

# Traffic Engineering Study Through the Implementation of a One-Way System on Suranadi Road on the Performance of the Narmada Intersection Using the PKJI 2023 and PTV VISSIM Methods

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## Abstract.

*The Narmada Intersection at the junction of Jalan Suranadi and Jalan Mataram Sikur experiences traffic congestion due to high vehicle volume, market activity, and side obstacles in the form of on-road parking. This study aims to evaluate the performance of the unsignalized intersection in its existing condition and analyze the effect of implementing a one-way system on the A arm (Jalan Suranadi) on intersection performance. The methods used are the 2023 Indonesian Road Capacity Guidelines (PKJI) and microscopic simulations using PTV VISSIM software. Data were obtained through traffic volume surveys, road geometry measurements, and observations of traffic conditions in the field. The analysis results show that the existing condition has a degree of saturation (DJ) of 0.76 with a delay of 14.99 seconds/vehicle so that the intersection is in a condition close to saturation. The implementation of the one-way outflow scenario (outflow only) resulted in a DJ value of 0.81 with a delay of 15.79 seconds/vehicle, while the one-way inflow scenario (inflow only) resulted in a DJ value of 0.66 with a delay of 13.17 seconds/vehicle. The PTV VISSIM simulation results show that the inflow only scenario provides a better level of service than the outflow only scenario. Overall, the implementation of the one-way inflow system on arm A is considered more effective in improving intersection performance by reducing traffic conflicts and increasing the regularity of vehicle flow.*

**Keywords:** *Traffic Engineering; Unsignalized Intersection; PKJI 2023; PTV VISSIM and One-Way Road.*

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## I. INTRODUCTION

The increase in the number of motorized vehicles in the district area also affects the performance of the road network, especially at intersections as meeting points for traffic flows.[1]. An increase in vehicle volume that is not balanced by road capacity can cause congestion, delays, and a decrease in the level of service.[2]This condition also occurs on the Mataram-Sikur section in the Narmada area, West Lombok Regency, which has quite high traffic activity.[3].

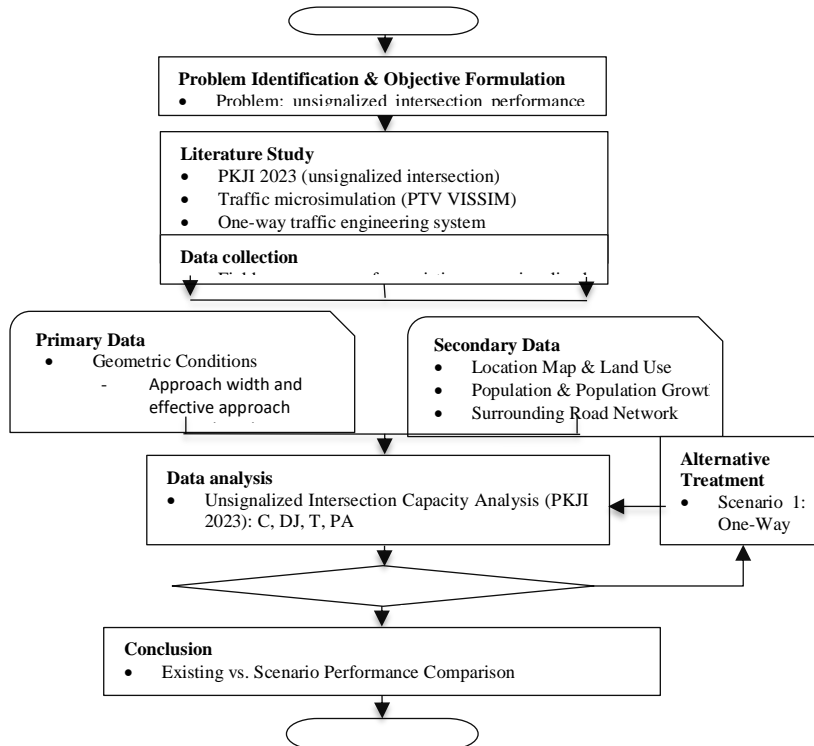
The Narmada Intersection is a crucial point for smooth traffic flow. Based on existing conditions, traffic volume at this location is relatively high, especially during peak hours on Saturday afternoons. Traffic congestion is influenced by market activity near the intersection and the presence of heavy vehicles, such as trucks, parked on the roadside due to the activities of roadside stalls.[4]This condition causes increased vehicle conflicts, queues, and delays.[4].

