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Selection of traffic management scenarios for an unsignalized intersection using PTV vissim and PKJI 2023: a case study at Mengger intersection, Pandeglang Regency, Indonesia

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ABSTRACT

Unsignalized intersections may experience declining operational performance as traffic demand increases, resulting in longer vehicle delays, queues, and reduced levels of service. This study aims to evaluate the operational performance of the Mengger unsignalized intersection in Pandeglang Regency using the 2023 Indonesian Road Capacity Guidelines (PKJI) and PTV VISSIM, and to identify the most effective traffic management scenario. A quantitative approach was applied using field survey data consisting of traffic volume, vehicle composition, intersection geometry, vehicle movement, and speed data. The PKJI 2023 method was used to determine intersection capacity, degree of saturation, delay, queue probability, and level of service, while PTV VISSIM was used to simulate existing traffic conditions and three traffic management scenarios: side-friction control, approach widening, and three-phase traffic signal implementation. The PKJI 2023 analysis resulted in an intersection capacity of 3,287 pcu/h, a degree of saturation of 0.815, an average delay of 14.08 s/pcu, and Level of Service B. The PTV VISSIM simulation of the existing condition resulted in an average vehicle delay of 31.05 s/veh, an average queue length of 15.94 m, and Level of Service E. Among the three scenarios, approach widening produced the best performance, reducing average vehicle delay to 7.79 s/veh and average queue length to 0.04 m, with Level of Service B. These results indicate that approach widening is the most effective alternative for improving the operational performance of the study intersection.

Keywords: unsignalized intersection; PKJI 2023; PTV VISSIM; traffic management; approach widening

1 Introduction

The rapid growth of motorized transportation has increased traffic demand on urban and regional road networks. Intersections are particularly important components of road networks because they accommodate traffic movements from different directions and are therefore highly sensitive to changes in traffic volume, intersection geometry, vehicle composition, and driver behavior. Declining intersection performance can result in increased vehicle delay, queue formation, reduced travel speed, and lower levels of service.

Unsignalized intersections are still widely used in Indonesia, particularly in urban and regional areas. Their operation depends on traffic priority and driver gap acceptance, making their performance highly dependent on the interaction among traffic demand, geometric characteristics, and vehicle movements [1], [2]. As traffic demand increases while available intersection capacity remains relatively limited, delays and queues may increase and operational performance may deteriorate.

The intersection of Jl. Raya Labuan–Pandeglang, Jl. KH. Abdul Halim, and Jl. Raya Labuan in Pandeglang Regency, Banten Province, is a three-leg unsignalized intersection connecting residential areas, commercial activities, public facilities, and regional traffic routes. Based on field observations, the intersection experiences relatively high traffic demand during peak periods. A traffic survey conducted on Sunday, Monday, and Tuesday showed that Monday had the highest traffic volume, with the peak-period traffic

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selected as the basis for the analysis. The existing condition therefore requires an evaluation to determine its operational performance and potential traffic management alternatives. However, studies comparing the results of the 2023 PKJI analysis with those of microscopic simulations obtained from PTV VISSIM to evaluate the operational performance of intersections without traffic lights remain limited, particularly for intersections in Pandeglang Regency.

The 2023 Indonesian Road Capacity Guidelines (PKJI 2023) provide an analytical method for evaluating unsignalized intersections through parameters such as intersection capacity, degree of saturation, delay, queue probability, and level of service [1]. This analytical approach provides a useful assessment of overall intersection performance based on traffic demand and capacity. However, analytical methods do not explicitly represent the movement and interaction of individual vehicles.

Microscopic traffic simulation can provide more detailed information on individual vehicle movements. PTV VISSIM is a microscopic traffic simulation software capable of representing vehicle movements based on traffic volume, road geometry, vehicle composition, route distribution, and driving behavior [3], [4]. The use of VISSIM can therefore complement the analytical evaluation provided by PKJI 2023 by providing detailed information on vehicle delay and queue length for different traffic movements.

Previous studies have examined unsignalized intersection performance using PKJI 2023, PTV VISSIM, or a combination of both approaches. The studies reviewed in this research indicate that previous work has generally focused on intersection performance assessment without evaluating staged traffic management alternatives. Some studies have applied PKJI 2023 and VISSIM together, while others have focused on microscopic simulation or analytical evaluation separately. Previous research has also addressed driving behavior calibration and intersection performance analysis, but the evaluation of staged interventions at a three-leg unsignalized intersection remains limited. In particular, an integrated assessment involving PKJI 2023, PTV VISSIM, and multiple traffic management scenarios at an unsignalized intersection in Pandeglang Regency has not been sufficiently addressed.

Therefore, this study aims to evaluate the operational performance of the Mengger unsignalized intersection using PKJI 2023 and PTV VISSIM and to identify the most effective traffic management scenario. Three intervention scenarios are evaluated, namely side-friction control, approach widening, and three-phase traffic signal implementation. The analysis compares the existing condition and intervention scenarios based on traffic performance indicators, including delay, queue length, and level of service.

