

Performance Evaluation of Interchange Not Communicating With Unofficial Traffic Control Officers (Case Study of Simpang Bong Cino Kota Madiun)

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ABSTRACT

Simpang Bong Cino is an uncited interchange that, in the field, is arranged by unofficial officers to be located in the outer cordon that connects Madiun and Magetan Regencies with Madiun City. This study aims to assess the performance of intersections with and without officers, use Traffic Signal Control Tools, and recommend the best type of arrangement. The primary data collection used is an interchange inventory survey. A classified deflection movement survey was carried out twice on the same day and time on different dates, namely Wednesday, June 15 and 22, 2022, which was then analyzed using MKJI 1997—the analysis results obtained. The existing intersection condition with traffic control officers received a degree of saturation of 0.75, a significant road delay (DMA) of 6.46 sec / SMP, a minor road delay of 14.96 sec / SMP, and an intersection delay of 12.88 sec / SMP. Suppose a saturation degree value of 0.74 is obtained without a traffic control officer. In that case, the significant road delay is 6.31 sec/SMP, the minor road delay is 15.43 sec/SMP, and the interchange delay is 12.66 sec/SMP. When set up with the Traffic Signal Control Tool, a saturation degree of 0.51 was obtained, and the average wait for the entire intersection was 20.14 sec/SMP. The best interchange setting recommendation is an intersection without unofficial officers.

Keywords: *Up to five keywords should also be included*

Introduction

Transportation is an integral part of a community function that closely relates to the lifestyle, range, and location of productive activities [1]. However, this sector can provide an urban transportation problem that is difficult to solve, namely traffic jams. Congestion can cause various negative impacts, both on the driver and from an economic and environmental perspective [2].

Madiun City is one of the administrative areas of the western part of East Java Province, which has a strategic location. This city is the main inter-provincial land transportation crossing through the Surabaya – Madiun – Solo – Jakarta/Bandung route. This city is also a transit city which is quite strategic because it is the choice of courses easily traversed by bus and train transportation. It supports hinterland areas with well-known cultural and tourism potential [3].

Stated that Mr Ogah prioritized helping four-wheeled vehicles because it was more difficult to sneak into traffic jams; this includes social injustice in regulation, prioritizing motorists willing to pay for services because they have been given a road [4][5]. Illegal road controllers usually ask for wages on the road for their assistance in managing traffic [6]. These unofficial officers work in groups, and they come to the location together. Still, only one person who contains traffic [7][8] states that the presence of an unofficial traffic controller can increase the capacity of un-signalized intersections compared to the absence of officers. Sukarsa (2019) explains that unofficial officers can cause more excellent delays at unsignalized meetings.

Nonetheless, [9], [10] state that signals four-way intersections without officers have a small intersection delay value but a significant accident risk. [4] stated that from their research on the effect of volunteer traffic controllers on the Ganesha Surakarta un-signalized intersection, Supertas positively affected intersection performance, namely increasing intersection capacity, even though the degree of saturation of the meeting increased. [11] state that traffic signals and road widening are carried out to improve the performance of unsignalized intersections.

Madiun City has a grid-shaped road network infrastructure composed of roads and intersections. This road network system binds and connects growth centres with areas under its services' influence. A meeting is a node in the road network where roads and vehicle passages intersect. Cars on a moving approach use the space at the intersection with vehicles from other systems [12]. One of the intersections in this city is the Bong Cino Intersection in the outer cordon that connects Madiun and Magetan Regencies with Madiun City. This intersection is the direct access to the town, so the volume of traffic that passes is relatively high. This

intersection is an unsignalized one in the field and is managed by an unofficial officer called Pak Ogah. Based on observations, this intersection is passed by various types of vehicles, such as non-motorized vehicles, motorcycles, cars, buses, and trucks. High volume without any traffic control causes congestion during rush hour. Based on the background above, evaluating the presence of unofficial traffic control officers at unsignalized intersections is necessary. Therefore this research needs to be conducted to assess the performance of the existing hubs with officers, in addition to determining scenario conditions without officers and with a Traffic Signal Control Tool (APILL) and recommending the best type of arrangement.

Research Methods

The research was conducted at the Bong Cino Intersection, Madiun City, as shown in Figure 1. This intersection is located in and out of the City from Madiun Regency and Magetan Regency. This research consists of several stages, namely[13]–[19]:

Preparation

The preparation stage is an activity step before starting data collection and processing. This stage Arranges essential things that must be done immediately to streamline time and work. This stage includes the preparation of proposals, and exhibitions, the study of study literature, observation, problem formulation, goal setting, and preparation of research methods[20]–[26].

Data collection

Secondary data is collected from related agencies like the Department of Transportation and the Central Bureau of Statistics. This data includes road inventory and regional geographic, administrative, demographic, and socio-economic data.

Primary data is data collected directly in the field. The Intersection Inventory Survey was conducted when the low traffic volume was 14.00 - 15.00 WIB; This is done to make it easier to carry out geometric measurements of intersections and improve safety for surveyors—inventory survey personnel as many as two people. The equipment needed is a counter, clipboard, stationery, and a walking measure. The surveyors, consisting of 2 (two) note takers and measurers, walk along the road while measuring and recording the condition of the road sections. The intersection survey was carried out by measuring and describing the intersection condition and recording at the foot of the intersection, which is 100m.

