CERUCUK
Volume 10 No. 4 2026 (186-195)

ANALYSIS OF NOISE LEVEL AND PERFORMANCE OF SIMPANG NAN SARUNAI TANJUNG SELATANG TABALONG REGENCY

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ABSTRACT

The Nan Sarunai Tanjung Selatan four-leg intersection, previously a T-intersection, now functions as a four-leg intersection following the construction of the Nan Sarunai Road. This change has increased vehicle volume, resulting in delays and noise. This study aims to evaluate the intersection's performance, noise levels, and the correlation between vehicle volume and noise using the IHCM 2023 methodology and Excel application, with traffic volume and noise data collected over 12 hours on October 21, 2024.

The analysis shows that the current intersection performance is still optimal with a Degree of Saturation (DS) of 0.35. However, a 20-year projection indicates a performance decline with a DS of 0.99. The proposed solution is to convert the intersection into a signalized intersection, which can improve performance to a Level of Service (LOS) C with a DS of 0.81. The study also found a strong correlation between vehicle volume and noise, with a correlation coefficient of r = 0.63 at the intersection and r = 0.54 in the surrounding area.

Keywords**:** Indonesian Highway Capacity Manual (IHCM 2023), Signalized Intersection, Level of Service Index, Capacity, Degree of Saturation, Delay Time, Queue Probability, Noise Levels, Forecasting, Correlation

1. INTRODUCTION

Tabalong Regency holds a strategic location in the northern part of South Kalimantan Province. This area is planned to serve as a supporting region for the new capital city of Indonesia (Ibu Kota Nusantara) due to its proximity. The abundance of natural resources in Tabalong attracts many migrants, which in turn contributes to population growth and an increase in the number of vehicles in the regency.

The growing number of vehicles in Tabalong Regency has led to more congested roads, increasing the potential for traffic jams. This issue is common in urban areas with high population density, often occurring during morning and evening rush hours, especially at road intersections where traffic from various directions converges.

Intersections are crucial components of the road network system, where traffic flow capacity can be managed by regulating traffic volumes. Proper management at intersections is essential to ensure smooth and safe traffic flow. In addition to congestion,

the increasing number of vehicles also causes noise pollution. This noise affects the areas surrounding the intersection, such as offices and shops, which ideally require a quiet environment.

The Nan Sarunai Tanjung Selatan four-leg intersection was chosen as the research location because it was previously a T-intersection. Following the construction of the Nan Sarunai Road, this intersection now functions as a four-leg intersection, resulting in increased vehicle volumes, delays, and noise levels.

2. THEORETICAL FRAMEWORK

Road Intersections

Intersections are critical areas within a roadway system where traffic flows from different directions or approaches meet at a single point. This convergence can cause conflicts between opposing or crossing traffic flows, potentially leading to congestion along the intersection's arms (Rorong et al., 2015). The purpose of constructing intersections is to control conflicts among road users, ensuring ease and comfort in vehicle movement.

Unsignalized Intersection Analysis

An unsignalized intersection is the meeting point of two or more at-grade roads without traffic signals (APILL), as defined in IHCM 2023. The management of unsignalized intersections is based on conflict points. When the traffic volume on one leg of the intersection is significantly higher than that on the other legs, the dominant traffic flow will control the intersection.

Signalized Intersection Analysis

A signalized intersection is the meeting point of two or more at-grade roads regulated by traffic signals (APILL). Traffic signals play a crucial role in reducing potential conflicts, both primary and secondary, by regulating the movement of traffic flows in a timed manner. The primary objectives of traffic signals are to maintain intersection capacity during peak hours, manage and optimize the use of intersection space, facilitate smooth traffic flow, prevent accidents, and improve road user safety.

Forecasting

Forecasting is the process of predicting future traffic volumes passing through an intersection at a specific time. The goal is to estimate traffic conditions, such as the

number of vehicles passing through, maneuvers at the intersection, or vehicle queue times.

Handling Alternatives

Intersection handling alternatives are implemented when intersection performance becomes suboptimal, indicated by a Degree of Saturation (DS) value exceeding 0.85 or when intersection delays or Level of Service (LOS) index fall within categories D-F (Table 1). Proposed solutions include widening and adding lanes to the intersection legs or planning for a signalized intersection.

Table 1. Level of Service Index for Intersections with STOP Control

Service Level	Average Stop Delay (seconds per vehicle)
A	≤ 5,0
B	5 – 10
C	11 – 20
D	21 – 30
E	31 – 45
F	> 45

(Source: Regulation of the Minister of Transportation Number: KM 14 of 2006)

Traffic Noise

Traffic noise is sound originating from motor vehicles, including engine noise, horns, exhaust, and the friction of tires with the road. Large vehicles such as trucks and buses, along with passenger cars, are the main contributors to noise on roads.

Linear Regression

Regression analysis is a statistical method used to describe the relationship or model structure between multiple variables. In this analysis, two types of variables are involved: dependent variables, which are influenced by other factors, and independent variables, which act as the influencing factors.