2 Data and Methods

2.1 Research Method

This study employs a descriptive quantitative approach to evaluate the operational performance of an intersection without traffic lights. The descriptive approach is used to characterize the traffic conditions observed in the field, while the quantitative approach is used to analyze traffic performance based on the 2023 Indonesian Road Capacity Guidelines (PKJI) and microscopic traffic simulations using PTV VISSIM. The evaluation considered several operational performance indicators, such as intersection capacity, saturation level, vehicle queue length, and vehicle delay under existing traffic conditions [1], [3].

2.2 Study Location

This study was conducted at the unmarked intersection of Jl. Raya Labuan–Pandeglang, Jl. KH. Abdul Halim, and Jl. Raya Labuan in Pandeglang Regency, Banten Province, Indonesia. This intersection serves as a key junction connecting residential, commercial, and regional transportation routes. Due to relatively high traffic demand during peak hours, this location frequently experiences traffic queues and delays, making it suitable for evaluating the intersection's operational performance.

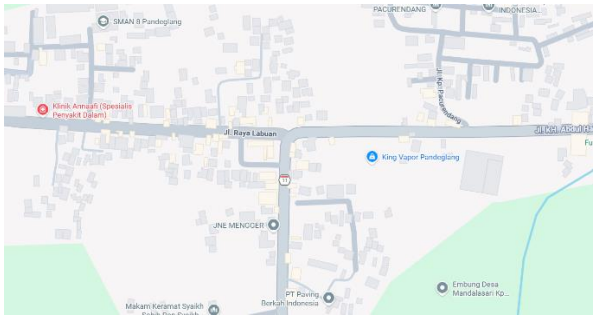


Figure 1. Research Location

Reference: Data Processing 2026

2.3 Data Collection

The data used in this study consist of primary and secondary data.

1. Primary data were obtained through field surveys conducted at the study intersection. The collected data included traffic volume, vehicle composition, vehicle movement, intersection geometry, and vehicle speed. Traffic surveys were conducted on Sunday, Monday, and Tuesday from 15:00 to 17:00 WIB. Based on the observed traffic conditions, Monday recorded the highest traffic volume and was selected as the basis for the operational analysis. The selected peak-period dataset was collected on 23 April 2026 from 15:00 to 17:00 WIB and was used as the input for both the PKJI 2023 analysis and the PTV VISSIM simulation. to accurately represent traffic conditions at the study site. In addition, field documents were collected to support the

development of the PTV VISSIM simulation model [3], [8].

Table 1. Traffic Survey Schedule

Survey Day	Survey Period
Sunday	15:00–17:00 WIB
Monday	15:00–17:00 WIB
Tuesday	15:00–17:00 WIB

Source: Data Analysis, 2026

2. Secondary data were obtained from the 2023 Indonesian Road Capacity Guidelines (PKJI), the PTV VISSIM User Guide, previous studies, scientific journals, and other references related to the analysis of the operational performance of unsignalized intersections [1], [3], [5], [6], [7], [9].

The collected traffic volume, geometric, vehicle composition, vehicle movement, and speed data were used as inputs for the PKJI 2023 analytical calculations and the microscopic PTV VISSIM simulation. The results were subsequently used to characterize the existing intersection condition and to evaluate the proposed traffic management scenarios.

2.4 PKJI 2023 Analysis

The evaluation of intersection performance was conducted based on the Indonesian Road Capacity Guidelines (PKJI) 2023. This method provides procedures for estimating key traffic performance indicators, including intersection capacity (C), degree of saturation (DS), average delay (T), and level of service (LOS) [1].

The degree of saturation is calculated using Equation (1) [1].

$$DS = Q/C \quad (1)$$

where DS is the degree of saturation, Q is traffic volume (pcu/hour), and C is intersection capacity (pcu/hour).

The obtained degree of saturation value is used as a basis for determining the intersection level of service in accordance with PKJI 2023 provisions [1], [2]. The average approach width for three-leg intersections is determined using Equation (2); the adjusted intersection capacity is calculated using Equation (3); and the total intersection delay (comprising traffic delay and geometric delay) is estimated using Equation (4). Variables and adjustment factors for each equation are defined in the Results and Discussion section where numerical computations are presented [1].

2.5 PTV Vissim Simulation

PTV VISSIM is used to perform microscopic traffic simulations based on field data, including intersection geometry, traffic volume, vehicle composition, and the proportion of turning movements. The simulation model was created to represent the existing traffic conditions at the studied intersection and to evaluate its performance under actual traffic demand conditions [3], [4].

The simulation results include average vehicle delay and queue length for the simulated traffic movements. These indicators were used to evaluate the existing operational condition and the relative performance of the proposed traffic management scenarios. Unlike the analytical PKJI 2023 method, which estimates aggregate intersection performance using capacity-based equations, PTV VISSIM represents individual vehicle movements and interactions through microscopic simulation [1], [3].