The target data obtained includes detailed cross sections, which include land use conditions, approach width, number and width of traffic lanes, median, hardened shoulders, sidewalks, turning radius, and other information related to road signs and markings.

The Classified Turning Movement Enumeration Survey aims to obtain traffic volume data for each intersection leg, vehicle composition and turning movement ratio. The Indonesian Highway Capacity Manual (MKJI) is the standard for determining vehicle classification.

This survey was carried out at intersections, where a strategic location was taken at the foot of the meeting to observe the number of vehicles making turns. The survey time was carried out at peak from 06.00 to 08.00 WIB; this was done to obtain traffic volume during peak times. The survey was conducted twice on the same day and time on different dates, namely Wednesday, 15, and 22 June 2022.

The equipment needed to survey turning movements at intersections is a counter, clipboard, stationery, and Traffic Cone. The procedure for analyzing shifting trends at meetings is that the surveyor occupies a survey point at the foot of the intersection where he can observe the movement of traffic flow as much as possible. There are 18 surveyors divided into six people on each leg and are tasked with recording the number of vehicles that turn right, left, and straight.

Analysis

At this stage processing of secondary data and primary data that has been obtained is carried out. An analysis is carried out: the performance of the current conditions of the Bong Cino Intersection with unofficial traffic officer arrangements and research of the performance of the intersection without officers. As well as an analysis of the regulatory plan using traffic lights.

Unsignalized Intersection Analysis

Capacity

The total capacity of the intersection is the product of the multiplication between the vital capacity (C_0) and the adjustment factors (F) according to field conditions. The capacity value can be calculated by Formula 1 (MKJI 1997).

$$C = C_0 \times F_w \times F_M \times F_{CS} \times F_{RSU} \times F_{LT} \times F_{RT} \times F_{MI}$$

With :

- C = Unsignalized Intersection Capacity (pcu/hour)
- Co = Base Capacity (pcu/hour)
- FW = Approach Width Adjustment Factor
- FM = Main Street Median Type Adjustment Factor
- FCS = City Size Adjustment Factor
- FRSU = Adjustment Factor for Road Environment Type, Side Barriers, and Non-Motorized Vehicles
- FLT = Left Turn Adjustment Factor
- FRT = Right Turn Adjustment Factor
- FMI = Minor Road Current Ratio Adjustment Factor

Degree of Saturation

According to MKJI (1997), the degree of saturation is the ratio of traffic flow (Q, pcu/hour) to capacity (C, pcu/hour). The value of the degree of saturation is calculated using formula 2:

$$DS = Q / C \dots\dots\dots(2)$$

Intersection Delay

Intersection delay can be calculated by Formula 3 (MKJI 1997).

$$D = DG + DTI \dots\dots\dots(3)$$

With :

- DG = Geometric Delay
- DTI = Intersection Traffic Delay

$$S = S_0 \times F_{cs} \times F_{sf} \times F_g \times F_p \times F_{rt} \times F_{lt} \dots\dots\dots(4)$$

With :

- S₀: Basic saturation current
- F_{cs}: City size correction factor
- F_{sf}: Side resistance correction factor
- F_g: Road grade in the correction factor
- F_p: Parking correction factor
- F_{rt}: Right-turn proportion correction factor
- F_{lt}: Correction factor of left proportion tomorrow

Intersection Capacity (C)

$$C = S \times g / c \dots\dots\dots(5)$$

With :

- C: Capacity (pcu/hour)
- S: Saturation current (pcu/hour)
- g: Green time (s)
- c: Cycle time (s)

Results and Discussion

Interchange Geometric Conditions

Simpang Bong Cino is a triple intersection consisting of Jl. Mayjen Sungkono, Jl. Raya Madigondo, and Jl. Hayam Wuruk. This type of interchange is type 322, which means it has three legs with two lanes of minor roads and two lanes of major highways.

The major lanes at the intersection above are Jl. Mayjen Sungkono and Jl. Hayam Wuruk, while the minor roads are Sambirejo roads. Jl. Mayjen Sungkono is a national road with a width of 7 meters which is divided into two lanes and two lanes with a short code A. Jl. Hayam Wuruk with a short code C and Jl. Sambirejo, with a short code B, is a city road with a width of 8 meters, each divided into two lanes and two lanes. This intersection is how much in a residential area with low side barriers.

Interchange with officers

Traffic Volume

Traffic volume interchanges with officers (smp / hour) at each distance. The highest traffic volume is on Jl. Mayjen Sungkono, which is 717 SMP, then the short is Jl. Hayam Wuruk, which is 528 SMP, and the smallest is jl. Sambirejo short by 438 smp. The large traffic volume at short A is due to the main road that continues traffic from Ponorogo towards Magetan and Surabaya. The total traffic volume of significant roads is 1,244 smp/h, and of minor roads, 438 smp/h.

