CERUCUK
Volume 10 No. 5 2026 (231-238)

ANALYSIS OF INTERSECTION PERFORMANCE AND NOISE LEVELS AT TANJUNG BARU - NAN SARUNAI INTERSECTION, TABALONG REGENCY

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ABSTRACT

The Tanjung Baru - Nan Sarunai four-way intersection, a strategic non-signalized junction connecting the national roads of South, Central, and East Kalimantan, experiences significant traffic congestion due to heavy vehicle flows, particularly mining employee fleets. This study employs the 2023 Indonesian Highway Capacity Guidelines (PKJI 2023) and Excel-based calculations using geometric intersection data, traffic volume, noise levels, and population data from Tabalong Regency.

The peak traffic hour was identified between 3:10 PM and 4:10 PM WITA, with existing conditions showing Dj = 0.30, T = 8.48, and Pa = 9.10%. A 21-year traffic forecast indicates increased congestion (Dj = 0.86, T = 14.70, Pa = 43.99%). Proposed alternatives, including lane widening and signalization, yielded a service level index of C (Dj = 0.82, T = 20.06, TLL = 37.4). Peak noise levels reached 100.9 dB at the intersection and 92.8 dB in the surrounding area, with strong correlation values observed (R = 0.76 for the intersection; R = 0.56 for the area).

Keywords: Indonesian Road Capacity Guidelines (PKJI 2023), Forecasting, APILL Intersection, Level of Service Index, Capacity, Degree of Saturation, Delay Time, Queue Probability, Noise Level, and Correlation.

1. INTRODUCTION

The designation of East Kalimantan as the new capital city is expected to lead to an increase in population migration to Kalimantan, including South Kalimantan, particularly in Tabalong Regency. This population surge is likely to raise the use of private vehicles, potentially resulting in traffic congestion, pollution, noise, and an increased demand for parking spaces. Therefore, strategic measures are necessary to anticipate these impacts.

An intersection is a meeting point of road segments that serves to regulate traffic flow. As a crucial part of the road network, the capacity of an intersection can be controlled by managing traffic volume. Intersections occur when two or more roads meet, often leading to congestion and vehicle delays. This density can be influenced by various factors, including inefficient traffic management.

The Tanjung Baru - Nan Sarunai four-way intersection, without traffic lights, was chosen as the research location due to its strategic position near essential facilities and a

national road connecting three provinces in Kalimantan. Traffic flow is particularly heavy during weekdays, with large vehicles such as coal mining trucks contributing to congestion. Performance analysis of the intersection and noise levels is required to address these issues and find effective solutions.

2. THEORETICAL FRAMEWORK

Intersection

An intersection is an area where two or more road segments meet or cross. Intersections can be simple, involving only two roads, or complex, involving multiple roads (Prasetyanto, 2019).

Signal-Free Intersection Analysis

A signal-free intersection is a road junction without traffic lights or Traffic Signal Giving Devices (TSGD), where drivers themselves must decide whether it is safe to enter the intersection. (Haradongan, 2019). This decision depends on observations of the surrounding situation, such as the speed and distance of other vehicles, as well as factors like weather or visibility. Signal-free intersections are often found in areas lacking adequate traffic infrastructure or locations where vehicle volume is relatively low, but they still require high vigilance from drivers to avoid potential accidents.

Signalized Intersection Analysis

According to PKJI 2023, a signalized intersection regulates traffic by separating flow times to reduce conflicts, both primary conflicts (direct collisions) and secondary conflicts (delays or congestion). In this way, TSGD improves order, reduces accident risks, and enhances the efficiency of vehicle movement.

Forecasting

Forecasting is a method used to predict future traffic conditions based on historical data and factors influencing vehicle movement patterns. In the context of intersections, traffic forecasting is useful for predicting the volume of vehicles that will pass through, which helps in planning more efficient intersection management..

Handling Alternatives

Alternative handling of an intersection is necessary when its performance becomes inadequate, which occurs when the Degree of Saturation (D_J) at the intersection exceeds 0.85 or when delays and the level of service fall within categories D-F (Table 1). One

alternative that can be considered is widening and adding lanes to the intersection approaches or designing the intersection with TSGD.

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

Servise 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)

Noise

Noise refers to unwanted sounds that disturb life, including humans. In some cases, noise can lead to hearing impairments or even traffic accidents. (Mahkamah, 1996).

Linear Regression

The multiple linear regression analysis explained in this study is a statistical method used to understand the relationships between various factors in a given problem. In this research, the method will be applied to calculate the equivalent passenger car units (PCU). Noise is used as the dependent variable (Y), while the independent variables include the volume of passenger cars (X_1), medium vehicles (X_2), and motorcycles (X_3).