Intersections as conflict points are greatly influenced by interactions between vehicles which have the potential to reduce the level of service and trigger congestion.[2]Therefore, traffic engineering efforts are needed that are able to regulate vehicle movement more efficiently.[5].

One alternative solution is to implement a one-way system on Jalan Suranadi as an engineered route to reduce traffic congestion on the Mataram-Sikur section. This system aims to reduce traffic conflicts and increase road capacity.[6]. Previous research has shown that implementing a one-way system can improve intersection performance by reducing traffic conflicts and improving vehicle flow.[6].

Intersection performance evaluation was conducted using the 2023 Indonesian Road Capacity Guidelines (PKJI) which includes capacity parameters, degree of saturation, delays, and queue opportunities.[7]. In addition, simulation using PTV VISSIM software is used to analyze traffic behavior microscopically.[8].

Although various studies have discussed intersection performance analysis using PKJI 2023 and VISSIM, most of them still focus on existing conditions and have not examined in depth the implementation of a one-way system as an alternative solution.[1]. In addition, research that combines analysis of unsignalized intersections with one-way system scenarios in local conditions such as the Narmada Three-



**Fig. 1. Diagram of research stages**

Way Intersection is still limited.[2]. Therefore, this study aims to examine the performance of the Narmada Intersection and analyze the implementation of a one-way system on Suranadi Street as an alternative traffic management using the PKJI 2023 method and PTV VISSIM simulation.

## II. METHODS

This study began with a preliminary survey at the Narmada Intersection and the Suranadi Road section to identify road geometry, the number of intersection arms, the effective approach width, and side obstacles. Measurements were conducted directly in the field, with observation segments approximately 100 meters long from the intersection conflict point. Environmental conditions such as market activity and heavy vehicle parking were also observed because they affect traffic performance.[4].

Traffic volume data was collected on Saturdays to represent peak conditions, with observation periods from 6:00–9:00, 11:00–14:00, and 16:00–19:00. Vehicle traffic was recorded every 15 minutes and classified into motorcycles, light vehicles, heavy vehicles, and non-motorized vehicles. The data was then converted to passenger car units (pcu) based on the 2023 PKJI.[2].

Intersection performance analysis was conducted using the PKJI 2023 method with parameters of capacity, degree of saturation (DJ), delay, and queue probability in existing conditions.[2]The results of this analysis are used to evaluate the level of intersection service and to determine the operational traffic conditions at the research location.

Next, modeling was performed using PTV VISSIM software based on geometric conditions and actual traffic volumes. Driver behavior parameters were adjusted to reflect traffic characteristics in Indonesia, and then calibration was performed until the simulation results approximated field conditions.[8].

An engineering scenario involving the implementation of a one-way system on Jalan Suranadi was implemented in a model with adjustments to the direction of movement and distribution of vehicle flow. The analysis was conducted by comparing existing conditions and the scenario to assess improvements in intersection performance.[6].

### III. RESULTS AND DISCUSSION

#### Traffic Characteristics and Intersection Geometry

The intersection studied is an unsignalized three-way intersection with commercial characteristics on all approach arms. Jalan Suranadi (A) is 12.40 m wide with no median, Jalan Mataram Sikur (B) is 12 m wide with no median, and Jalan Mataram Sikur (C) is 12 m wide with no median. This condition indicates that the intersection has variations in width and flow priority that have the potential to affect traffic performance, especially in the distribution of vehicles on each approach.