2.6 Research Flowchart

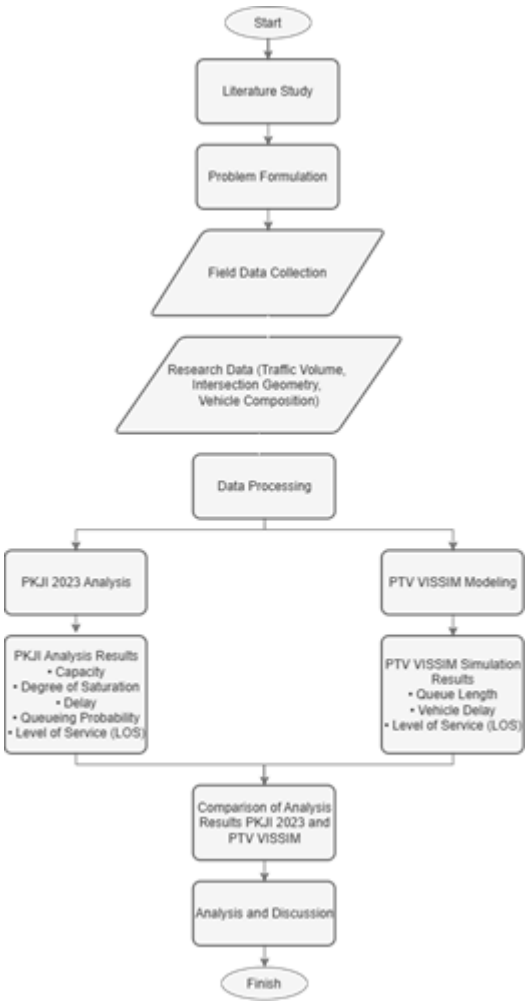


Figure 2. Research Flowchart
Reference: Data Processing 2026

The study was conducted in several systematic stages. First, a literature review was conducted to establish the theoretical background regarding intersection performance analysis, the 2023 PKJI, and microscopic traffic simulation using PTV VISSIM [1], [3], [4]. Next, a field survey was conducted to collect

geometric characteristics and traffic volume data at the intersections under study.

The collected data were analyzed using the PKJI 2023 guidelines and modeled with PTV VISSIM. Finally, the analysis results obtained from the PKJI 2023 were compared with the simulation results generated by PTV VISSIM to evaluate the intersection's operational performance under existing traffic conditions [1], [3]. The overall research procedure is illustrated in **Figure 2.**

3 Results and Discussion

3.1 Peak Hour Traffic Volume

The geometric characteristics of the study intersection were obtained from direct field measurements. The intersection consists of three approaches connecting Jl. Raya Labuan–Pandeglang, Jl. KH. Abdul Halim, and Jl. Raya Labuan. Jl. Raya Labuan–Pandeglang and Jl. KH. Abdul Halim function as the major road approaches, while Jl. Raya Labuan functions as the minor road approach. The measured road widths were 7.0 m, 7.0 m, and 6.0 m, respectively. The entry and exit widths were 3.5 m, 3.5 m, and 3.0 m, while the shoulder width was 1.2 m for all approaches. These geometric characteristics were used as inputs for the PKJI 2023 analysis and the PTV VISSIM model.

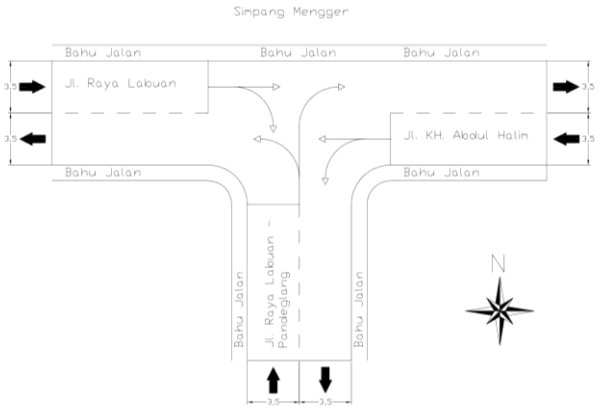


Figure 3. Three-Leg Intersection Geometry, Mengger, Pandeglang Regency

Source: Data Analysis

Table 2. Intersection Approach Width

	Jl. Raya Labuan - Pandeglang	Jl. KH Abdul Halim	Jl. Raya Labuan
Road Width	7 m	7 m	6 m
Entry Width	3.5 m	3.5 m	3.0 m
Exit Width	3.5 m	3.5 m	3.0 m
Shoulder Width	1.2 m	1.2 m	1.2 m

Source: Data Analysis

3.2 Peak Hour Traffic Volume

Traffic volume surveys were carried out on three days: Sunday, Monday, and Tuesday. Survey results indicate that Monday recorded the highest traffic volume, with 4,627 vehicles per hour during the peak period. Accordingly, Monday peak-hour data were selected as the basis for the PKJI 2023 and PTV VISSIM analyses, as they represent the most critical traffic conditions at the study location.

