saturation will be directly proportional to the value of the delay. The higher the number, the condition of vehicle travel time is relatively high. This is what causes the traffic flow zone to be unstable. Meanwhile, intersection capacity is defined as the maximum traffic flow that can be accommodated on the intersection arms, taking into account geometric characteristics and traffic volume. The intersection geometry is obtained by direct measurement of the number and width of the approach, the entry and exit width of the intersection, including the effective width, distance, and ramps of the road. The volume of intersection traffic is obtained by counting the number of vehicles passing through the arms of the intersection at a given time.

In signaled intersection characteristics, traffic flow (Q) must reflect the movement characteristics of vehicles ranging from light vehicles to heavy vehicles. The measure of movement current in vehicle units per hour will be converted into units (pcu) per hour so that the intersection capacity (C) can be determined. Furthermore, the value parameters in the characteristics of the signaled intersection will be the basis for determining the service level of the signaled intersection.

2.3 Level of Service

The level of service is a qualitative description of traffic flow acceptable to road users, one of whom is the driver of the vehicle. The level of service at intersections that use traffic control lights is often associated with the length of the delay. Level of service criteria are determined in the form of an average stopped delay for each vehicle in the analysis period of 15 minutes. The relationship between level of service and delay time can be classified into several levels, as shown in Table 1.

Table 1. Level of service criteria for signalized intersection

Level of service	Waiting time per vehicle (sec)
A	< 5.0
B	5,1 – 15.0
C	15,1 – 25.0
D	25,1 – 40 .0
E	40,1 – 60.0
F	> 60.0

Source: MKJI, 1997

3 Methodology

In this research, the data collection technique used was observation. The data is obtained directly at the observation location and serves as primary data. The data classified as primary data includes road geometric data and traffic data. However, before the observation is made, a study of the evaluation of the performance of the signaled intersection, which includes the characteristics of problems at the signaled intersection, procedures for data collection and processing, as well as steps to provide predictions and recommendations for improvement, is dissected through literature studies.

3.1 Determination of Research Location and Time

The observation location was carried out at the Simpang Empat Lengan Demang Lebar Daun Palembang city, which connects access to Jalan Parameswara, Jalan Demang, Jalan Ogan, and Jalan Arah SMA 10 Kec Ilir Barat I Palembang City. The details of the observation location (see Fig. 1), which is a screenshot using the Google Maps application.

Fig. 1. Intersection survey location based on google maps

The research was conducted during peak hours, namely morning, afternoon, and evening, which were carried out within three days. This time includes the flow of intersection traffic on two weekdays and one day on the weekend. The data collection time range is carried out from 07.00 to 18.00 local time.

3.2 Research Variable

After determining the location of the observation, the next step is to determine the data variables that will be taken when the observation is carried out. Based on theories relevant to the formulation of the problem and objectives, the variables used in the study can be seen in Table 2.

Table 2. Research variable

Aspects	Variable	Parameter
Signalized intersection performance	Traffic volume, the amount of traffic flow per vehicle per hour	-
	Geometric intersection	Narrow approach Exit width Entry width Lebar belok kiri
	Real saturation current	Basic saturation current Size correction factor Side obstruction adjustment factor Adjustment factor due to road gradient Right turn correction factor Left turn correction factor
	Capacity	Real saturation current Green time Cycle time
	Degree of saturation	Traffic flow Intersection capacity
	Queue length	Degree of saturation Green ratio Intersection capacity Cycle time
	Vehicle stop	Number of vehicles queuing at the approach Cycle time Traffic flow
	Delay	Cycle time Queue length Capacity Green ratio Degree of saturation

Source: MKJI, 1997

3.3 Data Analysis Methods

After the preparation and survey stages are carried out, the next step is to process and analyze the data. Primary and secondary data processing and data analysis refer to the 1997 MKJI guidelines so that intersection performance is obtained in current conditions. The details of the data analysis techniques are described as follows:

Surveyors. Geometric calculations are done separately for each approach. Each junction arm may consist of one or more approaches. The interchange arm with more than one short is separated into two or more subshorts to separate turning and straight motion.

The determination of the short and subshort widths is effectively carried out by considering the layout of the entrance and exit of an intersection and the distribution due to the deflection movement.