Fig. 2. Research Location

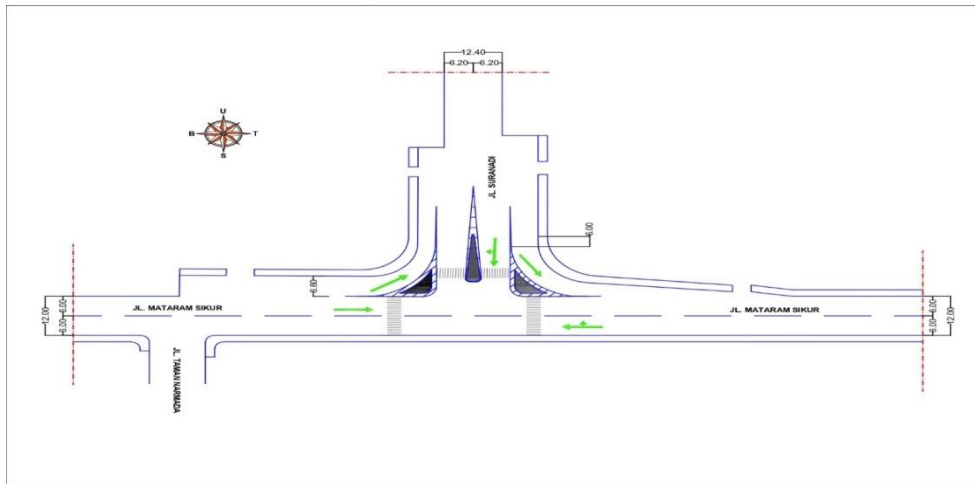


Fig. 3. Research Location

#### Vehicle Volume

Vehicle volume data collection at the intersection was conducted on Saturday, February 7; Monday, February 9; and Wednesday, February 11. Observations were conducted between 6:00 and 18:00 (WITA). Based on the recapitulation results, peak hours occurred between 17:00 and 18:00 WITA on Saturdays.

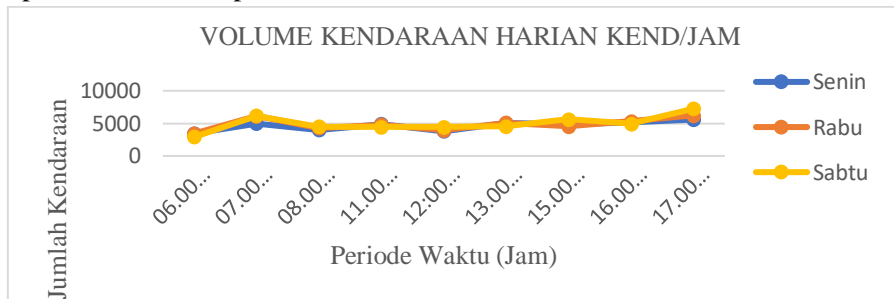


Fig. 4. Graph of Total Number of Vehicles at the Intersection Per 1 Hour

Based on the graph, the maximum vehicle volume recorded during the time period of 5:00 PM–6:00 PM WITA was 7,254 vehicles. This volume was then converted to passenger car units (pcu/hour) using the equivalence factor according to the 2023 PKJI, namely 1.0 for light vehicles (MP), 1.8 for heavy vehicles (KS), and 0.2 for motorcycles (SM). The results of the maximum condition calculations are presented in Table 1.

**Table 1. Vehicle Volume at Maximum Conditions**

Arm	MP		KS		SM		Total	
	Vehicle/hour	Junior high school/hour	Vehicle/hour	Junior high school/hour	Vehicle/hour	Junior high school/hour	Vehicle/hour	Junior high school/hour
A (Q BKI)	180	180	4	7.2	527	105	711	293
A (Q BKA)	142	142	9	16.2	825	165	976	323
Total A	322	322	13	23.4	1352	270	1687	616
B (Q BKI)	70	70	4	7.2	799	160	873	237
B (Q LRS)	404	404	21	37.8	1986	397	2411	839
Total B	474	474	25	45	2785	557	3284	1076
C (Q LRS)	375	375	46	82.8	1362	272	1783	730
C (Q BKA)	120	120	5	9	375	75	500	204
Total C	495	495	51	91.8	1737	347	2283	934
Total A+B+C	1291	1291	89	160	5874	1175	7254	2626

Based on survey results, traffic volume at the Narmada Intersection is dominated by traffic from the B and C arms, which approach the main road to Jalan Mataram Sikur. High traffic volume during the afternoon peak hour, coupled with side obstacles such as market activity and on-road parking, leads to increased delays and queues at the intersection. This high traffic volume has a negative impact on the performance of the unsignalized intersection.[3].

