

## **Performance Analysis of the Unsignalized Nusantara Cilacap Three-Way Intersection Based on the 2023 Indonesian Road Capacity Guidelines**

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*Degree of Saturation; Capacity; Performance; Delay*

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**ABSTRACT**

The increase in traffic volume, especially during long holidays coinciding with Eid al-Adha, can affect intersection performance and potentially cause issues such as changes in intersection capacity, degree of saturation, and traffic delays. Therefore, an analysis of intersection performance is necessary to evaluate the level of service at the Nusantara Three-Way Intersection in Cilacap. This study aims to calculate the intersection capacity, degree of saturation, traffic delay, and determine the level of service of the Nusantara Three-Way Intersection due to increased traffic volume. This research uses a quantitative approach based on primary and secondary data. The analysis was conducted according to the provisions of the Indonesian Road Capacity Guidelines (PKJI) 2023. The results show that the peak traffic volume occurred on Thursday, 5 June 2025, at 16:00–17:00 WIB with a value of 886.40 PCU/hour (SMP/hour). The intersection capacity was 2,414.886 PCU/hour, with a degree of saturation of 0.367 and an average delay of 4.799 seconds per vehicle. The performance of the Nusantara Three-Way Intersection can be categorized as good, indicating that the level of service is still optimal and no additional lanes or traffic management measures are required.

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### **INTRODUCTION**

Transportation is a component that has an important role in society, especially as a support for economic, social and community mobility activities in a region (Nugroho *et al.*, 2022). The need for safe and efficient transportation facilities continues to increase along with the development of economic activities and the increasing number of people (Dwiyanti and Kurniati, 2025). Good transportation should be supported by ideal transportation infrastructure, especially roads (Wahyuni *et al.*, 2021). Roads have a strategic role in realizing connectivity and mobility in an area (Wahyuni Sappali *et al.*, 2023). The connectivity and mobility of an area, in addition to affecting the movement of people and goods, also affect the economic and social progress of the community (Husen & Baranyanan, 2021). In the road network system, road intersections have a role as a meeting point between two or more road sections and function as a distribution point for vehicle flow to improve traffic efficiency (Philip, 2024; Pratama and Elkhasnet, 2019). Road intersections are often a critical point in the traffic system because at road intersections there are often conflicts with vehicle flows that result in congestion as well as delays and can trigger accidents if left unattended and not managed properly (Aderamo & Atomode, 2012; Mandhare *et al.*, 2018; NamGung *et al.*, 2020; Olayode *et al.*, 2020).

Road intersections that are widely encountered are generally equipped with signals or

signaled intersections Unsignaled intersections are a type of intersection that is widely found in road networks in developing or urban areas with characteristics as a differentiator of this type of intersection, namely not using traffic signaling devices (APILL) and more depending on general rules in traffic and traffic signs in determining the priority of vehicle movement (Prasetyo *et al.*, 2022). The function of the non-signalized intersection is influenced by the distribution of vehicle flow and traffic volume, if the traffic still has a relatively low volume and the balance of vehicle flow distribution is still achieved, then the non-signalized intersection is still functioning properly. The potential for long queues, vehicle delays and traffic conflicts at non-signalized intersections is generally caused by a significant increase in vehicle volume or an imbalance in traffic flow that can cause a decrease in the level of road services.

Unsignaled intersections are often considered the main cause of congestion, especially in the urban transportation system because of their small capacity when compared to connecting roads. The confluence of vehicle flows at the same point from several directions results in interaction between vehicles which can trigger movement barriers, especially if it occurs in densely populated areas, public activity centers and trade areas. The problem of non-signaling intersections can basically be overcome by taking appropriate and efficient steps in solving them and periodic evaluations of the intersection to be able to find out the latest traffic conditions so that it can improve the performance of the intersection