Traffic flow. Traffic flow calculations are carried out per unit hour for one or more periods, for example, based on traffic flow conditions planned for peak hours in the morning, afternoon, and evening. Traffic flow (Q) for each left (QLT), straight (QST), and right turn (QRT) movement must be converted from an hourly vehicle to an hourly passenger car unit (in Indonesia, it called SMP). The conversion is carried out using passenger vehicle equivalents (in Indonesia, it called EMP) for each protected and opposed fighter.

Basic model development. The development of basic models in data analysis includes the calculation of the capacity of the approach arm, the timing of signals, the calculation of capacity and degree of saturation, and traffic behavior. The quality of traffic and traffic behavior include queue length, stop rate, ratio of stopped vehicles, and delays.

To understand the research flow concisely, the implementation procedure is depicted in the flow chart (see Fig. 2).

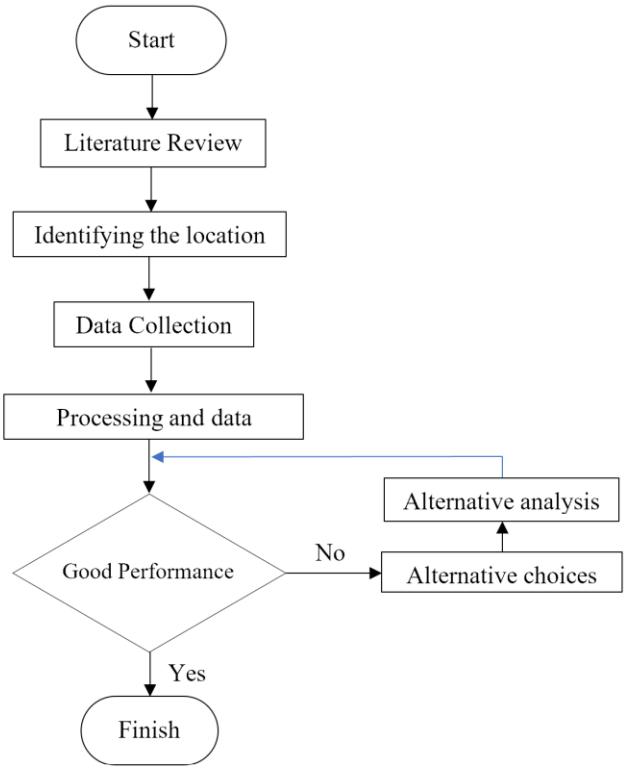

Fig. 2. Research data flow chart

4 Results and Discussion

4.1 Webster Method Traffic Volume

Data on traffic volume passing through observation points is obtained through the results of traffic counting surveys using Webster and MKJI methods. All categories of vehicle types that cross the observation point in 2-hour intervals during peak hours will be recorded. Furthermore, the traffic volume output will be converted into passenger car units (junior high school) by multiplying the number of vehicles by the equivalence number according to the vehicle type category. An observation graph of traffic volume (see Fig. 3).

