JOURNAL OF GREEN SCIENCE AND TECHNOLOGY

EVALUATION OF SIGNALIZED INTERSECTION PERFORMANCE USING VISSIM MICROSIMULATION AND PKJI 2023 (CASE STUDY: GUNUNG SARI INTERSECTION IN CIREBON CITY)

Mira Lestira Hariani [1*], Ikhlas Maddinah Pradana[1], Rendy Yogista W[1], Yunandhika Agung Yudiansyah[1], Romeo Yullezia Radical[1], Fais Hidayah Al Baihaqi[1]

[1]) Civil Engineering Department, Univeritas Swadaya Gunung Jati.*
Corresponding Author's Email: mira.hariani0103@gmail.com
Corresponding Author's Phone Number: 087718070807

ABSTRACT

The development of urban traffic in the city of Cirebon poses challenges to the performance of signalized intersections, particularly at the Gunung Sari intersection, which connects four main corridors: Jl. Cipto Mangunkusumo, Jl. Wahidin, Jl. Tuparev, and Jl. Kartini. This study aims to evaluate the existing performance of the intersection using a manual approach based on the 2023 Indonesian Road Capacity Guidelines (PKJI) and microscopic modeling with PTV VISSIM software. The survey was conducted by recording traffic volume for 5 days between 06:00 and 18:00 WIB, with peak conditions occurring on Saturday between 13:00 and 14:00 WIB at 8,082 vehicles/hour. The traffic composition was dominated by motorcycles (59.54%) and passenger cars (39.03%). The results of the 2023 PKJI analysis showed that all intersection arms in the existing condition were at service level F with an average delay of 92.24–98.24 seconds and a queue length of 76.63–204.84 meters. The 10-year projection shows an increase in the degree of saturation to >1.80 with the highest delay on the Kartini arm of 436.33 seconds. Validation of the VISSIM model using the GEH test produced a value of <5 with a conformity level above 95%, so the model is reliable. The simulation results show that Scenario 1 (simplifying the cycle to 3 phases by combining Wahidin and Cipto) is the most effective alternative because it can reduce the average delay and queue length evenly compared to other scenarios. This study emphasizes the importance of periodic evaluation and the application of simulation-based scenarios in supporting urban traffic management.

Keywords: *Signalized intersection, PKJI 2023, microsimulation, VISSIM, traffic performance.*

1. INTRODUCTION

The rapid development of urban areas in Indonesia has presented complex challenges in transportation system management, particularly at traffic nodes such as signalized intersections. Signalized intersections play an important role in regulating vehicle movement, reducing potential traffic conflicts, and improving the efficiency and safety of vehicle flow. As the volume of vehicles in urban areas increases, evaluating the performance of signalized intersections becomes a crucial aspect in designing responsive and sustainable traffic strategies. One signalized intersection with unique characteristics that is important to study is the Gunung Sari intersection in the city of Cirebon. This intersection connects four main roads, namely Jl. Cipto Mangunkusumo, Jl. Wahidin, Jl. Tuparev, and Jl. Kartini. These four approaches are important corridors with strategic functions as connectors between commercial, educational, and interregional transportation areas. The high volume of vehicles passing through this intersection, coupled with the diverse composition of traffic—ranging from motorcycles, private vehicles, public transportation, to medium-sized vehicles—makes the Gunung Sari Intersection one of the most congested and complex intersections in Cirebon City.

The uneven distribution of traffic flow between approaches and limited space at the intersection often causes long queues, significant delays, and even congestion during rush hours. These conditions not only affect travel time for road users, but also the overall operational efficiency of transportation and air quality around the intersection. Therefore, a comprehensive evaluation of the operational performance of this intersection is needed in order to formulate data-driven and realistically applicable solutions.

In the Indonesian context, the 2023 Indonesian Road Capacity Guidelines (PKJI) are the main reference for evaluating the capacity and performance of signalized intersections. PKJI 2023 provides an analytical approach based on local traffic conditions, with parameters such as capacity, degree of saturation, average delay, and queue length as key indicators[1], [2] . Various studies have utilized this approach in evaluating intersections in large and medium-sized cities in Indonesia[3], [4] . However, manual approaches such as PKJI have limitations in capturing real-time traffic dynamics, especially in the context of complex vehicle interactions.

As a complement, the microscopic simulation approach using software such as PTV VISSIM is becoming an increasingly popular choice in traffic research. VISSIM is capable of representing individual vehicle behavior based on geometric conditions and actual volume data, thereby capturing the complexity of traffic interactions more realistically [5], [6] . The main advantage of VISSIM lies in its ability to model different operational scenarios without disrupting actual traffic conditions in the field, while also enabling detailed visualization of traffic flows. The microscopic simulation approach using software such as PTV VISSIM is now popular in traffic research because it is able to model individual vehicle behavior based on geometric conditions and actual volume more realistically. For example, a study at the Demak Ijo intersection in Yogyakarta showed that the existing conditions, which were classified as LOS F with a delay of 80 seconds and a queue length of 48 m, were successfully analyzed in detail using VISSIM[7] . Another study at Pasteur, Bandung, also utilized VISSIM to compare existing conditions and alternative designs, with travel time, speed, and queue length as the main evaluation tools[8] . In addition, a study on pedestrian simulation by[9] shows that integrating pedestrian effects improves the accuracy of microsimulation models, as the number of pedestrians has a significant impact on the global LOS of intersections. Several studies show that combining the PKJI manual method and VISSIM microscopic simulation produces a more comprehensive analysis. References[10] and[11] , for example, reveal that manual calculation results can be used as a preliminary reference in the simulation model calibration process, so that the output is more in line with actual conditions. The integration of these two approaches also allows for testing alternative scenarios, such as adjusting traffic light cycle times, redistributing green time among approaches, or adding special phases.

The geometric aspects of intersections cannot be ignored in the study of signalized intersection performance. Research by[12] shows that the physical design of intersections, such as the number of lanes, approach length, turning radius, and the presence of direct turns, greatly affects capacity and delays. In the case of the Gunung Sari Intersection, the variation in geometry between approaches and the high intensity of right turns reinforce the importance of testing based on actual geometric conditions through VISSIM simulation. High and uneven traffic volume between approaches is also a major challenge in signal timing. Reference[13], [14] found that an increase in vehicle volume on one approach without accompanying signal timing adjustments can cause significant delays and local congestion. Several studies also highlight the importance of periodic signal phase optimization to adjust to daily and seasonal traffic dynamics[15], [16] .