**Existing Conditions with PKJI 2023**

The following is a table of the results of the geometric data calculations for the analysis of approach width, intersection type, basic capacity, and traffic behavior.

**Table 2. Calculation of Approach Width and Intersection Type**

Number of Arms	Approaching Arm (m)						LRP	Number of Lanes		Intersection Type
	Minor Road			Mayor Street				Road Minor	Road Major	
	LA	LD	LAD	LB	LC	LBC				
3	12.4	0	6.2	12	12	12	9.1	2	2	322

**Table 3. Basic Capacity and Traffic Behavior**

Basic CO Capacity	Traffic Performance							
	Wide	v	Size	Obstacle	Turn	Turn	Ratio	Capacity C
	Average	Road	City	Side	Left	Right	Minor / Total	
	Approacher	Major	FU	FHS	FBK <sub>i</sub>	FBK <sub>a</sub>	FR <sub>mi</sub>	
Junior high school/hour	FLP	FM	FK	FHS	FBK <sub>i</sub>	FBK <sub>a</sub>	FR <sub>mi</sub>	
2700	1,4261	1	0.94	0.93	1,165	0.91	0.976	3543

In analyzing the performance of signalized intersections, evaluative indicators are required that reflect the level of efficiency and traffic service. Based on the 2023 PKJI, the performance of unsignalized intersections is measured using the degree of saturation (DJ), queue length, and average vehicle delay. The results of the maximum condition calculations are presented in Table 1.

**Table 4. Intersection Performance**

qTotal	DJ	TLL	TLL <sub>ma</sub>	TLL <sub>mi</sub>	TG	T=TLL+TG	Pa %	Service Level
2626	0.76	8.78	6.53	16.10	6.22	14.99	23.42 46.85	B

Based on the analysis results, a degree of saturation (DJ) value of 0.76 was obtained, indicating that the intersection is approaching saturation. A total delay value of 14.99 seconds/vehicle indicates that the intersection is still operating in the fairly good category (LOS B), but its capacity is starting to be burdened. Interpretatively, a DJ value approaching 1 indicates that the intersection is vulnerable to decreased performance if there is an increase in traffic volume. This condition is characterized by increasing delays and traffic conflicts due to increasingly high vehicle interactions in the intersection area. This is in line with research.[2]which states that intersections with a high degree of saturation tend to experience increased delays and traffic conflicts.

Furthermore, although delays are still in the moderate category, this condition cannot be considered optimal. Intersections approaching saturation require traffic engineering intervention to maintain flow stability and prevent a decline in service levels. Therefore, traffic engineering efforts are needed to reduce the degree of saturation and improve intersection performance. One alternative that can be implemented in this study is a one-way system on one arm of the intersection. This scenario is then analyzed to evaluate its effectiveness in reducing the DJ value, reducing delays, and improving the overall level of intersection service. This condition is supported by research.[6]which explains that the implementation of a one-way system can be an effective traffic engineering alternative to reduce vehicle conflicts and improve intersection performance.

**One-Way Intersection Performance Scenario Based on PKJI 2023**

Planning analysis was conducted to obtain more optimal traffic performance compared to existing conditions. In this study, several traffic engineering scenarios were tested using the 2023 PKJI approach through the implementation of a one-way system on Jalan Suranadi (arm A). The developed scenarios focused on changing vehicle movement patterns through two alternatives: a one-way exit road (outflow only) and a one-way entrance road (inflow only). The testing of these two scenarios aimed to determine the effect of the one-way system implementation on the intersection's operational performance.