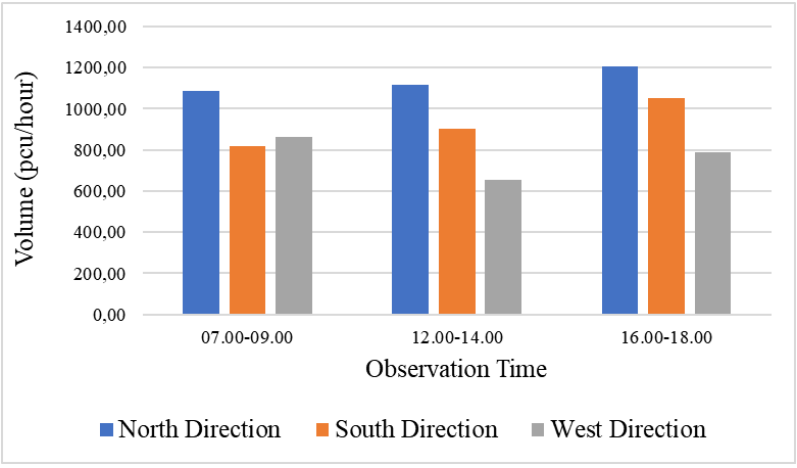

Fig. 3. Traffic volume data from observation point

Based on observations for three days, the highest movement occurred in the north direction of the intersection with Jalan Demang Lebar Daun, with daily traffic volume reaching 3408 pcu/hour. Then the south, towards SMA 10, with a volume of 2769 pcu/hour, and the west towards Jalan Parameswara, reach 2304 pcu/hour. In addition to daily movements, from Fig. 3 also shows how traffic movements fluctuate at peak hours. Traffic conditions tend to be heavy in the morning from 07.00 to 09.00 and in the afternoon from 16.00 to 18.00. The high number of vehicles at that hour is caused by vehicles that will carry out various daily activities. The north direction is the highest movement point because the short arm approaches the center of activity, such as government, offices, shopping, and other public facilities.

4.2 Webster Method Intersection Performance

From the data above, the ratio of movement (q / s) and Y at each mouth of intersection movement from North (N), South (S), and West (W) can be calculated. The calculation results can be seen in Table 3.

Table 3. The ratio of traffic movement and Y at the entrance of the intersection

Movement	q/s	y	Y
N	0,310	0,310	0,744 < 0,8
S	0,256	0,256	
W	0,183	0,183	

Source: Data processing, 2023

Furthermore, to ensure the performance of the intersection in terms of capacity, the parameter of the length of green time can be calculated. Green time is the time of a green phase during which traffic can cross an intersection. The calculation of the green time at each intersection mouth is shown in Table 4.

Table 4. Actual green time

Stage	Ki (sec)
N	27
S	21
W	15

Source: Data processing, 2023

From the data above, the actual green time (k) from the north is 27 seconds, the south is 21 seconds, and from the west it is 15 seconds with a cycle time C of 72 seconds. Based on these data, the delay time at signalized intersections due to traffic sign settings can be estimated. The timing stage is at each intersection entrance (see Fig. 4).

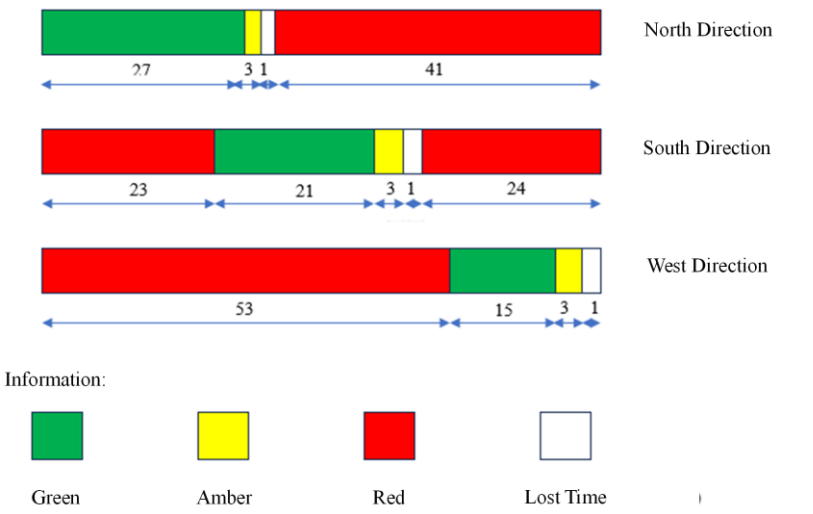

Fig. 4. Timings the traffic light at intersection point

Judging from the stage, the level of service at the intersection is in category E with an average delay of 50 seconds. This condition reflects an unstable current with sometimes stalled speeds and close to capacity volumes. If this condition is left unchecked, it will cause conflicts such as traffic jams.

4.3 MKJI 1997 Method Traffic Volume

Based on the MKJI method, the highest traffic flow movement is in the north direction, with a total vehicle flow of 1131 pcu/hour. Then the total flow of vehicles in the south and west directions respectively is 922 pcu/hour and 768 pcu/hour. The conditions of movement and current characteristics at peak hours obtained under the MKJI 1997 method have similarities with the Webster method. It is known that 07.00 to 09.00 and 16.00 to 18.00 are the peak vehicle volumes on each approach. The high number of vehicles at that time could not be separated from the generation of activity on the pull element.