Scenario-based approaches have been used in various studies to test the effectiveness of traffic engineering at congested intersections. Reference[17] developed simulations of three different signal timing scenarios at an intersection in Surabaya and found that the scenario with green time redistribution based on actual volume successfully reduced delays by up to 30%. A similar study was conducted by[18] at an intersection in Semarang with results that support the importance of field data-based modeling. In

P-ISSN: 2598-1277
E-ISSN: 2621-3966

addition to operational aspects, several studies have also linked intersection congestion to environmental impacts. According to[19] , congestion at intersections causes an increase in CO and CO2 emissions due to vehicles stopping and accelerating repeatedly. Thus, improving traffic efficiency through intersection evaluation and optimization not only impacts vehicle movement but also air quality and public health in general.

Based on the above literature review, it appears that the evaluation approach using PKJI 2023 as the basis for manual calculations, combined with VISSIM microsimulation, is an appropriate method for comprehensively analyzing the performance of signalized intersections. This approach allows for an assessment of existing conditions and exploration of improvement scenarios that can be implemented without risk to actual traffic in the field. Considering the complexity of traffic and the strategic position of the Gunung Sari Intersection in Cirebon City, this study aims to evaluate the performance of this four-arm signalized intersection using the PKJI 2023 method and VISSIM microscopic simulation. The results of this study are expected to provide an objective picture of the existing performance of the intersection and propose data-based operational improvements in line with local traffic characteristics.

2. RESEARCH METHOD

2.1 Research Design

This research was conducted through several systematic stages as illustrated in the following flowchart:

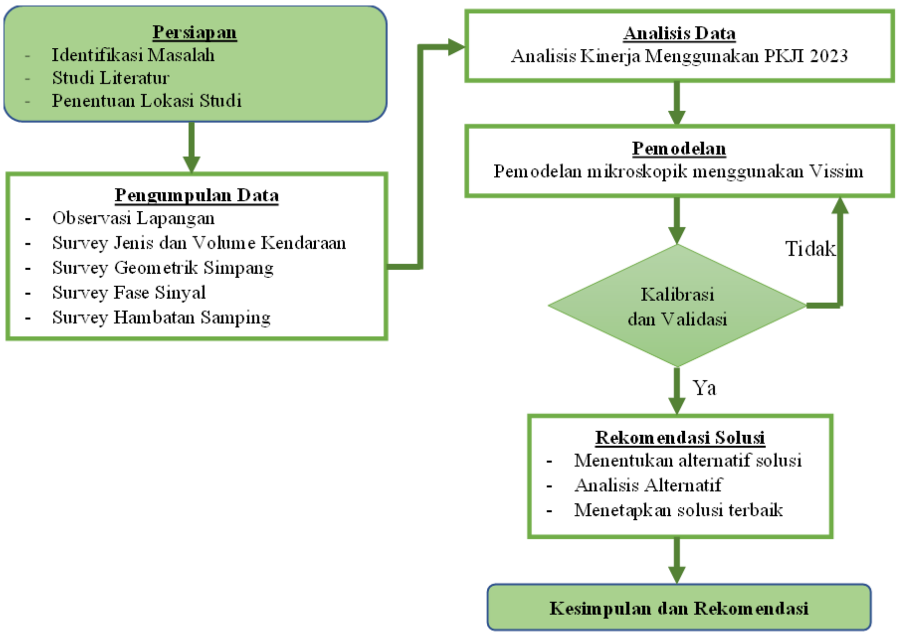

Figure 1. Research Flow

Figure 1 above shows that this research began with preparatory activities, including literature studies, problem identification, and study location determination. This was followed by data collection through field surveys. After that, performance analysis was carried out using the PKJI 2023 method and microscopic simulation modeling using VISSIM software. The results of these two approaches were analyzed comparatively to produce conclusions and recommendations.

2.2 Data Collection

Data collection was conducted directly in the field using two main methods:

1. Geometric Intersection Survey, which included measuring the number of lanes, approach length, lane width, turning radius, and other relevant physical data.

P-ISSN: 2598-1277
E-ISSN: 2621-3966

2. Traffic Counting, conducted manually to obtain vehicle volume data at each approach based on morning and afternoon peak times. Data was collected in units of vehicles/hour and grouped by vehicle type (motorcycles, cars, light trucks, heavy trucks).
3. Side Barrier Survey, to determine the side barrier class used in determining capacity
4. Signal phase survey

2.3 Data Analysis

Data analysis was conducted using two approaches:

1. Performance Calculation Using PKJI 2023. In this approach, the following are carried out:
    - capacity, volume, degree of saturation (DS), average delay, and queue length calculations.
    - Parameters are evaluated for each approach and compared with the thresholds according to PKJI 2023.
2. Simulation Using PTV VISSIM
    - The intersection model was built according to the actual geometric conditions based on the survey results.
    - Traffic volume is entered as input into the simulation model.
    - Calibration is performed by comparing simulation results with field data.
    - Scenario simulations are performed to test possible improvements such as signal time redistribution.

The results of both the PKJI 2023 and VISSIM approaches are analyzed comparatively to see the differences in results and the effectiveness of each method in evaluating intersection performance. Simulation results are also used to identify potential operational improvements.

2.4 Study Area

This study was conducted at the Gunung Sari Intersection in Cirebon City. This intersection is a signalized four-way intersection connecting:

1. Jl. Cipto Mangunkusumo (south approach)
2. Jl. Wahidin (north approach)
3. Jl. Tuparev (western approach)
4. Kartini Street (eastern approach)

This location was chosen because it is one of the intersections with high traffic volume in Cirebon City, and it serves as the main link between the city center and residential and commercial areas.

Figure 2. Study Area

P-ISSN: 2598-1277
E-ISSN: 2621-3966

3. RESULTS AND DISCUSSION

3.1 Traffic Characteristics at the Gunung Sari Intersection

Figure 3. Intersection Geometry

The Kejaksan intersection is a four-arm signalized intersection that connects four main roads in Cirebon City, namely Jl. Wahidin on the north side, Jl. Cipto Mangunkusumo on the south side, Jl. Tuparev on the west side, and Jl. Kartini on the east side. Each approach has a different geometric configuration, which affects the capacity and operational performance of the intersection.