Therefore, traffic volume during Monday rush hour was used as input data for the 2023 PKJI analysis and the PTV VISSIM simulation [1], [3].

3.3 Passenger Car Equivalency

Traffic volume data obtained from field survey results are still in units of vehicles per hour (veh/hr). For the purpose of intersection performance analysis based on PKJI 2023, the traffic volume is converted into passenger car units (PCU/hr) [1]. The conversion process is carried out by multiplying the number of each vehicle type by the passenger car equivalency (PCE) value stipulated in the Indonesian Road Capacity Guidelines (PKJI) 2023 [1]. The PCU conversion results are presented in **Table 3**.

Table 3. Peak Hour Traffic Volume Data by Vehicle Type (PCU Conversion)

INPUT DATA		**Date**	**: April 23, 2026**			**Handled by**	**: Muhammad Idang Suryaman**				
		City	**: Pandeglang**			**Province**	**: Banten**				
		Major Road	**: Jl. Raya Labuan – Pandeglang – Jl. KH. Abdul Halim**								
1. GEOMETRIC DATA		**Minor Road**	**: Jl. Raya Labuan**								
2. TRAFFIC FLOW DATA		**Period**	**: 15:00 – 17:00**								
Intersection Geometry Data								**Traffic Flow Data**			
Median on the main road = 0 meters											
Traffic composition (%)		MP =		KS =		SM =		K Factor =			
SMP Factor =		MP, EMP =	1	KS, EMP =	1.8	SM, EMP =	0.2		q Total kb		q KTB
Traffic Flow		Veh/hr	SMP/hr	Veh/hr	SMP/hr	Veh/hr	SMP/hr	Veh/hr	SMP/hr	RB	Veh/hr
A	q Bki	0	0	0	0	0	0	0	0	0	0
	q Lrs	0	0	0	0	0	0	0	0	0	0

	q Bka	0	0	0	0	0	0	0	0	0	0
	q Total	0	0	0	0	0	0	0	0	0	0
	q Bki	0	0	0	0	0	0	0	0	0	0
	q Lrs	123	123	93	167	421	84	637	375	0.69	63
Jl. Raya Labuan	q Bka	41	41	53	95	166	33	260	170	0.31	43
	q Total	164	164	146	263	587	117	897	544	1.00	106
Total minor road, q mi		164	164	146	262.8	587	117.4	897	544.2	1	106
	q Bki	38	38	50	90	158	32	246	106	0.19	25
	q Lrs	0	0	0	0	0	0	0	0	0	0
Jl. Raya Labuan – Pandeglang	q Bka	230	230	187	337	610	122	1027	289	0.81	133
	q Total	268	268	237	427	768	153	1273	848	0.40	158
	q Bki	460	460	111	200	713	143	1284	802	0.62	25
	q Lrs	217	217	102	184	414	83	733	483	0.38	89
Jl. KH. Abdul Halim	q Bka	0	0	0	0	0	0	0	0	0	0
	q Total	677	677	213	383	1127	225	2017	1286	0.60	114
Total road major, q ma		945	945	450	810	1895	379	3290	2134	1	272
	q Bki	498	498	161	290	871	174	1530	962	0.36	50
Total from minor roads & major roads	q Lrs	340	340	195	351	835	167	1370	858	0.32	152
	q Bka	271	271	240	432	776	155.2	1287	858.2	0.32	176
q total = q mi + q ma =		1109	1109	596	1073	2482	496	4187	2678	1.00	378
									R mi = q mi/q TOT =		0.28
									RKTB = q KTB/q KB =		0.0903

(Source: Data Analysis)

3.4 Operational Performance Analysis Using PKJI 2023

3.4.1 Average Approach Width

In unsignalized intersection analysis, the average approach width (LAP) is an important geometric parameter. It is calculated as the mean of all observed approach widths and is used to determine the intersection type and adjustment factors in accordance with PKJI 2023 [1].

For three-leg (T) intersections, the average approach width is calculated using Equation (2) [1]:

$$L_{RP} = \frac{\text{LA} + \text{LB} + \text{LD}}{3} \quad (2)$$

where LRP is the average approach width of the intersection (m), calculated as the mean value of all approach widths. L_A, L_B,and $L_C$represent the width of each approach leg (m).

For the three-leg unsignalized intersection, the average approach width was determined based on the measured width of each approach. The approach widths of Jl. Raya Labuan–Pandeglang, Jl. KH. Abdul Halim, and Jl. Raya Labuan were 7.0 m, 7.0 m, and 6.0 m, respectively. Therefore, the average approach width was calculated as follows:

Average Approach Width (LRP)

$$L_{RP} = \frac{7 + 7 + 6}{3}$$

$$L_{RP} = 6.67 \text{ m}$$

The resulting average approach width of 6.67 m corresponds to intersection type 322, consisting of three approaches with two lanes on the major road and two lanes on the minor road. The results from measuring the approach widths are shown in **Table 4**.