**1. Scenario 1: Arm A as a One-Way Outflow Only**

In this scenario, arm A only serves the movement of vehicles exiting towards the other approaches. Vehicles from arm A can move towards approaches B and C, while vehicles from other approaches cannot move towards arm A. This arrangement aims to reduce vehicle movement conflicts at the intersection and smooth traffic flow. Furthermore, the implementation of a one-way exit system is expected to reduce congestion caused by vehicle buildup at the intersection.

**2. Scenario 2: Arm A as a One-Way Inflow Only Road**

In this scenario, arm A only receives traffic from other approaches and does not serve outbound traffic. Vehicles from approaches B and C can proceed to arm A, while vehicles from arm A cannot proceed to other approaches. This arrangement aims to reduce traffic conflicts and improve traffic flow distribution at the intersection. Furthermore, a more targeted distribution of traffic is expected to reduce potential queues and improve overall intersection performance.



**Fig. 5. One-Way Street Scenario**

The intersection performance results for each scenario are presented in the following table, which includes key evaluation parameters such as degree of saturation, delay, and service level.

**Table 5. Intersection Performance After Scenario**

Scenario	qTotal	DJ	TLL	TLLma	TLLmi	TG	T=TLL+TG	Pa %	Service Level
1 (Direction Go out)	2626	0.81	9.53	7.05	17.63	6.26	15.79	26.13 51.89	C
2 (Direction Enter)	2626	0.66	7.36	5.54	0.00	5.80	13.17	17.74 36.57	B

Based on the analysis results, the two scenarios have different impacts on intersection performance. In scenario 1 (outflow), the degree of saturation (DJ) value was 0.81 with a delay of 15.79 seconds per vehicle. This value indicates that intersection performance has decreased compared to the existing condition. This condition indicates that the distribution of traffic flow in the one-way outflow system is not yet optimal, resulting in vehicle congestion on certain approaches. This finding is supported by [3] which states that unbalanced flow distribution can increase delays and the degree of intersection saturation.

Conversely, in scenario 2 (inflow), the degree of saturation (DJ) value decreased to 0.66 compared to the existing condition of 0.76, with a delay of 13.17 seconds per vehicle. This condition indicates that the implementation of a one-way inflow system can reduce vehicle movement conflicts, resulting in a more orderly and stable traffic flow. These results align with research [6] which states that one-way systems can improve intersection performance and reduce traffic conflicts.

Overall, scenario 2 (inflow) is the best alternative because it reduces saturation and delays compared to the other scenarios. However, implementing a one-way system still requires consideration of the overall road network conditions to avoid causing traffic problems on other roads. This is in line with research [5] regarding the importance of balanced flow distribution in traffic engineering.

### One-Way Intersection Performance Scenario Based on PTV Vissim Software

The performance analysis of unsignalized intersections was conducted using PTV VISSIM software as a traffic microsimulation tool. This model aims to evaluate intersection performance in more detail by considering vehicle interactions and driver behavior, thus resulting in traffic conditions that more closely reflect actual conditions in the field.

The analysis phase included modeling the intersection geometry based on existing conditions, inputting vehicle volumes based on survey results, and adjusting intersection operational conditions. Observation parameters used included data collection points, vehicle travel time, and queue counters to obtain comprehensive intersection performance indicators. The simulation was run five times using random seed variations to reduce bias and obtain a more representative average value.

The results of the intersection performance analysis after the running process on the PTV VISSIM application are presented as follows:

#### 1. Scenario 1: Arm A as a One-Way Outflow Only

In this scenario, arm A functions as a one-way exit (outflow only) with the aim of reducing traffic flow conflicts at the intersection. However, this change in traffic patterns causes a redistribution of traffic flow to other approaches, thereby increasing the load on some vehicle movements. The simulation results show variations in the level of service at each movement, where most movements are dominated by LOS D to F with relatively high delay values. Overall, the intersection performance is in the LOS E category with a node delay value of 42.449 seconds per vehicle. Complete results are presented in Table 6.