Correlation

Correlation is a statistical technique used to assess the degree of relationship between variables. It refers to the link between noise levels and various performance aspects at intersections. In this study, the independent variable is traffic volume, while the dependent variable is noise level. The strength of the relationship between these variables is determined based on specific criteria.

Table 2. Correlation Criteria

R = 0	: There is no relationship between variables
0 ≤ R ≤ 0,25	: very weak relationship
0,25 ≤ R ≤ 0,5	: The relationship is quite strong
0,5 ≤ R ≤ 0,75	: Strong Relationships
0,75 ≤ R ≤ 0,99	: The relationship is very strong
R = 1	: Perfect relationship

3. METHOD

Preparation Stage

The preparation stage is divided into two parts: site inspection and literature review. The site inspection aims to gather information about the research location's conditions prior to data collection. Meanwhile, the literature review aims to summarize the materials required for the research, enabling a better understanding and resolution of the problems encountered during the study and the preparation of the final report. Additionally, it ensures that data processing complies with applicable standards.

Research data and survey

Research data comprises two types: primary and secondary data. Primary data is obtained directly through field surveys, while secondary data is sourced from other references, such as books, journals, or other relevant sources.

Table 3. Research Data

No	Primary Data	Secondary Data
1	Traffic Flow	Population
2	Intersection geometry	Location Map
3	Noise Level	

The survey was conducted to collect geometric data, traffic volume, noise levels, and environmental conditions. Geometric data was measured in the field, traffic flow was recorded based on vehicle types and their maneuvers, while noise levels were measured using a Sound Level Meter.

Research Period

The research was conducted at the Nan Sarunai Tanjung Selatan Intersection in Tabalong Regency. Data collection was carried out from 06:00 to 18:00 WITA over the course of one day, specifically on a Monday, after the site inspection had been completed.

Data Processing

The collected data were analyzed to extract meaningful insights. Traffic volume data processing included calculating intersection capacity, degree of saturation to assess traffic performance, and delay time based on traffic flow and geometry. Analysis was also conducted on the traffic noise data obtained at the site. Following the analysis of traffic volume and noise data, regression analysis and correlation analysis were performed to identify the relationship between these two datasets.

4. Result and Discussion

Noise Analysis at the Intersection

This analysis aims to identify the noise levels generated at the intersection and in the surrounding area. The intersection acts as the source of traffic noise, while the surrounding area is impacted by the intersection's noise. A field survey conducted from 06:00 to 16:00 on October 21, 2024, recorded the highest noise level at the intersection as 94.3 dB, and the highest noise level in the surrounding area as 94 dB. The data from both locations indicate that the noise levels exceed the average noise standard specified in the South Kalimantan Governor Regulation No. 53 of 2007, which sets the noise limit at 65 dB for office and commercial areas.

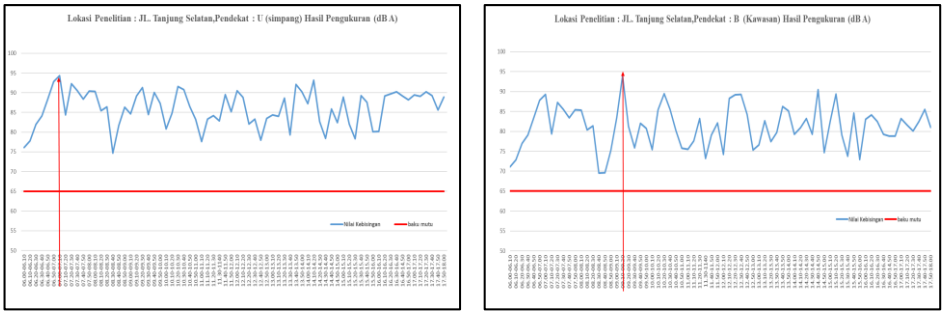

Figure 1. Noise graph at intersections and Areas

Correlation Between Traffic Volume and Noise Levels

As traffic volume increases, the noise level at the intersection also rises. The correlation between traffic volume and intersection noise shows a strong relationship, with a correlation coefficient of R = 0.63. Meanwhile, the correlation between traffic volume and noise in the surrounding area also indicates a strong relationship, with a correlation coefficient of R = 0.54.

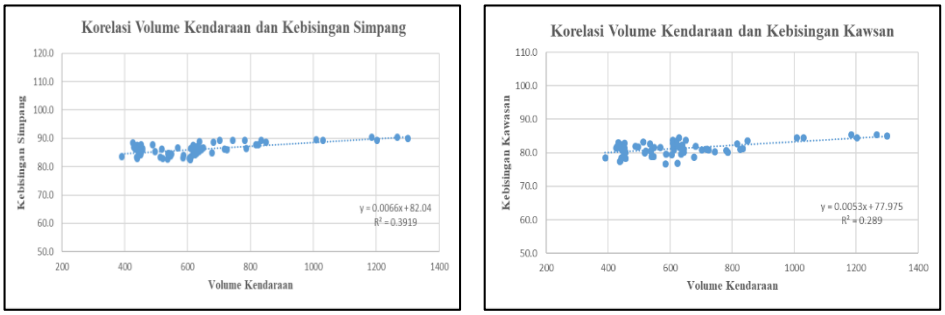

Figure 2. Vehicle Volume and Noise Correlation Graph

Exisiting Intersection Performance

Based on the data collected from the four intersection legs—north, east, south, and west—over a 12-hour period on October 21, 2024, the peak traffic volume was recorded during the morning rush hour from 07:00 to 08:00 WITA, with a total of 1,301 PCU/hour.