Table 4. Approach Width and Intersection Type

Option	Number of Branch Arms	Short Sleeve, M						L_{RP}	Number of Lanes		Junction Types
		Minor Street			Mayor Street				Minor Street	Mayor Street	
		L_C	L_D	L_{CD}	L_A	L_B	L_{AB}				
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
1	3	6	0	3	7	6	7	6.67	2	2	322

(Source: Data Analysis)

3.4.2 Capacity Analysis

Intersection capacity was calculated using the 2023 Indonesian Road Capacity Guidelines (PKJI 2023). The calculation considers the basic intersection capacity and several adjustment factors representing the geometric, environmental, and traffic conditions at the study site [1]. For the study intersection, the basic capacity was 2,700 pcu/h. The adjustment factors consisted of the approach width factor (FLP) of 1.2367, major-road median factor (FM) of 1.000, city-size factor (FUK) of 1.000, side-friction factor (FHS) of 0.880, left-turn factor (FBKi) of 1.418, right-turn factor (FBKa) of 0.795, and minor-road flow ratio factor (FRMI) of 0.990.

The intersection capacity was calculated using Equation (3):

$$C = C0 \times FLP \times FM \times FUK \times FHS \times FBKi \times FBKa \times FRmi \quad (3)$$

By substituting the obtained adjustment factor values, the intersection capacity is calculated as follows:

$$C = 2700 \times 1.2367 \times 1,000 \times 1,000 \times 0.880 \times 1,418 \times 0,795 \times 0,990$$

$$C = 3287\ pcu/hr$$

The resulting capacity of 3,287 pcu/h indicates the maximum traffic volume that can be accommodated by the intersection under the observed geometric, traffic, and environmental conditions. This value represents the maximum capacity the intersection can achieve in handling traffic flow, based on the physical conditions and traffic characteristics present at the time of the study.

Table 5. Intersection Capacity

Option	Base Capacity C0	Traffic Performance							Capacity C
		Average width of the approach	Median road mayor	City size	Side barrier	Turn left	Turn right	Minor Ratio/Total	
	SMP/hr	F_{LP}	F_M	F_{UK}	F_{HS}	F_{BKi}	F_{BKa}	F_{Rmi}	SMP/hr
	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]
1	2700	1.2367	1	1	0.880	1,418	0,795	0.99	3287

(Source: Data Analysis)

Based on the base capacity, average approach width, city size factor, side obstructions, left-turn factor, right-turn factor, and minor road ratio, the intersection capacity value for Intersection C was determined to be 3287 pcu/hour [1].

3.4.3 Degree of Saturation

The degree of saturation (DS) is a primary indicator of intersection performance. It represents the ratio of traffic volume to intersection capacity, and higher DS values indicate greater utilization of available road capacity, increasing the likelihood of congestion and excessive queue formation [1], [2].

A traffic survey during rush hour showed that the total number of vehicles passing by each hour was 2,678.20. Meanwhile, the calculations for the intersection's capacity showed that the capacity (C) is 3,287 vehicles per hour. The degree of saturation was calculated using Equation (1), defined in Section II.

$$DS = Q/C \quad (1)$$

By entering the traffic volume and intersection capacity values obtained, the degree of saturation can be calculated as follows:

$$DS = \frac{2678}{3287} = 0.815$$

The resulting degree of saturation of 0.815 indicates that approximately 81.5% of the available intersection capacity was utilized during the selected peak period. The intersection therefore remained below its nominal capacity, although the relatively high saturation level indicates that the intersection should be monitored as traffic demand increases.

A DS value approaching one indicates that the road's capacity is beginning to be compromised due to the high volume of vehicles passing through [1], [2]. If traffic volume increases in the future without any efforts to address the issue, it could lead to increased congestion, longer wait times, and a decline in service quality at the intersection [2].

3.4.4 Delay and Level of Service

Delay is one of the key indicators used to evaluate the operational performance of intersections without traffic signals, as it reflects the additional time vehicles experience due to traffic interactions and geometric characteristics. According to the 2023 Indonesian Road Capacity Guidelines (PKJI), total delay at an intersection consists of traffic delay and geometric delay, which together describe the overall operational conditions of an intersection [1].

According to PKJI 2023, total intersection delay consists of traffic delay and geometric delay [1]. Based on the calculation results, the traffic delay at the study intersection was 9.71 s/pcu, while the geometric delay was 4.37 s/pcu. Therefore, the total intersection delay was calculated as follows:

$$T = T_{LL} + T_G \quad (4)$$

By substituting the values obtained from the calculations, the junction delay can be calculated as follows:

$$T = 9.71 + 4.37$$

$$T = 14.08\ s/pcu$$

The resulting average intersection delay was 14.08 s/pcu. Based on the level-of-service classification applied in the study, this delay corresponds to Level of Service (LOS) B. The result indicates that, from the PKJI 2023 analytical perspective, the intersection still operates under relatively stable conditions during the selected peak period.