The performance of intersections may change following changes in traffic volume influenced by an increase in the number of vehicles due to an increase in population (Suthanaya, 2023). The increase in population also has an impact on increasing social activities and new crowd points from various sectors in a region (Ardhaneswari & Agustapraja, 2023). The performance of the intersection can be analyzed using the methods that have been provided by the government through the 2023 Indonesian Road Capacity Guidelines (PKJI). PKJI 2023 is the result of an update to the previous guidelines to provide an improvement in the analysis approach in the calculation of traffic performance parameters as well as a standard in evaluating the performance and capacity of various traffic facilities. The PKJI 2023 method can be used in analyzing *the level of service* (LOS) or service level of a road intersection and other parameters such as delays, queue opportunities, intersection capacity, traffic volume, and degree of saturation as a benchmark to assess the ability of intersections to serve traffic flow.

The degree of saturation as a performance parameter of intersections has a role in assessing the ratio of traffic volume to intersection capacity. The increase in the degree of saturation at an intersection shows the potential for congestion and vehicle congestion which also increases at that location (Rizal, *et al.*, 2022). The vehicle delay parameter describes the additional time for the vehicle due to traffic interaction and as a sign that the intersection needs certain handling either in the form of repairs intersection geometry, traffic regulation and installation of traffic signals so that intersection performance is optimal (Pakpahan and Susilo, 2020).

Cilacap Regency as one of the districts in the Central Java Province area has experienced quite rapid development, especially in economic activities and community mobility which has caused an increase in the volume of vehicles at intersections on several main roads in Cilacap Regency. One of the crowded points in Cilacap Regency is the Simpang Tiga Nusantara which has an important role in supporting community mobility as well as connecting three roads that are routes of community activities in the area. Simpang Tiga Nusantara is a meeting between the student army road which has the status of a national road

or more closely like the national road 6 and the archipelago road which is a link between several activity centers in Cilacap Regency which is located in Trirtih Kulon Village, North Cilacap District, Cilacap Regency. Simpang Tiga Nusantara is a type of non-signalized intersection that experiences an increase in traffic volume at certain times and is located in commercial areas such as offices, shops, restaurants. The location of the intersection on a path with fairly high traffic activity causes the potential for traffic problems, especially during peak hours and certain moments due to the flow of vehicles that intersect from various directions and results in conflicts in vehicle movements until there are delays and queues of vehicles around intersections. The impact of these traffic problems can certainly reduce the safety and comfort of road users as well as the level of efficiency of the transportation system as a whole if it is not handled properly.

The background in this study is that there is an increase in traffic volume at the Simpang Tiga Nusantara Cilacap during long holidays as well as coinciding with Eid al-Adha when compared to normal days which can affect the performance of the intersection so that it raises problems due to the increase in the volume of the crossing on the performance of the intersection, namely changes in intersection capacity, degree of saturation and traffic delays based on the highest traffic volume that occurred during the study.

The calculation of traffic delays, degree of saturation, and intersection capacity using the highest traffic volume is commonly used in other similar studies that are also referenced in this study, such as in the study on the evaluation of unsignalized intersections (Pedo, 2022), Performance and Service Level Evaluation based on the 2023 Indonesian Road Capacity Guidelines (PKJI) (Hawinuti & Megawati, 2025), as well as Performance Analysis of the Menara Kudus intersection (Pratiwi et al., 2023). The approach of the 2023 Indonesian Road Capacity Guidelines used in the intersection performance analysis is expected to provide a clear picture of traffic operational conditions at the Cilacap Nusantara T-junction so that it can be information for related parties in formulating traffic engineering policies and improvement efforts in improving intersection performance, especially reducing congestion and vehicle delays and improving the safety and comfort of road users.

Based on the background and existing conditions, this study was conducted to analyze the performance of the unsignalized intersection of the Cilacap Nusantara T-junction by referring to the 2023 Indonesian Road Traffic Guidelines (PKJI). The purpose of this study is to calculate intersection capacity, traffic delays, degree of saturation and determine the level of Simpang Tiga Nusantara Cilacap service due to an increase in traffic volume, especially due to the long holiday as well as coinciding with Eid al-Adha.