Correlation

This study involves two types of variables: independent and dependent variables. The independent variable (X) is one whose value can change depending on certain conditions, while the dependent variable (Y) is influenced by the independent variable. In this study, vehicle volume serves as the independent variable, while noise level is the dependent variable affected by the vehicle volume. The strength of the relationship between the two variables is measured according to the following criteria:

$R = 0$	: No correlation between the two variables
$0 \leq R \leq 0.25$	: Very weak correlation
$0.25 \leq R \leq 0.5$	: Moderate correlation
$0.5 \leq R \leq 0.75$	: Strong correlation
$0.75 \leq R \leq 0.99$	: Very strong correlation
$R = 1$	: Perfect correlation

3. METHOD

Preparation Stage

The preparation stage is divided into two parts: site inspection and literature review related to the final thesis. The site inspection aims to collect information about the condition of the site before data collection and to ensure its suitability for the research. The literature review is conducted to gather relevant references to the research topic. Its purpose is to understand the issues to be faced in the study and the final thesis writing, as well as to ensure that data processing is in accordance with existing theories.

Research Data and Survey

The research requires an object closely related to the collected data as the focus of the study. This data is essential for obtaining accurate research results. Therefore, it is important to categorize the data before conducting surveys and collection. The data is divided into two types: primary data and secondary data.

Table 2. Research Data

No	Primary Data	Secondary Data
1	Traffic Volume	Location Map
2	Traffic Noise	Population Statics
3	Road Geometry	

The data collection survey is conducted to gather information regarding road geometry, traffic volume, environmental conditions, and noise levels. Road geometry data is obtained through direct field measurements, while the traffic volume survey records the types of vehicles passing through. Noise level measurements are taken using a Sound Level Meter to assess the noise level in the area.

Research Duration

Traffic volume and noise level surveys are conducted at the Tanjung Baru - Nan Sarunai intersection. To obtain accurate data, the survey is carried out over several days of research and several hours of observation. In this study, the survey is conducted on a single day, Wednesday, with observation hours from 6:00 AM to 6:00 PM (WITA).

Data Processing

Analysis is conducted on the collected data, including the processing of traffic volume by calculating flow capacity, degree of saturation to evaluate traffic performance, and delay time affected by traffic flow and road geometry. Additionally, analysis is

performed on the traffic noise data collected in the field. Regression and correlation analyses are then performed to identify the relationship between traffic volume and noise levels.

4. RESULT AND DISCUSSION

Analysis of Existing Intersection Performance

Based on the data obtained from the four approach lanes of the intersection—north, east, south, and west—over a 12-hour period on October 23, 2024, peak traffic occurred between 3:10 PM and 4:10 PM (WITA), with a total of 1449 passenger car units per hour (PCU/hr).

Table 3. Existing Intersection Performance Analysis Results

No	Analysis Component	Calculation Results
1	Capacity (C)	4891 PCU/hour
2	Degree of Saturation (D_J)	0.30
3	Traffic Delay (T_{LL})	3.94 sec/PCU
4	Average Delay on Major Road (T_{Llma})	2.99 sec/PCU
5	Average Delay on Minor Road (T_{Llmi})	7.62 sec/PCU
6	Geometric Delay of Intersection (T_G)	4.55 sec/PCU
7	Intersection Delay (T)	8.48 sec/PCU
8	Queue Probability (Pa)	9.10%

The intersection's current performance is reflected in the table above, with a Degree of Saturation (DJ) of 0.30, indicating a level of service B, which suggests that the intersection is still operating optimally. Based on this, the researcher proceeded with forecasting the intersection's performance for future years.

Noise Analysis at the Intersection and Surrounding Area

This analysis measures the noise level at the intersection and its vicinity, with the intersection as the main source. A survey conducted on October 23, 2024, from 06:00 to 18:00 recorded the highest noise level at the intersection at 100.9 dB, and in the surrounding area at 92.8 dB, both exceeding the noise limit set by the Governor of South Kalimantan Regulation No. 53 of 2007, which is 65 dB for office and commercial areas.

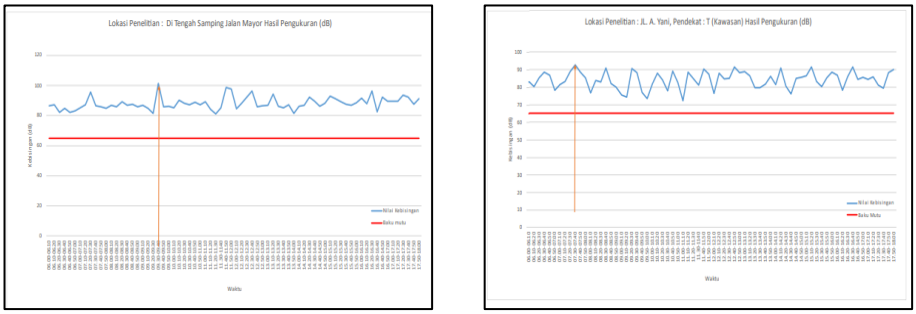

Figure 1. Noise Graph at the Intersection and Surrounding Area

Correlation Between Vehicle Volume and Noise

As vehicle volume increases, the noise level at the intersection also tends to rise. The correlation between vehicle volume and intersection noise is found to be very strong with an R value of 0.76. Similarly, the correlation between vehicle volume and noise in the surrounding area also shows a significant relationship with an R value of 0.56.