The North Approach (Jl. Wahidin) consists of two entry lanes with a total effective width of 9.5 meters and two exit lanes with a width of 10.5 meters, separated by a 1-meter median. The width of the lane approaching the stop line (LM) is 7.5 meters, while the width of the left turn lane (LBKJT) is 3 meters. This approach is located in an urban road environment (KOM) with low side obstacles (R), an active median, and no parked vehicles near the intersection (distance to the first parked vehicle = 0 m). The South Approach (Jl. Cipto Mangunkusumo) is the approach with the largest total width, namely 25 meters. There are two entry lanes and three exit lanes, with entry lanes measuring 9.5 meters and exit lanes measuring 14 meters, separated by a 1.5-meter median. The lane width approaching the stop line (LM) is 9.5 meters and the LBKJT is 4.5 meters. Similar to the northern approach, this road is classified as a KOM environment, has low side barriers (R), and has an active median. The distance to the first parked vehicle is 0 meters.

The West Approach (Jl. Tuparev) has two entry lanes with an initial approach width of 6.5 meters and two exit lanes with a width of 8 meters. There is no median on this approach. The LM is recorded at 5 meters and the LBKJT at 3 meters. The road environment is classified as KOM, but has high side barriers (T) due to commercial activities around the approach. The East Approach (Jl. Kartini) also has two entry lanes and two exit lanes. The entrance lane width is 8.25 meters, LM is 5.25 meters, and LBKJT is 3 meters. The exit lane has a total width of 8.25 meters. There is no median, and the side obstacle class is moderate (S). The road environment is classified as KOM, and no parked vehicles were found to be obstructing this approach.

In general, the intersection geometry shows significant variations between each approach, in terms of lane width, median presence, and side obstacle level. This condition is one of the considerations in capacity analysis and simulation modeling to evaluate the overall performance of the intersection.

Table 1. Intersection Geometric Data

Approach Code N, S, E, W	Environment Type	Side Obstacle Side	Median	Gradient (Slope)	Turn Left and Continue (BKiJT)	Distance to First Parked Vehicle (m)	Approach Width (m)			
							at the beginning of the lane (L) (m)	at the stop line (LM) (m)	On the left turn lane (LBKiJT) (m)	on the exit lane (LK) (m)
N	commercial	Low	Yes	0	Yes	0	8	5	3	8.25
S	commercial	Low	Yes	0	Yes	0	8.25	5.25	3	6.5
E	commercial	High	No	0	Yes	0	10.5	7.5	3	9.5
W	commercial	Medium	No	0	Yes	0	14	9.5	4.5	9.5

Traffic signal settings at the Kejaksan intersection use a four-phase signal system with customized time distribution for each approach based on traffic volume and characteristics. The total duration of one signal cycle is 161 seconds, which includes green, yellow, red, and all red lights.

- Phase 1 is assigned to the West approach (Jl. Tuparev) with a green light duration of 60 seconds, yellow for 3 seconds, and red for 98 seconds. The "all red" (intergreen) time is 4 seconds.
- Phase 2 or Phase ¾ is for the East approach (Jl. Tuparev – Jl. Kartini) with a time configuration of 25 seconds green, 3 seconds yellow, and 133 seconds red, as well as 4 seconds all red.
- Phase 3 for the North approach (Jl. Wahidin) has a green duration of 35 seconds, with 3 seconds yellow and 123 seconds red. This phase has an all-red time of 4 seconds.
- Phase 4 regulates traffic flow from the southern approach (Dr. Ciptomangunkusumo Street), with a green duration of 45 seconds, 3 seconds yellow, and 113 seconds red. The intergreen time (all red) in this phase is 4 seconds.

The varying green time settings between phases reflect a time allocation strategy based on the actual traffic load distribution at each approach. The "all red" time value is used as a safety period between movements to prevent conflicts between vehicles coming from different approaches. This cycle time is an important input in evaluating intersection capacity using the PKJI 2023 method and as a parameter for signal logic settings in microscopic simulations using VISSIM.

Table 2. Signal Phase Times

Signal	Approach	Red (Second)	Green (Second)	Yellow (Seconds)	All Red (Second)
Phase 1	Tuparev Street (West)	98	60	3	4
Phase 2	Tuparev Street – Kartini Street (E)	133	25	3	4
Phase 3	Wahidin Street (N)	123	35	3	4
Phase 4	Cipto Street (S)	113	45	3	4
Cycle Time			161		

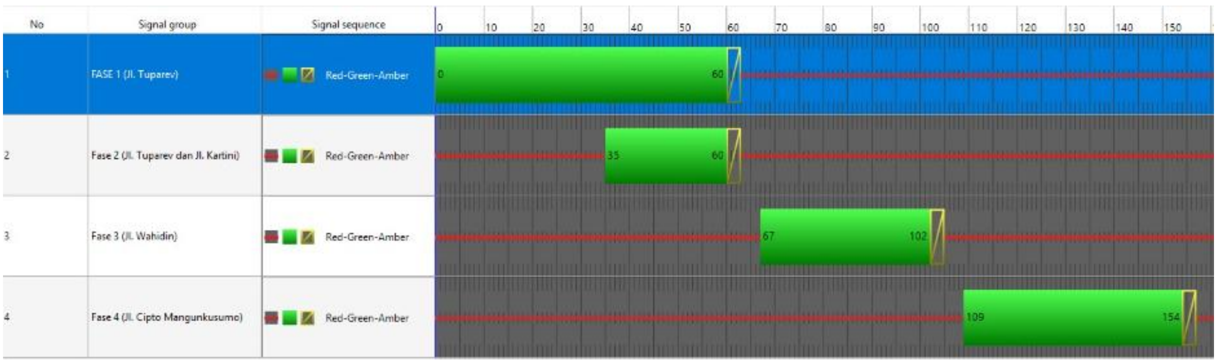

Figure 4. Signal Time Diagram

P-ISSN: 2598-1277
E-ISSN: 2621-3966

The traffic flow survey at Gunung Sari Intersection, Cirebon City, was conducted over 5 days, namely on Saturday, December 14, 2024, Sunday, December 15, 2024, Tuesday, December 17, 2024, Wednesday, December 18, 2024, and Thursday, December 19, 2024. Data was recorded every hour from 06:00 to 18:00 WIB to obtain an overview of daily traffic volume fluctuations. **Figure 5** shows that based on the survey results, the lowest vehicle volume was recorded on Sunday at 06:00–07:00 WIB with 3,400 vehicles/hour. This is understandable because on Sunday mornings, community activities are relatively lower than on weekdays. Conversely, the highest vehicle volume occurred on Saturday from 1:00 p.m. to 2:00 p.m. with a total of 8,082 vehicles/hour. This condition shows a surge in activity on weekends, especially in commercial areas along Jalan Dr. Cipto Mangunkusumo, which is a center for shopping and services.

