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Assessment of Traffic Noise Impact and Noise Barrier Effectiveness in Residential Areas: Case Study of the Kunciran–Cengkareng Toll Road

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ABSTRACT: The construction of the Kunciran Batu Ceper Cengkareng toll road is part of the construction of the Jakarta Outer Ring Road II. One of the environmental impacts due to the operation of the new toll road is noise from vehicle sounds. This research aims to determine the traffic movement pattern and noise levels that occur in the Banjar Wijaya residential area. Traffic movement observations were carried out on two lanes from 06.00 to 19.00. The noise intensity was obtained using a traffic noise prediction calculation model, namely the CoRTN model and using a Sound Level Meter (SLM) tool. The noise intensity from the noise prediction with the CoRTN model was 51.40 dB (A) during the research, Data from BUJT Kunciran Cengkareng 49.55 dB (A). Noise intensity using the Sound Level Meter tool: during RPL 72.40 dB (A), research 75.18 dB (A). The noise intensity with the CoRTN Model is smaller than the Sound Level Meter tool. The procurement of sound barrier construction adjacent to the Banjar Wijaya residential is appropriate because the noise intensity value at the location is above the noise level standard for housing and settlement areas of 55 dB (A).

KEYWORDS: Noise, Residential Areas, Traffic, CoRTN Model, Sound Level Meter

I. INTRODUCTION

The construction of the Jakarta Outer Ring Road (JORR) II toll road is to strengthen the existing road network with the following objectives:

1. To reduce traffic congestion in the city of Jakarta and its surrounding areas.
2. As a connecting access between the provinces of DKI Jakarta, West Java and Banten.
3. For easy access to arterial roads, especially in the surrounding areas.
4. To reduce the traffic load on arterial roads in the surrounding areas.
5. Can provide benefits to the community or local people.

The Kunciran-Batu Ceper-Cengkareng toll road section connects the northern and southern regions of Tangerang City. Geographically, the northern region contains Soekarno Hatta Airport, residential areas, industrial areas and warehousing. The southern region contains residential areas, industry and quarry materials. In the northern region, this toll road is connected to the Sediatmo toll road leading to Ancol and Tanjung Priok Port, while in the southern region it will be connected to the JORR II and Jagorawi toll roads so that the movement of people, goods and services from the Bogor area to Soekarno Hatta Airport is shorter.

The Kunciran - Batu Ceper - Cengkareng toll road route crosses rice fields, lakes, swamps, warehouses, factories and housing complex for the local people. When the toll road is operated, it will certainly affect the environment around the toll road. Potential environmental impacts that can occur due to the operation of the road include air pollution and noise [2] [20].

Noise comes from vehicles that come from engine sounds, exhausts and friction between vehicle wheels and the road surface. To anticipate the noise that occurs, it is necessary to observe and measure the noise level that occurs [7] [9]. Based on the above, it is necessary to observe and calculate the noise that occurs whether the noise level can still be tolerated or has exceeded the threshold so that an activity needs to be carried out to reduce the negative impact of noise [10] [12].

The objectives of this research are to determine the traffic flow movement pattern on the Jasamarga Kunciran Cengkareng (JKC) Toll Road, to analyze the noise levels that occur along the toll road, and to evaluate the presence and effectiveness of noise barriers based on the permitted noise level standards.

II. LITERATURE REVIEW

According to the *Kamus Besar Bahasa Indonesia* (KBBI), or the Great Dictionary of the Indonesian Language, "noise" is defined as a sound that is disorganized or unwanted. Even if the sound is very soft or faint, it can still be considered noise if it is not desired.

Sound is usually characterized by two main properties: frequency and intensity. Sound frequency is an objective measure of tone. Sound waves are longitudinal waves that are heard as sound when they enter the ear at a frequency of 20-20,000 Hz or also called the range of sound that can be heard by humans.

The level of sound intensity is an objective measure of its loudness (subjective measure). Intensity is a measure of sound energy. The level of sound intensity is expressed in units of bel or decibel (dB).

According to Lipscomb, noise can be categorized into two main types based on its characteristics: steady-state noise and non-steady noise. Steady-state noise refers to continuous sound with relatively constant intensity over time. Meanwhile, non-steady noise varies in intensity and duration, and it can be further classified into three subtypes: fluctuating noise, which changes continuously; intermittent noise, which starts and stops at irregular intervals; and impulse noise, which occurs suddenly in short, high-intensity bursts [8].

Noise can originate from a variety of sources, including transportation, construction, industrial activities, residential areas, and other specific causes, all of which contribute to environmental noise pollution in both urban and suburban settings [19].

A. *Noise Level Standard*

Decree of the Minister of Environment No. 48 of 1996 that the noise level standard is the maximum limit of noise level that is allowed to be released into the environment from a business or activity so as not to cause human health problems and environmental comfort, as shown in Table 1 [12].