Based on the delay criteria in PKJI 2023, an average delay of 14.08 s/pcu corresponds to Level of Service (LOS) B. This level of service indicates that the

intersection still operates under stable traffic conditions with relatively minor delays. Although vehicles occasionally experience short waiting times due to traffic interactions, the intersection is still able to accommodate the existing traffic demand effectively [1].

Table 6. Intersection Performance

Option	Traffic Flow	Traffic performance						
	Flow Total q TOT SMP/hour [21]	Degree saturation DJ [22]	Delay Traffic Intersection TLL [23]	Delay Traffic Road Major TLLma [24]	Delay Traffic Road minor TLLmi [25]	Delay Geometry Road TG [26]	Delay Intersection T = TLL + TG [27]	Opportunity queue [28]
1	2678	0.815	9.71	7.17	19.67	4.37	14, 08	-0.69 53.04

(Source: Data Analysis)

Based on **Table 5**, the intersection has a capacity of 3,287 pcu/h and handles a traffic volume of 2,678 pcu/h, resulting in a saturation level of 0.815. These results indicate that approximately 83.1% of the intersection's available capacity is utilized during peak hours. Although the intersection remains within its capacity, the relatively high saturation level indicates that operational conditions are approaching its maximum service limit.

An average delay of 14.08 seconds per vehicle indicates that vehicles can still pass through the intersection with acceptable operational performance. However, if traffic demand continues to increase without improvements in traffic management or geometric design, the intersection may experience longer queues and greater vehicle delays during future peak periods. Therefore, the operational performance obtained from the 2023 PKJI analysis provides a baseline for comparison with the macroscopic simulation results generated using PTV VISSIM.

3.5 PTV VISSIM

3.5.1 Development of the Simulation Model

A microscopic traffic simulation model was developed using PTV VISSIM to represent the existing operational condition of the Mengger unsignalized intersection. The model was constructed based on field-measured intersection geometry, traffic volume, vehicle composition, vehicle movement distribution, and vehicle speed characteristics. The road network consisted of links and connectors representing the three intersection approaches and the observed vehicle movement patterns.

Traffic volumes and vehicle compositions obtained from the field survey were assigned to the corresponding approaches. Vehicle movements were defined using static vehicle routing based on the observed proportions of left-turn, through, and right-turn movements. In addition, the observed vehicle speed characteristics were incorporated into the model through the Desired Speed Distribution. Conflict areas were also configured to represent the interactions among traffic streams at the unsignalized intersection.

The simulation was then run to obtain operational performance measures, primarily vehicle delay and queue length. These outputs were used to evaluate the existing intersection condition and to assess the effectiveness of the proposed traffic management scenarios.

3.5.2 Vehicle Speed Input & Traffic Simulation Results

Vehicle speed data collected during the field survey were incorporated into the PTV VISSIM model using the Desired Speed Distribution. The observed speeds were classified according to vehicle type, namely motorcycle (MC), light vehicle (LV), and heavy goods vehicle (HGV). The average observed speeds were 27.1 km/h for motorcycles, 23.7 km/h for light vehicles, and 18.0 km/h for heavy goods vehicles.

These observed speed characteristics were used to define the desired speed distribution in the simulation model so that the simulated vehicle movements represented the speed characteristics observed at the study intersection.

Table 7. Average Vehicle Speed from Field Survey

Vehicle Type	Average Speed (km/h)
Motorcycle (MC)	27.1
Light Vehicle (LV)	23.7
Heavy Goods Vehicle (HGV)	18.0

Source: Data Analysis

The PTV VISSIM simulation was conducted using the field-surveyed traffic demand, vehicle composition, vehicle movement distribution, intersection geometry, and observed speed characteristics. The simulation results were evaluated in terms of average vehicle delay and queue length.

Under existing conditions, the simulation produced an average vehicle delay of 31.05 s/veh and an average queue length of 15.94 m. The results indicate that traffic interactions at the unsignalized intersection still produce measurable delays and queues during the peak period, particularly on approaches with higher traffic demand.

Based on the Node Evaluation results, the existing intersection condition corresponds to Level of Service (LOS) E. This indicates that although traffic can still pass through the intersection, operational

performance is relatively poor during the selected peak period.

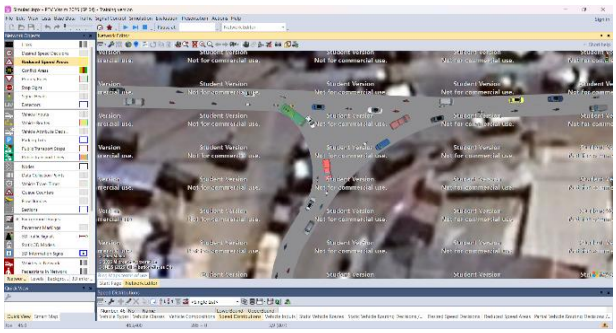


Figure 4. PTV VISSIM Simulation Results

Source: PTV VISSIM Modeling Results, 2026

Based on the simulation results, it is evident that traffic at the intersection is quite dense, particularly on the lanes leading to the main road. These conditions cause vehicles to interact more frequently, which can lead to traffic conflicts [5].