When viewed from the daily pattern, peak hours generally occur between 12:00 PM and 2:00 PM, with consistently high traffic volume on all observation days. For example, from 1:00 PM to 2:00 PM, the traffic volume was recorded at 8,082 vehicles/hour (Saturday), 6,584 vehicles/hour (Sunday), 6,973 vehicles/hour (Tuesday), 6,930 vehicles/hour (Wednesday), and 6,024 vehicles/hour (Thursday). Based on these results, the traffic flow on Saturday at 13:00–14:00 WIB was selected as the basis for performance analysis. The reason for this is that this period recorded the highest volume of all survey data, thus representing the worst case scenario in terms of traffic performance at the research location. By using these peak conditions, the performance evaluation will be more comprehensive and able to illustrate the capacity of the intersection when maximum traffic load occurs.

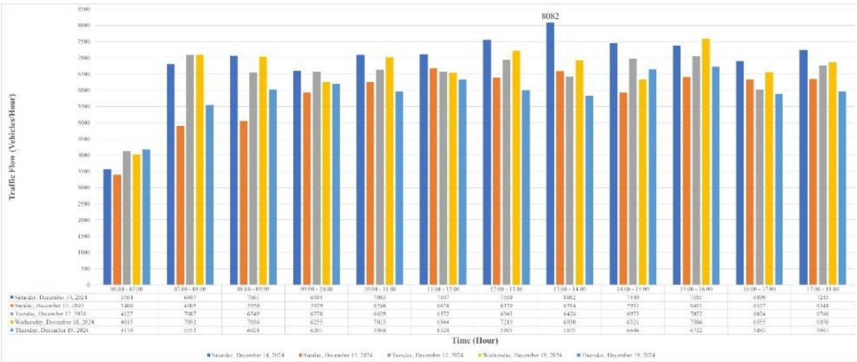

Figure 5. Traffic Flow Fluctuations at the Gunung Sari Intersection

The composition of vehicles during peak hours is shown in **Table 3**, which shows the distribution of movements based on the intersection approach. From Jl. Cipto Mangunkusumo (South), traffic flow was quite high with 1,054 vehicles turning left, 836 vehicles going straight, and 526 vehicles turning right, confirming the role of this road as the main corridor. Jl. Wahidin (North) shows a dominance of straight movement with 964 vehicles, while the right turn flow is relatively low (194 vehicles). From Jl. Kartini (East), the traffic flow is relatively balanced between left turns (928 vehicles) and straight (922 vehicles), while right turns are recorded at 423 vehicles. Meanwhile, from Jl. Tuparev (West), right turns are very dominant with 1,152 vehicles, followed by straight (780 vehicles) and left turns (237 vehicles).

Table 3. Movement Distribution Based on Intersection Approach

Road Approach	TURN LEFT				STRAIGHT				TURN RIGHT			
	Motor cycle	Passeng er Car	Medium Vehicle	Non-Motorized Vehicles	Motor cycle	Passeng er Car	Medium Vehicle	Non-Motorized Vehicles	Motor cycle	Passeng er Car	Medium Vehicle	Non-Motorized Vehicles
Tuparev Road Section (West)	153	77	0	7	475	294	6	5	727	418	4	3
Kartini Road Section (East)	523	396	3	6	629	283	6	4	59	62	0	2
Wahidin Road Section (North)	237	117	1	7	534	409	15	6	105	89	0	0
Cipto Mangunkusumo Road Section (South)	661	383	5	5	460	354	16	6	247	271	2	6
TOTAL VEHICLES	1574	973	9	25	2098	1340	43	21	1138	840	6	11
TOTAL	8078											

P-ISSN: 2598-1277
E-ISSN: 2621-3966

Figure 6 shows that overall, traffic during peak hours at this intersection is dominated by motorcycles (59.54%) and passenger cars (39.03%), while medium-sized vehicles (0.72%) and non-motorized vehicles (0.71%) contribute very little. The dominance of motorcycles reflects the general characteristics of urban traffic in Indonesia, especially in commercial areas that are the center of community activities. Thus, the data on vehicle volume and composition on Saturday at 13:00–14:00 WIB provides a comprehensive picture of the heaviest traffic conditions at the Gunung Sari intersection. This information will form the basis for calculating the intersection's performance using the 2023 PKJI approach, particularly in relation to the degree of saturation (DS), delay, and intersection capacity.

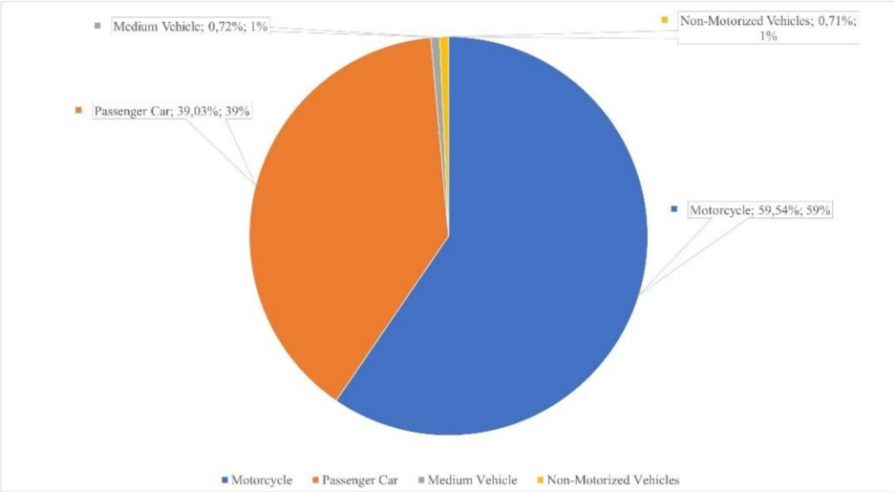

Figure 6. Proportion of Vehicles at the Gunung Sari Intersection

3.2. Existing Conditions Based on PKJI 2023

Based on **Table 4**, it shows that all arms of the intersection in the existing condition have a service level of F, which indicates that the intersection is congested with a fairly high average delay, ranging from 92.24 seconds to 98.24 seconds. The longest queue length is found on the Tuparev Road Section (West) with 204.84 m, while the shortest queue is found on the Jl. Cipto Mangunkusumo Road Section (South) with 76.63 meters.