No	Intersection Performance Components	Calculation Value
1	Capacity (PCU/hour)	3676
2	Degree of Saturation	0,345
3	Traffic delays (seconds /PCU)	4,49
4	Major road traffic delays (seconds /PCU)	3,41
5	Minor road traffic delays (seconds /PCU)	7,06
6	Geometry delay (seconds /PCU)	4,51
7	Junction delay (seconds /PCU)	9,00
8	Queue opportunities (%)	11,27

The results of the existing intersection performance are shown in the table above, with a Degree of Saturation (DS) of 0.345 and a Level of Service (LOS) index of B, indicating that the intersection's performance is still optimal. Therefore, the researcher conducted a future performance prediction using the forecasting method.

Forecasted Intersection Performance

Based on the analysis of the existing intersection performance, the current condition is still optimal. However, forecasting was conducted to predict the year in which the intersection would reach a Degree of Saturation (DS) > 0.85. The analysis results indicate that in the 20th year, the intersection's performance is expected to become suboptimal, based on the projected peak hour traffic volume.

$P_n = P_O(1 + r)^n$

$P_n = 1301\ (1 + 0{,}0514)^{20}$

$P_n = 1301$ x 2,725

$P_n = 3545$ PCU/hour

Table 4. Results of forecasting intersection performance

No	Intersection Performance Components	Calculation Value
1	Capacity (PCU/hour)	3599
2	Degree of Saturation	0,99
3	Traffic delays (seconds /PCU)	14,38
4	Major road traffic delays (seconds /PCU)	10,13
5	Minor road traffic delays (seconds /PCU)	24,48
6	Geometry delay (seconds /PCU)	4,01
7	Junction delay (seconds /PCU)	18,39
8	Queue opportunities (%)	57,99

The results of the forecasted intersection performance are shown in the table above, with a Degree of Saturation (DS) of 0.99 and a Level of Service (LOS) index of C, indicating that the intersection's performance is no longer optimal. Therefore, alternative intersection treatments are necessary.

Conversion to a Signalized Intersection

Based on the analysis of the forecasted intersection performance, the intersection shows suboptimal performance, with a Degree of Saturation (DS) of 0.99. Therefore, alternative measures are necessary, one of which is converting the unsignalized intersection into a signalized intersection. This approach uses forecasted peak hour traffic volume data, with a value of 3,545 PCU/hour.

Table 5. Results of Alternative Signalized Intersection Handling

intersection arms	Time 07.00 – 08.00 (Peak Hours)						
	C (SMP/hour)	D_J	N_q (SMP)	R_{KH} (stop/SMP)	P_A (m)	T (sec/SMP)	ITP
JL. Tanjung Selatan (North)	786	0,81	12,6	0,959	39	23,59	C
JL. Tanjung Selatan (South)	853	0,81	13,2	0,924	53		

JL. Nan Sarunai (east)	292	0,81	5,7	1,155	23
JL. Tanjung Selatan (west)	731	0,81	11,8	0,968	36

The results of the alternative signalized intersection handling are shown in the table above, with a Degree of Saturation (DS) of 0.81 and a Level of Service (LOS) index of C, indicating that the intersection performance is optimal. Therefore, converting the intersection into a signalized intersection can be a relevant solution for improving its performance.

5. CONCLUSION

Based on field survey results and calculation analysis at the Nan Sarunai Tanjung Selatan four-leg intersection in South Kalimantan, it was found that the noise levels in this area exceed the standard limits set by South Kalimantan Governor Regulation No. 53 of 2007, which specifies 65 dB for office and commercial areas. The highest intersection noise was recorded between 07:00–07:10 WITA at 94.3 dB, caused by high traffic volume and heavy vehicles stopping. Meanwhile, the highest noise level in the surrounding area was recorded between 09:10–09:20 WITA at 94 dB, caused by frequent vehicle movement and non-compliant exhaust systems. Additionally, correlation analysis results indicate that traffic volume has a strong impact on noise levels, with a correlation coefficient of 0.63 for intersection noise and 0.54 for noise in the surrounding area.

The existing performance of the Nan Sarunai Tanjung Selatan intersection shows a Degree of Saturation (DS) of 0.35, a delay of 9 seconds/PCU, and a queue probability of 11.27%, indicating good performance. However, in the 20-year projection, the intersection's performance is expected to decline, with a DS of 0.99, a delay of 14.38 seconds/PCU, and a queue probability of 57.99%, indicating that the intersection will no longer be optimal. To address this issue, it is recommended to convert the intersection into a signalized intersection, which could reduce the DS to 0.81 and improve its performance in the future.

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