Table 1. Noise Level Standard

No	Area Designation/Activity Environment	Noise Level dB (A)
A	**Area Allocation**	
	1. Residential	55
	2. Trade & Services	70
	3. Office & Trade	65
	4. Green Open Space	50
	5. Industry	70
	6. Government and Public Facilities	60
	7. Recreation	70
	8. Harbor	60
	9. Cultural Heritage	70
B	**Activity Environment**	
	1. Hospital	55
	2. School	55
	3. Worship place	55

In the Regulation of the Minister of Health No. 718/MENKES/PER/XI/1987 concerning "Noise Related to Health" that noise levels are grouped into four regional zones as in Table 2 [14].

Table 2. Regional Zones

No.	ZONE	Noise dB (A)	
		Recommended Maximum	Maximum Allowed
1	A	35	45
2	B	45	55
3	C	50	60
4	D	60	70

There is a similarity in the permissible noise level between the Ministry of Environment and the Ministry of Health, namely that the maximum permissible noise level for residential areas is 55 dB(A) [12] [14] [3].

B. *Criteria for noisy areas*

According to the Construction and Building Guidelines of the Department of Settlement and Regional Infrastructure (2004), a noisy area is a lane with a certain distance (width) located on both sides and parallel to the road lane based on a certain noise level, the length of exposure time, and the designation of land on the side of the road for settlements, housing. From this definition, the noise area is grouped as follows [5] [19]:

1. Noise Safe Area / Daerah Aman Bising (DAB),
2. Moderate Noise Area / Daerah Moderat Bising (DMB),
3. Noise Risk Area / Daerah Resiko Bising (DRB).

C. *Impact of Noise*

According to the World Health Organization (WHO), sound levels of less than 70 dB will not damage living organisms, regardless of how long or consistent the exposure is (Merdeka.com). Exposure to noise for more than 8 hours from constant sound exceeding 85 dB can be hazardous to health [17] [7].

Some health disorders that commonly occur due to noise are:

1. Physiological Disorders
2. Communication Disorders and Deafness
3. Sleep Disorders
4. Task Implementation Disorders
5. Body Function Disorders

D. *Factors Affecting Traffic Noise*

According to Atteborogh, 1982, the level of traffic noise is influenced by the following factors [1]:

1. Traffic Volume,
2. Vehicle Speed, and
3. Percentage of Heavy Vehicles

Traffic volume is defined as the number of vehicles passing a certain point during a certain time interval. The results of research from the Department of Transport, UK London, 1988 showed that noise levels are influenced by traffic volume. The higher the traffic volume, the higher the noise level that occurs [4] [6].

Vehicle volume can be expressed in:

1. Vehicles / hour,

2. Passenger car units / minute,
3. Passenger car units / cycle time,
4. Vehicles / hour.

From the traffic volume, it can be analyzed to obtain information about traffic flow patterns. Traffic patterns show fluctuations in traffic volume over a certain time span [13]. The traffic volume of a road will vary and form traffic flow patterns such as: hourly volume, daily volume, monthly volume [16].

Traffic Law No. 22 of 2009 defines traffic as the movement of vehicles and people in road traffic space. Road traffic space is an infrastructure intended for the movement of vehicles, people and / or goods in the form of roads and supporting facilities, Vehicles are defined as a means of transportation on the road consisting of motorized vehicles and non-motorized vehicles [21].

According to the 1997 Indonesian Road Capacity Manual (Manual Kapasitas Jalan Indonesia, MKJI), traffic elements are classified into the following categories [11]:

1. Light Vehicles (LV)
2. Heavy Vehicles (HV)
3. Motorcycles (MC)
4. Non-Motorized Vehicles (NMV)

E. Vehicle Speed

The Regulation of the Minister of Transportation No. 111 of 2015 concerning Procedures for Determining Speed Limits Article 3 paragraph 4 the speed limit for toll roads is a minimum of 60 km/hour and a maximum of 100 km/hour [15]. The purpose of the lower speed threshold is so that no road users drive slowly to cause vehicle congestion (traffic jams), while the purpose of the highest threshold is to reduce the number of traffic accidents. Eighty percent of the causes of traffic accidents are due to human factors .

According to Warpani (1988), Traffic flow speed consists of [22]:

1. Spot Speed
2. Running Speed
3. Journey Speed

F. Percentage of Heavy Vehicles

The Department of Transport, UK London (1988) stated that the percentage of heavy vehicles (1,525 kg and above) has a significant effect on noise levels, this is because vehicles weighing more than 1,525 kg have engines with a large capacity (cc) so that the resulting sound will be higher compared to vehicles with small cc with the same technology [6].

G. Noise Measurement

The level of noise due to transportation activities can be carried out based on direct measurements and noise predictions from traffic volume.