## **METHOD**

This research was conducted at the intersection of three unsignalized Cilacap Nusantara T-junctions as the object of study with consideration of the frequent occurrence of vehicle conflicts due to high traffic activity. This study uses a quantitative approach based on primary and secondary data followed by calculation of intersection capacity and performance to analysis in accordance with the provisions in the 2023 Indonesian Road Capacity Guidelines (PKJI). Primary data that has been collected through a direct field survey at the location of Simpang Tiga Nusantara Cilacap includes the physical condition of the road, including the width of the road, the width of the shoulder of the road, and the recording of traffic volume in order to identify trends and patterns of movement of road users in the research area. Geometric data on the arm at the intersection, traffic volume during peak hours, number of vehicles based on the type, environmental conditions around the intersection and side obstacles are also

needed in this study. The secondary data needed in this study includes the 2023 PKJI document, location maps, and population data obtained from credible sources. The subjects in this study are intersection capacity, degree of saturation, delay, and service level at intersections with calculations guided by PKJI 2023 (Directorate General of Highways, 2023). The intersection capacity based on the 2023 Indonesian Road Capacity Guidelines (PKJI) is calculated with the following equation:

$$C = C_0 \times FLP \times FM \times FUK \times FHS \times FBK_i \times FBK_a \times Fr_{mi}$$

The degree of saturation can be calculated by the following equation:

$$DS = Q/C$$

The implementation of the traffic survey is carried out during morning rush hours, namely 06.30 – 07.30, afternoon rush hour 12.00 – 13.00 and afternoon rush hour 16.00-17.00 for seven days starting from 4 June 2025 to 10 June 2025 with details of 4 June 2025 and 5 June representing normal working days, 6 June 2025 representing the Eid al-Adha holiday, 7-9 June 2025 representing holidays, and June 10 represents the first working day after the long holiday.

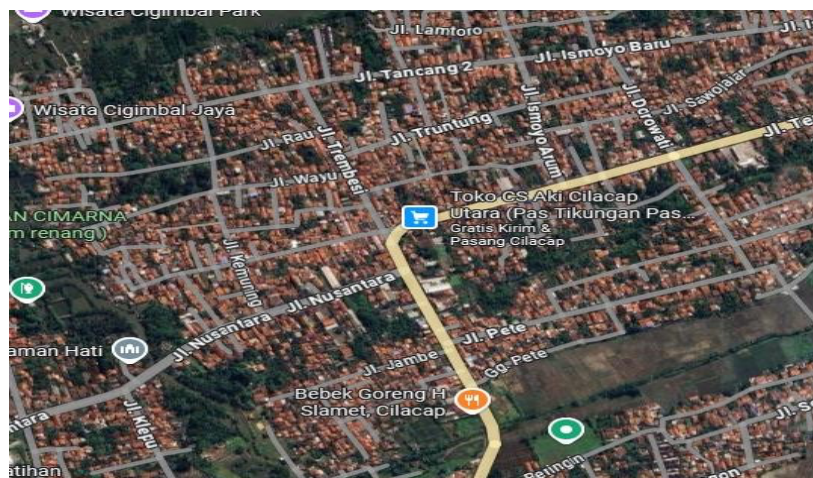


Figure 1. Data collection locations

## RESULTS AND DISCUSSION

The analysis of the performance of the non-signaling intersection at the Simpang Tiga Nusantera was carried out by referring to the 2023 Indonesian Road Capacity Guidelines using data from field surveys in the form of the geometric condition of the intersection, traffic volume and side obstacles around the location. The results of the data processing obtained are then used to determine the performance parameters of the intersection which include the degree of saturation, delay, capacity of the intersection and the level of service. The geometric condition at Simpang Tiga Nusantera Cilacap has a different road width between Jalan Tentera Siswa which has a road width of 9m and Jalan Nusantera which has a road width of 7m as presented in table 1. Each existing road consists of two lanes for two directions without the presence of a median at the intersection that causes vehicles from the opposite direction to interact directly.