Table 4. Existing Service Level Conditions at the Gn. Sari Intersection

EXISTING PERFORMANCE CONDITIONS BASED ON PKJI 2023							
Road Approach	Vehicle Inflow (Veh/Hour)	Vehicle Inflow (SMP/Hour)	Capacity	Saturation Degree	Delay (Seconds)	Queue Length (m)	Vehicle Level of Service
Tuparev Road Section (West)	2169	1086	1223	0.89	92.24	204.84	F
Kartini Road Section (East)	1973	628	720	0.87	96.18	116.02	F
Wahidin Road Section (North)	1520	613	691	0.89	98.24	80.25	F
Cipto Mangunkusumo Road Section (South)	2416	754	850	0.89	95.66	76.63	F

P-ISSN: 2598-1277
E-ISSN: 2621-3966

These findings indicate that the existing Gunung Sari intersection is unable to handle traffic flow effectively, necessitating further evaluation through microscopic simulation using PTV VISSIM software to formulate more effective management scenarios.

3.3. 10-Year Performance Projection

The 10-year performance projection for the Gunung Sari intersection is based on data from the West Java Provincial Statistics Agency regarding vehicle growth in the city of Cirebon. Growth calculations were performed using the Compound Annual Growth Rate (CAGR) method for each type of vehicle.

Table 5. Cirebon City Vehicle Growth Data

Cirebon City Vehicle Growth Data					
Year	Vehicle Type				Total
	Passenger Car	Bus	Truck	Motorcycle	
2020	29,085	418	12,656	130618	172,777
2021	29,501	415	12,543	130,628	173,087
2022	29,964	411	12,429	130,009	172,813
2023	29,964	411	12,426	130009	172,810
2024	30541	434	12,076	130,179	173,230
CAGR	1.23%	-1.10%		-0.08%	
		0.02			

Based on **Table 5**, it shows that passenger cars experienced positive growth of 1.23%, while buses and trucks experienced a decline of -1.10% and motorcycles experienced a decline of -0.08%.

Table 6. Data Analysis for the next 10 years

10TH YEAR DATA PKJI ANALYSIS							
Road Approach	**Vehicle Inflow (Veh/Hour)**	**Vehicle Inflow (SMP/Hour)**	**Capacity**	**Saturation Degree**	**Delay (Seconds)**	**Queue Length (m)**	**Vehicle Level of Service**
Tuparev Road Section (West)	2259	1447	1223	1.18	136.87	82.52	F
Kartini Road Section (East)	2058	1333	720	1.85	436.33	129.89	F
Wahidin Road Section (North)	1591	846	691	1.22	193.68	58.67	F
Cipto Mangunkusumo Road Section (South)	2533	1372	850	1.61	301.29	112.58	F

Based on **Table 6**, it shows that the existing conditions in the next 10 years will experience a decline in service levels with a sharp increase in delays, with the highest value on the Kartini Road Section (East) at 436.33 seconds and the smallest delay on the Tuparev Road Section (West) at 136.87 seconds. The longest queue length is found on the Kartini Road Section (East) at 129.89 meters, and the shortest queue length is found on the Wahidin Road Section (North) at 58.67 meters.

3.4. Results of Microscopic Simulation Using PTV VISSIM

In developing a transportation model, driving behavior parameters are needed to adjust driver behavior to actual field conditions.

 P-ISSN: 2598-1277
E-ISSN: 2621-3966

Table 7. Driving Behavior Parameters

		Driving Behavior Parameters	**Core Values**	**Calibration Value**
1		Following		
	a	Look ahead distance Minimum	0 m	0 m
	b	Maximum look ahead distance	200 m	225 m
	c	Number of Interaction Objects	4	8
	d	Minimum Look Back Distance	0 m	15 m
	e	Maximum Look Back Distance	150 m	100 m
2		Car Following Model		
	a	Wiedemann 74 (motorcycle)		
		Average Standstill Distance	2 m	0.2 m
		Additive part of safety distance	3	0.3
		Multiplicative part of safety distance	3	0.4
	b	Wiedemann 74 (All Vehicles)		
		Average Standstill Distance	2 m	0.6 m
		Additive part of safety distance	3	0.6
		Multiplicative part of safety distance	3	1
3		Lane Change		
	a	Waiting time before diffusion	60 s	180 s
	b	Minimum headway	0.5 m	0.3 m
4		Lateral		
	a	Consider next turning direction	No	Yes
	b	Desired position at free flow = Any	Middle	Any
	c	Overtake on same lane	No	On Left and Right
	d	Minimum lateral distance at 0 and 50 km/h (m) Motorcycle	0.2 and 1	0.1 and 0.3
	e	Minimum lateral distance at 0 and 50 km/h (m) Passenger Car	0.2 and 1	0.2 and 1.0
	f	Minimum lateral distance at 0 and 50 km/h (m) Truck	0.2 and 1	0.5 and 1.5
	g	Collision Time Gain Motorcycle and All Vehicles	2 s and 2 s	0.5 s and 1 s
	h	Minimum Longitudinal Speed for Motorcycles	3.6 km/h	0 km/h

Before Calibration After Calibration

Figure 7. Before – After Calibration

 P-ISSN: 2598-1277
E-ISSN: 2621-3966

To ensure the suitability of the simulation model with real conditions, a validation process was carried out using the GEH (Geoffrey E. Havers Statistic) test. This was based on a comparison between the traffic volume in the field and the simulation results.

Table 8. GEH Validation

NO	Road Approach	Field Volume (Veh/Hour)	Vissim Volume (Veh/Hour)	GEH	Presentation %	Note
1	Tuparev Road Section (West)	2259	2307	1,003	98	OK
2	Kartini Road Section (East)	2058	2033	0.556	99	OK
3	Wahidin Road Section (North)	1591	1525	1,669	96	OK
4	Cipto Mangunkusumo Road Section (South)	2533	2528	0.101	10	OK

Based on **Table 8**, it shows that the comparison between the field traffic volume and the simulation results obtained GEH values for all intersection arms below the threshold value of 5, with a conformity level of more than 95%. This indicates that the simulation model used is valid and reliable for further analysis.