3.5.3 Traffic Performance Analysis

Traffic performance was evaluated using the PTV VISSIM simulation results for each observed traffic movement. The primary indicators considered were queue length and average vehicle delay. These indicators describe the variation in operational performance among different vehicle movement directions under the existing traffic condition.

Table 8. Traffic performance results from PTV VISSIM simulation

Approach	Queue Length (m)	Average Delay (sec/veh)
Jl. Raya Labuan–Pandeglang → Jl. KH. Abdul Halim	19.07	33.74
Jl. Raya Labuan–Pandeglang → Jln. Raya Labuan	0.22	40.67
Jl. KH. Abdul Halim → Jl. Raya Labuan–Pandeglang	7.34	36.24
Jl. KH. Abdul Halim → Jln. Raya Labuan	8.57	36.10
Jln. Raya Labuan → Jl. KH. Abdul Halim	3.62	31.43
Jln. Raya Labuan → Jl. Raya Labuan–Pandeglang	3.43	38.51

(Source: Data Analysis)

Based on **Table 8**, operational performance varies across the six traffic movements due to differences in traffic demand and vehicle interactions. The queue lengths range from 0.22 to 19.07 m, while the average vehicle delays range from 31.43 to 40.67 s/veh. These variations indicate that traffic movement performance is not uniform across the intersection and that movements with different demand and interaction characteristics experience different levels of delay and queue formation.

3.6 Comparison of PKJI 2023 and PTV VISSIM Results

The operational performance obtained from PKJI 2023 and PTV VISSIM was compared to provide complementary information on the existing condition of the study intersection. The two methods represent intersection performance using different analytical approaches and performance measures. PKJI 2023 provides an analytical assessment based on traffic demand, capacity, degree of saturation, delay, queue probability, and level of service, whereas PTV VISSIM represents individual vehicle movements through microscopic simulation and provides vehicle delay and queue length for the simulated condition.

Based on the PKJI 2023 analysis, the intersection had a capacity of 3,287 pcu/h, a degree of saturation of 0.815, an average delay of 14.08 s/pcu, and Level of Service B. The queue probability obtained from the PKJI calculation ranged from 0.69% to 53.04%.

Table 9. Existing Intersection Performance by Analytical Approach

Performance Indicator	PKJI 2023	PTV VISSIM
Traffic Demand	2,678 pcu/h	2,678 veh/h*
Intersection Capacity	3,287 pcu/h	Not directly reported
Degree of Saturation	0.815	Not directly reported
Delay	14.08 s/pcu	31.05 s/veh
Queue Indicator	0.69–53.04% queue probability	15.94 m average queue length
Level of Service	B	E

(Source: Data Analysis)

Under the existing condition, the PTV VISSIM model produced an average vehicle delay of 31.05 s/veh, an average queue length of 15.94 m, and Level of Service E.

The differences between the two approaches should not be interpreted as a direct numerical equivalence because the delay and queue indicators are expressed using different units and measurement

concepts. PKJI 2023 reports intersection delay on a passenger-car-unit basis and queue probability, while PTV VISSIM reports simulated vehicle delay and physical queue length. Therefore, the results are used to characterize the existing intersection from complementary analytical and microscopic perspectives rather than to establish direct numerical equivalence between the two methods.

The PTV VISSIM results were subsequently used as the basis for evaluating alternative traffic management scenarios. The scenarios were compared using the same simulation framework and the same primary performance indicators, namely vehicle delay, average queue length, and level of service.

3.7 Traffic Management Scenarios

3.7.1 Scenario 1: Side-Friction Control

Side-friction control was evaluated as the first traffic management scenario. The intervention represents the removal or control of activities that interfere with traffic movement around the intersection, including vehicles stopping or parking on the roadway and other roadside activities that may reduce traffic flow efficiency. The scenario was intended as an initial operational improvement measure without changing the physical geometry of the intersection.

The PTV VISSIM simulation resulted in an average vehicle delay of 48.78 s/veh, an average queue length of 6.04 m, and Level of Service E. Although the average queue length decreased compared with the existing condition, the delay remained relatively high and the level of service did not improve. Therefore, side-friction control alone was not sufficient to provide a substantial improvement in overall intersection performance.

Table 10. Simulation Results of Scenario 1

Parameter	Value	Unit
Average Vehicle Delay	48.78	s/veh
Average Queue Length	6.04	m
Level of Service	E	–

Source: Data Analysis, 2026

3.7.2 Scenario 2: Approach Widening

The second scenario involved widening the approach at the intersection, particularly on the approach with the highest traffic demand. The intervention was implemented by increasing the available approach width before vehicles entered the intersection. In the PTV VISSIM model, the approach geometry was modified by adjusting the corresponding link dimensions. The objective was to provide greater space for vehicle movements and improve the operational capacity of the approach.