**Table 1. Geometric data of intersections**

Code Arms	Directions	Road Width (m)
A	Student Army Road North Direction	9
B	Student Army Road Southbound	9
C	Jalan Nusantara	7

Source: Field Survey Data (2025)

The volume of traffic obtained during the survey, especially during peak times, shows that the peak time of each day has a different peak time. The traffic volume obtained is then converted based on the equivalent value of passenger cars into passenger cars per hour (SMP/hour) in accordance with the equivalence factor in the 2023 Indonesian Road Capacity Guidelines so that the highest traffic volume that occurs on each research day is obtained as shown in table 2.

**Table 2 Highest traffic volume**

Date	Peak Time	Traffic volume (junior high school/hour)
4 June 2025	06.30-07.30	448,60
5 June 2025	16.00-17.00	886,40
6 June 2025	06.30-07.30	247,60
7 June 2025	12.00-13.00	346
8 June 2025	12.00-13.00	370,20
9 June 2025	16.00-17.00	471,80
10 June 2025	06.30-07.30	512,20

Source: Field Survey Data (2025)

The highest traffic volume at Simpang Tiga Nusantara occurred on Thursday, June 5, 2025, which was 886.40 junior high schools/hour as shown in table 2. Simpang Tiga Nusantara Cilacap is included in the criteria for the type of commercial road environment because based on observations made, it shows that the land at the location is used for commercial purposes such as offices, shops, restaurants, with direct access for both vehicles and pedestrians. The type of side obstacle class at the Simpang Tiga Nusantara Cilacap according to the 2023 Indonesian Road Capacity Guidelines is included in the high criteria, this can be seen from the departing flow at the entry and exit points.

The intersection is disrupted and reduced due to roadside activities along the approach so that it can have a significant effect in increasing delays and reducing vehicle speeds. Examples that are often encountered during observation are the existence of public transportation activities such as getting on and off passengers or boarding and vehicles exiting/entering the side of the approach. Cilacap Regency has a population of 2,027,379 people based on population census data obtained from the Cilacap Regency BPS (2024) so that it can be categorized into a large category city size factor (Fuk) with a value of 1.00. The data and traffic calculations surveyed at each intersection arm during peak time on June 2, 2025 can be seen in table 3.

**Table 3. Vehicle Traffic Data and Calculation during Peak Hours**

Junior High School Factor :		MP, EMP = 1,00	KS, EMP = 1,80	SM, SMP = 0,20				qKB Total	qKTB		
Past Flow Cross		Kend /jam	SMP /jam	Kend /jam	SMP /jam	Kend /jam	SMP /jam	Kend /jam	SMP /jam	RB	Kend /jam
Major Path of Approach A	qBK <sub>i</sub>	-	-	-	-	-	-	-	-	-	-
	qLR <sub>S</sub>	161	161	32	57,60	364	72,80	557	291,40		23
	qBK <sub>a</sub>	42	42	42	75,60	179	35,80	263	153,40	0,34	9
	qT <sub>o</sub> t <sub>a</sub> l	203	203	74	133,20	543	108,60	820	444,80		32
Major Path of Approach B	qBK <sub>i</sub>	21	21	16	28,80	23	4,60	60	54,40	0,19	13
	qLR <sub>S</sub>	137	137	39	70,20	121	24,20	297	231,40		16
	qBK <sub>a</sub>	-	-	-	-	-	-	-	-	-	-
	qT <sub>o</sub> t <sub>a</sub> l	158	158	55	99,00	144	28,80	357	285,80		29
The Mayor's Mansion QMA		361	361	129	232,20	687	137,40	1177	730,60		61
The Minor Path of the C Approach	qBK <sub>i</sub>	23	23	27	48,60	144	28,80	194	100,40	0,64	27
	qLR <sub>S</sub>	-	-	-	-	-	-	-	-		-
	qBK <sub>a</sub>	33	33	9	16,20	31	6,20	73	55,40	0,36	9
	qT <sub>o</sub> t <sub>a</sub> l	56	56	36	64,80	175	35,00	267	155,80		36
Total Minor roads, QMI		56	56	36	64,8	175	35	267	155,8		36
Total of Minor roads and roads Older	qBK <sub>i</sub>	44	44	43	77,4	167	33,4	254	154,8	0,17	40
	qLR <sub>S</sub>	298	298	71	127,8	485	97	854	522,8		39
	qBK <sub>a</sub>	75	75	51	91,8	210	42	336	208,8	0,24	18
qT <sub>o</sub> t <sub>a</sub> l = q <sub>m</sub> i + q <sub>m</sub> a =		417	417	165	297,00	862	172,40	1444	886,40	0,41	97
										R <sub>m</sub> i=q <sub>m</sub> i/qKB 0,176	
										=	
										RKT <sub>B</sub> =qKT <sub>B</sub> /qK 0,109	
										B=	