Table 9. VISSIM Simulation Results for the Next 10 Years

10TH YEAR DATA FROM VISSIM							
Road Approach	Vehicle Inflow (Veh/Hour)	Vehicle Inflow (SMP/Hour)	Capacity	Saturation Degree	Delay (Seconds)	Queue Length (m)	Vehicle Level of Service
Tuparev Road Section (West)	2307	1477	1223	1.21	131.50	166.49	F
Kartini Road Section (East)	2033	1317	720	1.83	173.44	191.63	F
Wahidin Road Section (North)	1525	811	691	1.17	232.78	191.12	F
Cipto Mangunkusumo Road Section (South)	2528	1369	850	1.61	42.03	27.87	E

Based on **Table 9**, it shows that the existing conditions in the Vissim Microscopic simulation in the next 10 years will experience a decline in service levels with a sharp increase in delays, with the highest value on the Wahidin Road Section (North) at 232.78 seconds and the smallest delay on the Cipto Mangunkusumo Road Section (South) at 42.03 seconds. The longest queue length is found on the Kartini Road Section (East) at 191.63 meters, and the shortest queue length is found on the Wahidin Road Section (North) at 27.87 meters.

3.5. Comparison, Integration of Results, and Recommendations for Handling

In this study, four management scenarios using microsimulation are recommended, including:

1. Scenario 1 involves simplifying the cycle by creating an intersection with 3 phases (Wahidin and Cipto are combined in the same phase)
2. Scenario 2 involves creating an intersection with 4 separate phases
3. Scenario 3 involves adjusting the green time in existing phase conditions
4. Scenario 4 involves simplifying the cycle by making the intersection into 3 phases (Tuparev and Kartini are combined into the same phase)

Figure 8 shows the simulation results **for Scenario 1** (3 phases – Wahidin and Cipto combined), where cycle simplification was able to reduce the average delay quite significantly. Green time is divided more

 P-ISSN: 2598-1277
E-ISSN: 2621-3966

proportionally by giving 40 seconds for Wahidin–Cipto, 35 seconds for Tuparev, and 30 seconds for Kartini. As a result, the main traffic flow is still well served while conflicts between approaches can be reduced.

In contrast, **Figure 9** shows the simulation results **for Scenario 2** (4 phases – all separated), which attempts to give equal opportunity to each approach with an equal green time distribution of 25 seconds. The principle is fair, but the simulation results show that delays at several approaches are still high, mainly because the traffic load is not the same. Although there is a slight improvement in the southern section (Cipto), in general this scenario is not yet effective enough.

Figure 10 shows the simulation results **for Scenario 3** (existing phases with green adjustments), which emphasizes time redistribution. Tuparev, as the main flow, receives a longer allocation, while other approaches are reduced. This method successfully reduces delays at Tuparev, but the consequence is that queues at other approaches remain large. So the improvements achieved are still partial.

Meanwhile, **Figure 11** shows the simulation results **for Scenario 4** (3 phases – Tuparev and Kartini combined), which attempts to balance the major flows by grouping the two main approaches into one phase ( ). As a result, performance at Kartini improved slightly, but Tuparev bore a greater burden, causing delays there to increase. This shows that combining major flows is not always successful when traffic distribution is unbalanced.