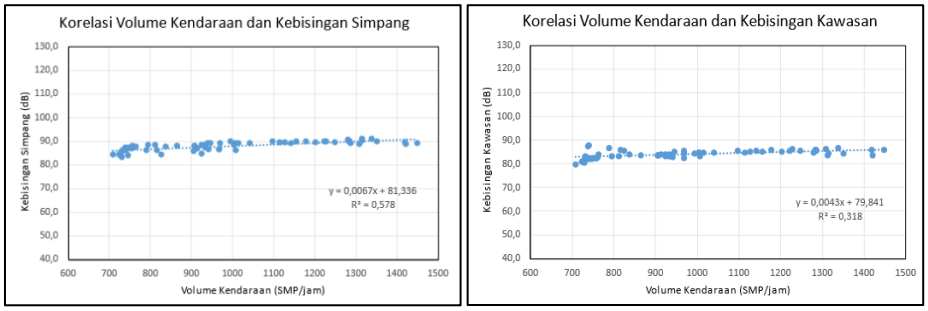

Figure 2. Correlation Graph Between Vehicle Volume and Noise

Intersection Performance Forecasting

The analysis of the existing intersection performance shows it is still optimal at present. However, forecasts predict the intersection will become suboptimal by the 21st year, with high peak-hour traffic volume. According to the forecasting calculations, the estimated traffic volume in the 21st year is expected to reach 4159 PCU/hour using the forecasting formula:

$$P_n = P_0(1 + r)^n$$

$$P_n = 1449\ (1 + 0.0514)^{21}$$

$$P_n = 1449 \text{ x } 2.87$$

$$P_n = 4159 \text{ PCU/hour}$$

Table 4. Forecested Intersection Performance Results

No	Analysis Component	Hasil Perhitungan
1	Capacity (C)	4891 PCU/hour
2	Degree of Saturation (D_J)	0.86
3	Traffic Delay (T_{LL})	10.59 sec/PCU
4	Average Delay on Major Road (T_{Llma})	7.75 sec/PCU
5	Average Delay on Minor Road (T_{Llmi})	21.67 sec/PCU
6	Geometric Delay of Intersection (T_G)	4.28 sec/PCU
7	Intersection Delay (T)	14.87 sec/PCU
8	Queue Probability (Pa)	43.99%

The forecasted intersection performance shows a DJ of 0.86 and a service level index of C, indicating that the intersection will no longer be optimal. Therefore, an alternative solution is needed.

Modification to APILL Signalized Intersection

Based on the forecasting results, which show suboptimal performance with a DJ of 0.86, an alternative solution is required, such as converting the unsignalized intersection to an APILL signalized intersection. The traffic volume during peak hours is recorded at 4159 PCU/hour.

Table 5. Alternative Signalized Intersection Treatment Results

Approach	15.10 – 16.10 (Peak Hour)						
	C (PCU/hour)	D_J	N_Q (PCU)	R_{KH} (stop/PCU)	P_A (m)	T (sec/PCU)	ITP
JL. Tanjung Baru (North)	203	0.82	10.8	1.251	17	20.06	C
JL. Nan Sarunai (South)	218	0.82	11.2	1.227	17		
JL. A. Yani (East)	1204	0.82	34.5	0.876	53		
JL. A. Yani (West)	960	0.82	29.3	0.915	45		

The signalized intersection treatment results show a D_J of 0.82 and a service level index of C, indicating that the intersection's performance has become optimal. Thus, the

implementation of APILL can be an effective solution to improve intersection performance.

5. CONCLUSION

The conclusions from the performance analysis of the Tanjung Baru – Nan Sarunai intersection are as follows:

1. The existing intersection performance is classified as level B with a D_J of 0.30, indicating optimal conditions.
2. The forecasted performance in 21 years will degrade to level C with a D_J of 0.86, signaling the need for intervention to manage increased traffic.
3. The noise level exceeds the safe limit, with the highest recorded at 100.9 dB, affecting public comfort.
4. There is a positive correlation between traffic volume and noise level, highlighting the importance of traffic management during peak hours.
5. The implementation of an signalized intersection can effectively reduce delays and improve traffic efficiency, with a D_J of 0.82, which is better than the optimal threshold.

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