Source: Field Survey Data (2025)

Based on observations and data collection that has been carried out both primary and secondary and guided by the 2023 Indonesian Road Capacity Guidelines, it can be known that Simpang Tiga Nusantara has a basic capacity of 2700 junior high schools/hour and has correction factors presented in table 4.

**Table 4. Intersection Capacity Correction Factors Based on PKJI 2023**

FUK	1
FHS	0,84
FBKI	1,121
Фбка	0,873
F <sub>r</sub> m <sub>i</sub>	1,015
Correction Factors	Value
FLP	1,072
FM	1

Source: PKJI 2023 and Field Data Analysis

The results of the calculation carried out using the 2023 Indonesian Road Capacity Guidelines method by adjusting the existing correction factors show that the intersection capacity reaches a value of 2,414,886 junior high schools/hour. The value of the intersection capacity is lower than the basic capacity due to the effect of a fairly high side resistance. This is of course proof that the management of side obstacles is an important aspect in improving the performance of an intersection. The calculation of the degree of saturation was obtained by comparing the actual traffic volume of 886.40 SMP/hour with the intersection capacity so that a saturation degree value (DJ) of 0.367 was obtained.

The traffic delay analysis yielded an average delay value of 4.799 seconds per vehicle. Based on these parameters, the service level of the Nusantara Cilacap intersection is categorized as good so that there is no need for additional lanes or traffic management. Traffic conditions at the Simpang Tiga Nusantara are considered to be stable even though it has been shown that the intersection has begun to require attention in terms of traffic management to prevent a decrease in performance, including regulating one-way traffic flow, controlling side obstacles in the form of parking prohibitions in the area around the intersection, adding road markings and traffic signs in setting the priority of vehicle movements, Minor widening to increase the capacity of the intersection to make it a signalized intersection if needed in the hope that in the future the intersection can provide better services for road users.

## **CONCLUSION**

The results of surveys and calculations that have been carried out using the 2023 Indonesian Road Capacity Guidelines method show that the peak of traffic volume occurred on Thursday, June 5, 2025 at 16.00-17.00 WIB, which was 886.40 SMP/hour. The Simpang Tiga Nusantara is included in the intersection with a high criterion side barrier and has an intersection capacity of 2,414,886 SMP/hour which is lower than the basic capacity of the intersection itself. The degree of saturation obtained from the calculation results is 0.367 and the average delay value is 4.799 seconds per vehicle so that it can be concluded that the performance of the intersection can be categorized as "good" and does not require additional lanes or traffic management, but it has begun to show that the intersection has begun to require attention in terms of traffic management to prevent a decrease in performance, including the regulation of one-way traffic flow, control of side obstacles, addition of road markings and traffic signs, minor widening and making signaled intersections if necessary.

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