Interchange Capacity

The total capacity of the intersection is the result of the multiplication between the base capacity (C_0) and the adjustment factors (F) according to field conditions. Essential Capacity Simpang bong cino is an interchange with three short legs, wherein the major shorthand has two lanes, and the minor short has two lanes, so this intersection is type 322. The vital capacity of this interchange is 2700 SMP / hour. Based on Formula 1 and the adjustment values in MKJI 1997 obtained, 2,223.9 SMP / hour was obtained.

Interchange Performance

The degree of saturation (DS) becomes the main factor in determining the level of interchange performance. The interchange volume (Q) is 1,682 SMP/hour, and the interchange capacity (C) is 2,223.9 SMP/hour. Then the degree of saturation is calculated using Formula 2, obtaining a value of 0.75. Intersection delay (D) is the sum of traffic and geometric delays calculated using Formula 3, obtaining a 12.88 seconds / SMP result.

Interchange Without Officers

Traffic Volume

The traffic volume is intermittent without officers (smp/hour) at each train. The highest traffic volume is on Jl. Mayjen Sungkono is 759 SMP / hour, then the short on Jl. Hayam Wuruk is 564 SMP / hour, and the smallest is jl. Sambirejo short is 406 smp / hour. The total volume of major roads is 1,323 SMP/hour, and minor roads are 406 SMP/hour.

Interchange Capacity

The total capacity of the intersection based on Formula 1 and the adjustment values in MKJI 1997 obtained a deal of 2,340.7 SMP / hour.

Interchange Performance

The interchange volume (Q) is 1,730 SMP/hour, and the interchange capacity (C) is 2,223.9 SMP/hour, then the degree of saturation (DS) using Formula 2 obtained a value of 0.74. The delay of intersection (D) is calculated using Formula 3 and obtained a result of 12.66 seconds / SMP.

Interchange

Saturated Current (S)

Saturated current can be determined as the multiplication of the saturated base current (S_0) for the normal state by the adjustment factor (F). The saturated current (S) value is calculated using Formula 4 obtained by Pendekat A of 3,416 SMP/hour, Pendekat B of 3,904 SMP/hour, and Pendekat C of 3,904 SMP/hour.

Interchange Capacity (C)

Each of the pedekats at this intersection uses a short shielded type. The traffic flow (Q) adjusted to the short style is Pendekat A at 588 SMP / hour, Pendekat B at 352 SMP / hour, and Pendekat C at 426 SMP / hour. The interchange capacity is calculated using Formula 5 obtained by Pendekat A of 1000.79 SMP / hour, Pendekat B of 598 SMP / hour, and Pendekat C of 726 SMP / hour.

Interchange Performance

The degree of saturation is calculated from the traffic flow value divided by the capacity and obtained by Short A by 0.59, Short B by 0.59, and Near C by 0.59. The average degree of saturation is 0.59. The average delay of the intersection was calculated using Formula 6 and obtained at 26.59 sec/SMP.

Comparison of Interchange Performance with Officers and Without Officers

A comparison of the performance of the intersection with the presence of officers, the absence of officers, and if using the Traffic Signal Control Tool can be seen in Table 1.

Table 1. Comparison of intersection performance

No	Indicators	By Officer (A)	No Officer (B)	APILL (C)
1	Capacity (smp/h)	2,223,9	2.340,7	-
2	Degree of Saturation	0,75	0,74	0,59
3	Tundaan Jl. Mayor	6,46	6,31	-
4	Minor Street	14,96	15,43	-

5	Interchange delay	12,88	12,66	26,59
6	Opportunity/ queue length	23-46	22-45	20,05

Existing comparison between regulated intersections (A) and without (B) officers. Interchange B results in greater interchange capacity and delay. Lower major is because officers allow passing longer on minor roads. Vehicles turning right from minor roads provide more frequent rewards, as seen in Table 4.6. The degree of saturation of intersection B is lower than that of intersection A, which is 0.74. The chance of queuing at intersection B is better at 22-45%.

The planned use of the Traffic Signal Control Device can reduce the Saturation Degree (DS) from 0.75 and 0.74 to 0.59 but results in a higher intersection delay of 26.59 sec/SMP. This is due to the cyclical timing. APILL can be more effectively used in addition to reducing the degree of saturation and reducing conflict points in the intersection to improve traffic safety. Although APILL installation requires an installation budget, it can reduce the burden on road users who spend money to provide officers when passing.

Conclusion

Based on the analysis, it can be concluded that:

The interchange with the regulating officer resulted in a degree of saturation of 0.75, a significant road delay of 6.46 sec/SMP, a minor road delay of 14.96 sec/SMP, an interchange delay of 12.88 sec/SMP, and a service level of B. Suppose unregulated the officer produced a saturation degree value of 0.74, a significant road delay of 6.31 sec/SMP, a minor road delay of 15.43 sec/SMP, an interchange delay of 12.66 sec/SMP and a service level B. If set with a Traffic Signal Control Device, it obtained a saturation degree of 0.51, an average delay for all intersections of 20.14 sec/SMP, and a service level of C.

Based on the above assessment, it can be concluded that the intersection without an officer is more feasible to use because, in addition to having better performance, but also removes the burden on the community who pass by the intersection to spend money to give officers.

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