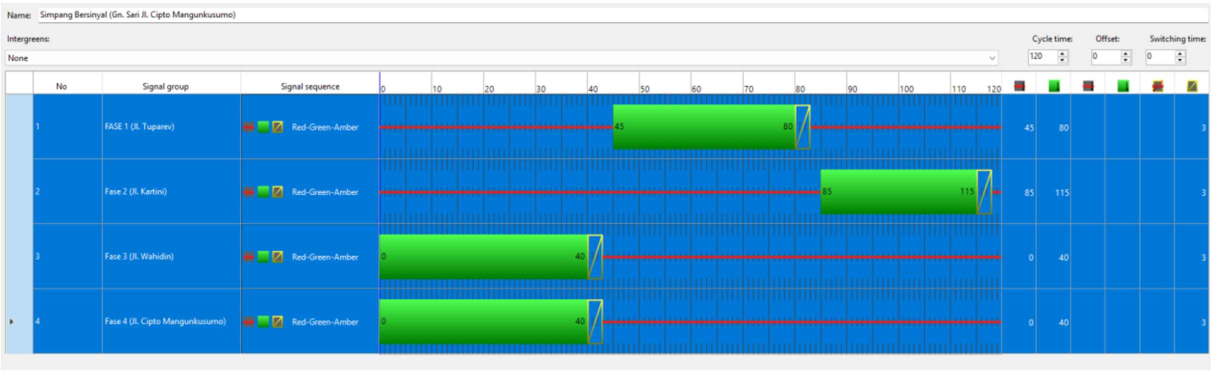

Figure 8. Signal Time Diagram Scenario 1

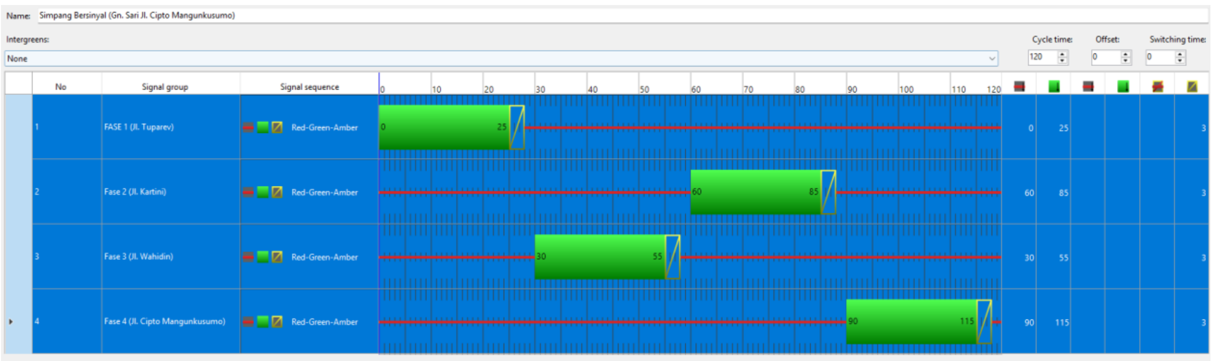

Figure 9. Signal Time Diagram Scenario 2

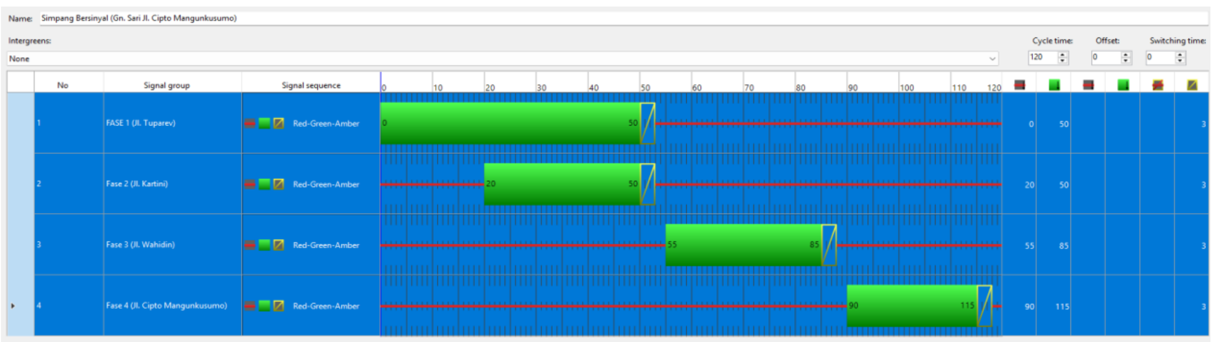

Figure 10. Signal Time Diagram Scenario 3

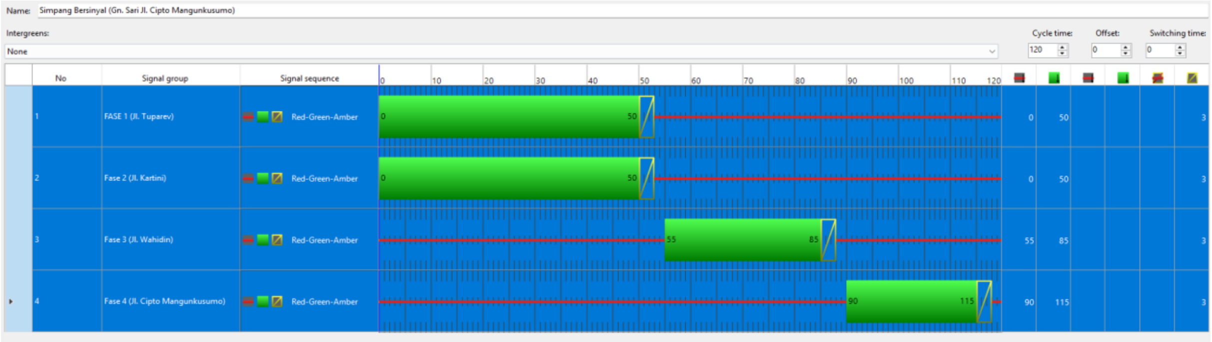

Figure 11. Signal Time Diagram Scenario 4

Table 10. VISSIM Scenario Simulation Results

Road Approach	SCENARIO 1			SCENARIO 2			SCENARIO 3			SCENARIO 4		
	Delay (Seconds)	Queue Length (m)	LOS	Delay (Seconds)	Queue Length (m)	LOS	Delay (Second)	Queue Length (m)	LOS	Delay (Second)	Queue Length (m)	LOS
Tuparev Road Section (West)	118.18	155.02	F	172.13	202.48	F	106.34	104.92	F	282.58	280.84	F
Kartini Road Section (East)	80.73	69.29	F	97.92	89.11	F	136.64	118.67	F	45.02	46.31	E
Wahidin Road Section (North)	124.65	113.92	F	233.44	207.17	F	212.17	167.39	F	223.35	168.61	F
Cipto Mangunkusumo Road Section (South)	52.14	34.49	E	34.81	19.98	D	53.07	39.77	E	49.25	32.62	E

Based on **Table 10**, **scenario 1** shows an increase in the Kartini, Wahidin, and Tuparev sections, with the longest delay occurring in Wahidin at 124.65 seconds and the longest queue length occurring in the Tuparev section at 155.02 meters. **Scenario 2** shows an increase in the Kartini and Cipto Mangunkusumo sections, with the longest delay occurring in the Wahidin section at 233.44 seconds and the longest queue length occurring in the Wahidin section at 207.17 meters. **Scenario 3** shows a significant increase on the Tuparev section, with the longest delay occurring on the Wahidin section at 212.17 seconds and the longest queue length occurring on the Wahidin section at 167.39 meters. Meanwhile, **scenario 4** shows a significant increase on the Kartini section with the longest delay occurring on the Tuparev section at 282.58 seconds and the longest queue length occurring on the Tuparev section at 280.84 meters.

Based on a comparison of the simulated scenario results, scenario 1 is considered the most effective alternative because it is able to reduce the average delay evenly without causing new problems. Therefore, it is recommended as the main strategy for handling the Gunung Sari intersection. In the long term, periodic signal time evaluation and integration with an adaptive traffic control system (ATCS) are recommended in order to maintain optimal intersection performance.

4. CONCLUSION

Based on the analysis results, it can be concluded that:

1. The existing condition of the Gunung Sari intersection is at service level F with an average delay of between 92.24 and 98.24 seconds and a maximum queue length of 204.84 meters (Tuparev approach).
2. The 10-year projection shows a significant decline in intersection performance, with the highest delay reaching 436.33 seconds (Kartini approach) and all approaches remaining at service level F.
3. The VISSIM modeling results have been well validated (GEH value < 5, conformity > 95%), so they can be used for testing improvement scenarios.
4. Of the four scenarios tested, Scenario 1 (3 phases – combining Wahidin and Cipto) is the most effective alternative, as it is able to reduce average delays and queue lengths more evenly than the other scenarios.
5. In the long term, periodic signal timing evaluations and the development of an adaptive traffic control system (ATCS) are needed to maintain optimal intersection performance.

REFERENCES

[1] D. W. Hidayat, Y. Oktopianto, and A. B. Sulistyo, "Improving the Performance of Signalized Intersections (Case Study of the Purin Kendal Intersection)," *J. Keselam. Transp. Jalan (Indonesian J. Road Safety),* vol. 7, no. 2, pp. 118–127, 2020, doi: 10.46447/ktj.v7i2.289.