**Table 6. Arm C as a One Way Exit (Outflow Only)**

SIM	TIME	MOVE	LOS	LOS VAL	VEH DELAY	DELAY AVG	LOS AVG
AVG	0-3600	AB	D	4	28,887	33,326	D
AVG	0-3600	air conditioning	E	5	37,765		
AVG	0-3600	BC	F	6	52,989	57,762	F
AVG	0-3600	CB	F	6	62,534		
AVG	0-3600	NODE	E	5	46,305	-	-



**Fig. 6. Results of Running Scenario 1**

Interpretatively, the high delays on some routes indicate that the outflow-only scenario has not been effective in improving intersection performance. This condition occurs due to the uneven distribution of traffic flow after the diversion of traffic flow, resulting in continued congestion on certain approaches. Furthermore, the dominance of LOS levels D to F indicates that traffic flow is becoming unstable and vehicles are experiencing significant congestion during peak hours.

This finding is in line with research[6] which states that unbalanced distribution of traffic flow can increase delays and the degree of intersection saturation. In addition, research[5] explains that the implementation of a one-way system without proper flow distribution arrangements has the potential to reduce intersection performance and increase queues on certain approaches.

**2. Scenario 2: Arm A as a One-Way Inflow Only Road**

In this scenario, the A-arm functions as a one-way inflow only road, thus only accepting vehicle flows from other approaches. This arrangement aims to reduce vehicle movement conflicts and improve vehicle flow distribution at the intersection. Simulation results show that the implementation of the one-way inflow system can significantly improve intersection performance compared to the existing condition. This is indicated by the dominance of the A service level for all vehicle movements with very low delay values. Overall, the intersection is in the LOS A category with an average delay of 0.918 seconds per vehicle. Complete results are presented in Table 7.

**Table 7. Arm A as a One Way Out (Inflow Only)**

SIM	TIME	MOVE	LOS	LOS VAL	VEH DELAY	DELAY AVG	LOS AVG
AVG	0-3600	BA	A	1	0.822	0.651	A
AVG	0-3600	BC	A	1	0.481		
AVG	0-3600	CA	A	1	0.592	0.613	A
AVG	0-3600	CB	A	1	0.634		
AVG	0-3600	NODE	A	1	0.595	-	-



**Fig. 7. Results of Running Scenario 2**

In general, implementing the inflow-only scenario creates a more stable and evenly distributed traffic flow at each approach. The low delay values indicate that traffic conflicts are minimized, allowing vehicles to move more smoothly without significant obstruction. This demonstrates that the implementation of the one-way inflow system is quite effective in improving intersection performance.

This finding is in line with research [6] which states that implementing a one-way system can increase the efficiency of vehicle movement and reduce traffic conflicts at intersections. However, the implementation of traffic engineering still needs to consider the overall condition of the road network to avoid shifting traffic loads to other road sections.

#### IV. CONCLUSION

This study shows that the implementation of a one-way system on Suranadi Street can improve the performance of the Narmada Intersection based on the analysis of the 2023 PKJI method and simulation using PTV VISSIM software. The results of the study show that the existing condition of the intersection has a relatively high level of saturation and delay due to increased vehicle volume, market activity, and side obstacles in the form of vehicle parking around the intersection. After traffic engineering through the implementation of a one-way system, there was a decrease in vehicle movement conflicts so that traffic flow became more orderly and the intersection capacity increased. These findings indicate that regulating the direction of vehicle movement can be an alternative solution to reduce traffic density and improve the level of intersection service in areas with high vehicle activity.

However, this study still has limitations because traffic observations were only conducted at specific times and did not include daily or seasonal variations in conditions that could affect vehicle flow characteristics. Furthermore, the simulation used still relies on assumptions about driver behavior and traffic conditions at the time of the study. Therefore, further research is recommended to conduct observations with a longer duration, add long-term traffic growth analysis, and examine other engineering alternatives such as signal arrangements or geometric widening of the intersection. Practically, the results of this study can be used as a consideration for local governments and related agencies in determining more effective traffic management policies to improve the smoothness, safety, and comfort of road users in the area of the Narmada Three-Way Intersection and Jalan Suranadi.

#### V. THANK-YOU NOTE

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