The simulation produced an average vehicle delay of 7.79 s/veh and an average queue length of 0.04 m. Based on the Node Evaluation results, the intersection achieved Level of Service B. Compared with the existing condition and Scenario 1, approach widening produced the most substantial improvement in the operational performance of the intersection.

Table 11. Simulation Results of Scenario 2

Parameter	Value	Unit
Average Vehicle Delay	7.79	s/veh
Average Queue Length	0.04	m
Level of Service	B	–

Source: Data Analysis, 2026

3.7.3 Scenario 3: Three-Phase Traffic Signal

The third scenario involved the implementation of a three-phase traffic signal at the study intersection. The signal operation was designed to regulate vehicle movements sequentially at each approach in order to reduce conflicts among traffic streams. The signal cycle used in the simulation was 120 seconds, with green, yellow, and red intervals assigned to each approach based on the scenario design.

The simulation resulted in an average vehicle delay of 146.02 s/veh, an average queue length of 298.32 m, and Level of Service F based on the Node Evaluation results. The high delay and queue length indicate that the applied signal timing did not improve the operational performance of the intersection. Therefore, the three-phase signal configuration used in this simulation would require further evaluation and optimization before being considered for field implementation.

Table 12. Simulation Results of Scenario 3

Parameter	Value	Unit
Average Vehicle Delay	146.02	s/veh
Average Queue Length	298.32	m
Level of Service	F	–

Source: Data Analysis, 2026

3.8 Comparison of Traffic Management Scenarios

The performance of the existing condition and the three traffic management scenarios was compared using average vehicle delay, average queue length, and level of service. The comparison was conducted within the same PTV VISSIM simulation framework to identify the alternative that provided the greatest improvement in intersection performance.

Table 13. Comparison of Existing Condition and Traffic Management Scenarios

Performance Parameter	Existing	Scenario 1:	Scenario 2:	Scenario 3:
Average Vehicle Delay (s/veh)	31.05	48.78	**7.79**	146.02

Average Queue Length (m)	15.94	6.04	**0.04**	298.32
Level of Service	E	E	**B**	F

Source: Data Analysis, 2026

The comparison shows that Scenario 1 did not improve the overall level of service, although the average queue length decreased relative to the existing condition. Scenario 2 produced the best operational performance, with average vehicle delay decreasing to 7.79 s/veh and average queue length decreasing to 0.04 m, while the level of service improved from E to B. In contrast, Scenario 3 produced substantially higher delay and queue length, resulting in Level of Service F.

Based on the comparison of the simulated alternatives, approach widening was identified as the most effective traffic management scenario for the study intersection. The result indicates that increasing the available approach space provides a greater operational benefit under the simulated traffic demand than the side-friction control and three-phase signal configurations evaluated in this study.

4 Conclusion

This study evaluated the operational performance of the Mengger unsignalized intersection in Pandeglang Regency using the 2023 Indonesian Road Capacity Guidelines (PKJI) and PTV VISSIM, followed by an evaluation of three traffic management scenarios.

Based on the PKJI 2023 analysis, the intersection has a capacity of 3,287 pcu/h and a degree of saturation of 0.815. The calculated average intersection delay was 14.08 s/pcu, with a queue probability ranging from 0.69% to 53.04%, corresponding to Level of Service B. These results indicate that the intersection remains below its analytical capacity under the selected peak-period traffic demand.

The PTV VISSIM simulation of the existing condition produced an average vehicle delay of 31.05 s/veh, an average queue length of 15.94 m, and Level of Service E. The differences between the PKJI 2023 and PTV VISSIM results reflect the different analytical approaches and performance measures used by the two methods. Therefore, the results should be interpreted as complementary representations of intersection performance rather than as directly equivalent numerical values.

The three traffic management scenarios produced different operational outcomes. Scenario 1, consisting of side-friction control, resulted in an average vehicle delay of 48.78 s/veh, an average queue length of 6.04 m, and Level of Service E. Scenario 2, consisting of approach widening, produced the best performance, with average vehicle delay reduced to 7.79 s/veh, average queue length reduced to 0.04 m, and Level of Service B. Scenario 3, consisting of a three-phase traffic signal, resulted in an average vehicle delay of 146.02 s/veh, an average queue length of 298.32 m, and Level of Service F.

Based on the comparison of the three simulated alternatives, approach widening is identified as the most effective traffic management scenario for improving the operational performance of the study intersection. The selected alternative provides the lowest vehicle delay and queue length and improves the level of service from E under the existing VISSIM condition to B.

For practical implementation, the approach-widening alternative should be considered as the primary improvement option, subject to further evaluation of geometric feasibility, land availability, safety, and implementation conditions. Future research should conduct more comprehensive calibration and validation of the PTV VISSIM model using field observations and should evaluate additional alternatives, including optimized traffic signal timing and combined intervention strategies. Further traffic surveys over additional days and time periods are also recommended to improve the representativeness of the traffic demand data.

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