[2] F. Juwita, R. R. Pratama, and C. Sujatmiko, "Performance Evaluation Study of Signalized Intersections on the Sultan Agung – Ki Maja Road Section Using the PKJI 2023 Method," *J. Sains J. Ilmu Tek.,* vol. 9, no. 2, pp. 222–229, 2024, doi: 10.24967/teksis.v9i2.3544.

[3] Y. A. Rafi and F. S. Widyatami, "Performance Analysis of Unsignalized Intersections Using the PKJI 2023 Method and Vissim Software (Case Study: Aria Putra Road T-junction, Ciputat)," *Snarstek,* vol. 5, no. 1, pp. 138–146, 2025, doi: 10.47970/snarstek.v2i1.804.

[4] M. Sa'dillah and R. A. Primasworo, "Performance of Signalized Intersections on the Semeru – Kahuripan – Basuki Rahmat Road Section After the Construction of the Whiz Prime Hotel Malang," *Fondasi J. Tek. Civil Engineering,* vol. 9, no. 2, p. 103, 2020, doi: 10.36055/jft.v9i2.8467.

[5] U. E. Shahdah, F. Saccomanno, and B. Persaud, "Application of Traffic Microsimulation for Evaluating Safety Performance of Urban Signalized Intersections," *Transp. Res. Part C Emerg. Technol.,* vol. 60, pp. 96–104, 2015, doi: 10.1016/j.trc.2015.06.010.

[6] A. Zakariah, B. A. Razak, F. A. Gani, A. Ardiansyah, and M. I. A. Bahar, "Optimizing Intersection Performance Using the Local Area Traffic Management Method (Case Study: Toddopuli Signalized Intersection in Makassar City)," *J. Appl. Civ. Environ. Eng.,* vol. 4, no. 2, pp. 32–44, 2025, doi: 10.31963/jacee.v4i2.5125.

[7] I. Noor and P. Utomo, "Analysis of congestion cost at signalized intersection using Vissim 9: Case study at Demak Ijo Intersection Sleman," *Res. Prepr.*, 2018, [Online]. Available: https://www.researchgate.net/publication/326688178_Analysis_of_congestion_cost_at_signalized_intersection_using_Vissim_9_Case_study_at_Demak_Ijo_Intersection_Sleman

[8] S. Utomo, A. Setiawan, and H. Pradana, "VISSIM Simulation-Based Analysis for Improving Traffic Conditions in Bandung, Indonesia," in *Proceedings of International Conference on Infrastructure Development*, 2020. [Online]. Available: https://www.researchgate.net/publication/342096643_VISSIM_Simulation-Based_Analysis_for_Improving_Traffic_Conditions_in_Bandung_Indonesia

[9] E. Ziemska-Osuch and M. Osuch, "The Importance of Including Pedestrian Traffic in Microsimulation Modelling: A Case Study," *Sustainability*, vol. 14, no. 14, p. 8945, 2022, doi: 10.3390/su14148945.

[10] A. Saputra, Maslina, and Mustakim, "ANALYSIS OF SIGNALIZED THREE-WAY INTERSECTIONS (Case Study at Tugu Jam Jalan Ahmad Yani, Balikpapan City)," *KoNTekS*,

vol. 2, no. 6, 2025, doi: 10.62603/konteks.v2i6.290.

[11] A. D. Beza, M. M. Zefreh, Á. Török, and A. A. Mekonnen, “How PTV Vissim Has Been Calibrated for the Simulation of Automated Vehicles in Literature?,” *Adv. Civ. Eng.,* vol. 2022, no. 1, 2022, doi: 10.1155/2022/2548175.

[12] I. Irawati, L. Anggraini, and S. Wanto, “Analysis of Service Level Performance of Signalized Intersections in Commercial Areas,” *J. Civ. Eng. Build. Transp.,* vol. 8, no. 1, pp. 129–137, 2024, doi: 10.31289/jcebt.v8i1.11564.

[13] S. Purwanto, S. Haq, and S. N. Yanti, “Performance Analysis of Unsignalized Intersections on Pandeglang Highway - Amd Lintas Tim Road - Serang Highway - Pandeglang,” *Struct. (Civil Engineering Journal),* vol. 4, no. 1, p. 26, 2023, doi: 10.31000/civil.v4i1.8043.

[14] Z. Zulfhazli, H. Hamzani, and L. Anggraini, “Analysis of the Effect of Traffic Performance on the*Teras J. J. Tek. Civil Engineering,* vol. 5, no. 2, 2021, doi: 10.29103/tj.v5i2.12.

[15] P. P. Indriani, N. Puspasari, and R. Z. Akbar, “Optimization of Traffic Light Duration at the Rajawali-Tingang Intersection Using PKJI 2023,” *Agregat,* vol. 9, no. 2, pp. 1185–1189, 2024, doi: 10.30651/ag.v9i2.24671.

[16] F. R. Naway and F. Suryani, “Planning an Area Traffic Control System (ATCS) for Intersection Performance Optimization on H.M Joyo Martono Road, Bekasi City,” *Ikraith-Teknologi,* vol. 7, no. 1, pp. 53–63, 2022, doi: 10.37817/ikraith-teknologi.v7i1.2320.

[17] K. W. Devi, B. Mardikawati, and A. B. Atmajaya, “The Effect of Geometry and Signal Configuration on Intersection Performance Using the Pkji 2023 and PTV Vissim Approaches,” *J. Ilm. Kurva Tek.,* vol. 13, no. 1, pp. 1–10, 2024, doi: 10.36733/jikt.v13i1.9027.

[18] C. Utary, D. S. Nababan, and N. U. Sholekhah, “Performance Analysis on the Pemuda Road Section in Merauke Regency with the Presence of a Median,” *Musamus J. Civ. Eng.,* vol. 4, no. 02, pp. 76–80, 2022, doi: 10.35724/mjce.v4i02.4449.

[19] R. A. D. Purnomoasri, T. Yuono, S. Sumina, and F. D. L. Utama, “Analysis of CO and CO2 Emissions at the Bejen Signalized Intersection in Karanganyar Regency,” *Enviro J. Trop. Environ. Res.,* vol. 25, no. 1, p. 24, 2023, doi: 10.20961/enviro.v25i1.78524.