4.4 MKJI 1997 Method Intersection Performance

The capacity of the defiance in each direction of the intersection mouth can be the basis for an analysis of intersection performance. From the traffic volume data, the maximum flow passing through the intersection as well as the green and cycle timing on the short can be seen in Tables 5 and 6.

Table 5. Characteristics of traffic movement at the entrance of the intersection

Movement	Traffic Volume q (pcu/hour)	Saturated Current s (pcu/hour)	Y
N	1137	3675	0,30938776
S	922	3675	0,25088435
W	786	4200	0,18714286
	Total		0,74741497

Source: Data processing, 2023

Table 6. Characteristics of timing at the intersection points

Movement	Green Time (sec)	Cycle Time (sec)
N	27	55
S	21	55
W	15	55

Source: Data processing, 2023

From the data above, the intersection capacity controlled by traffic signaling devices at each intersection entrance shows a relatively equal green time with an average of 21 seconds and a cycle time of 55 seconds. Based on this time, the average delay time at each intersection is 32 seconds. Judging from the level of service, the performance of the intersection is in category D with current characteristics close to the stable point of speed, and the ratio of volume to capacity is still tolerated.

5 Conclusions

Based on the analysis and calculations that have been carried out using the Webster and MKJI methods at the observation location at the signaled intersection of Jalan Demang Lebar Daun, it can be shown that:

1. Performance assessment is an evaluation of intersection services in terms of capacity, service levels are in categories E and D. The service level category needs to be changed so that the quality of traffic movement is relatively smooth with relatively stable speed conditions.
2. Alternative solutions to improve the category of service levels at intersections are speeding up the red-light time and slowing down the green time, as well as implementing traffic management such as prohibiting vehicle parking on the side of the road at least 50 m from the intersection with the installation of traffic signs.
3. Traffic simulation at intersections using software assistance needs to be considered in reviewing intersection performance. The existence of simulation makes it easy to choose the best traffic engineering according to the current criteria conditions.

References

1. Anita, D., Paransa, M., Elisabeth, L.: Performance Evaluation of the 17 August Signaled Interchange - Jalan Babe Palar Manado City. Journal of Static Civil, 621-630 (2015).
2. Artiani, G. P., Azhiary, R.: Efforts to improve the performance of Simpang Empat signaled on Jalan Duren Tiga Selatan with the Indonesian Road Capacity Guideline (PKJI) 2014 method. National Seminar on Science and Technology 2019 (pp. 1-13). Faculty of Engineering, University of Muhammadiyah Jakarta (2019).
3. Directorate General of Highways.: Indonesia Road Capacity Guideline (PKJI), No.09/P/BM/2023. Ministry of Public Works and Housing, Jakarta (2023).
4. Kiftiah, N., Hariyani, S., Agustin, I. W.: Evaluasi Kinerja Persimpangan di Jalan Ahmad Yani - Jalan Raden Intan Kecamatan Blimbing Kota Malang. Planning for Urban Region and Environment, 183-192 (2020).
5. Othman, A., Gloaguen, R.: River Courses Affected by Landslides and Implications for Hazard Assessment: A High Resolution Remote Sensing Case Study in NE Iraq–W Iran. Remote Sensing, 5(3), 1024–1044 (2013).
6. Prakoso, D. B., Sutoyo, Sudibyo, T.: Performance Evaluation of Signalized Intersections Pahlawan – Raden Saleh Sarif Bustaman Street in Bogor, West Java. Journal of Civil and Environmental Engineering, 135-148 (2019).
7. Roswita, C., Iqbal.: Performance Evaluation of Signalized Intersections at Langsa City Post. Scientific Journal of Engineers, 1-4 (2019).
8. Saputra, A. R., Lakawa, I., Rachmat, L. M.: Performance Analysis of Signalized Intersections at Wua-Wua PLN Intersections, Kendari City. Sultra Civil Engineering Journal (SCiEJ), 72 – 88 (2020).
9. Susetyo, D. A.: Evaluation of Traffic Performance at Grade-Separated Intersections Polda Palembang with Microsimulation. Pilar Journal Civil Engineering, Vol.18 No.02 (2023).