Noise levels were measured using a Sound Level Meter (SLM). The device must be equipped with at least the following features [18]:

1. A-weighting scale
2. Slow time-weighting response (S)

The direct measurement principle is based on the conversion of sound pressure into an electrical signal. When sound waves reach the microphone diaphragm of the Sound Level Meter (SLM), they are transformed into electrical signals, which are then processed through an A-weighted filter network. The filtered signal is amplified and displayed on the screen, allowing the sound pressure level to be read directly.

Traffic noise prediction using the Calculation of Road Traffic Noise (CoRTN) prediction model contained in the Construction and Building Guidelines published by the Department of Settlement and Regional Facilities (2004) [5]. Basic Noise Prediction or Predicted Noise Level (PNL) using the equation:

$$PNL = BNL + C_1 + C_2 + C_3 + C_4 + C_5 \dots\dots (1)$$

Where:

- PNL= Predicted Noise Level
- BNL= Basic Noise Level
- C_1 = Correction of vehicle speed and percentage of heavy vehicles
- C_2 = Gradient correction
- C_3 = Pavement surface correction
- C_4 = Horizontal distance correction
- C_5 = Reflection effect correction

The basic noise level prediction due to traffic is as follows:

1. Basic Noise Level (BNL) is calculated using the following equation:

$$L_{10} = 42.2 + 10 \log Q \dots\dots (2)$$

Where:

L_{10}= Basic noise level per 1 hour, in dB (A)

Q = Traffic Volume (vehicles/hour)

2. Corrections applied to the basic noise level

a. Correction for Vehicle Speed and Percentage of Heavy Vehicles (C_1)

$$C_1 = 33 \log(V + \frac{40 + 500}{V}) + 10 \log(1 + \frac{5p}{V}) - 68.8 \,..(3)$$

Where:

- V = Average vehicle speed (km/h), calculated as:

$$V = \frac{(V_{mc}.n_{mc}) + (V_{lv}.n_{lv}) + (V_{hv}.n_{hv})}{n_{mc} + n_{lv} + n_{hv}} \dots (4)$$

- p = Percentage of heavy vehicles (PHV), calculated as:

$$p = \left(\frac{Q_{hv}}{Q_{total}}\right) x\ 100\% \dots\dots (5)$$

Where:

Qhv = Volume of heavy vehicles (vehicles/hour)

Qtotal= Total traffic volume (vehicles/hour)

b. Gradient Correction (C_2)

$$C_2 = 0.3\ x\ G \dots\dots\dots (6)$$

Where:

G = road gradient (%)

c. Road pavement surface correction (C_3)

The road pavement surface correction (**C_3**) accounts for the influence of different pavement types on traffic noise levels. Pavement surfaces affect the generation and propagation of rolling noise, particularly at higher vehicle speeds. Noise level correction factors based on types of pavement surfaces as in Table 3 [5].

Table 3. Pavement Surface Correction

No	Description	Correction dB(A)
1	Chip Seal	3
2	Portland Cement Concrete	1
3	Dense Gradation Asphalt Concrete	-1
4	Open Gradation Asphalt Concrete	-5

d. The horizontal distance correction (C_4)

The horizontal distance correction (C_4)accounts for the distance from the edge of the road section to the receiver point (d) and the relative height difference (h) between the receiver and the effective sound source. The correction factor is calculated using the following formula:

$$C_4 = -10 \log\left(\frac{d'}{13.5}\right) \ldots\ldots (7)$$

The geometry of the distance between the receiver point and the effective sound source is illustrated in Figure 1.

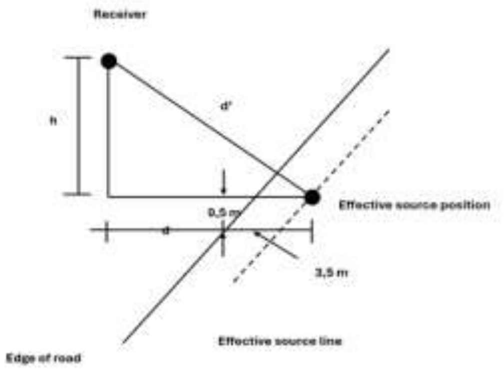

Figure 1 Schematic diagram of receiver-to-road distance

The effective distance (d′) is computed as:

$$d' = \sqrt{(d+3.5)^2 + h^2} \ldots\ldots (8)$$

Where:

- d′ = Effective slant distance from the sound source to the receiver (meters)
- d = Horizontal distance from the edge of the road to the receiver (meters)
- h = Height difference between the receiver and the sound source (meters)

e. Reflection Effect Correction (C_5)

The correction factor for the reflection effect (C_5) is determined based on the characteristics of the surroundings and their influence on sound reflection. The corresponding correction values are provided in table 4.

Table 4. Reflection Effect Correction

No	Description	Correction dB(A)
1	Open field / court	0
2	1 meter in front of building	+2,5
3	There are continuous walls on the left and right sides of the road	+1

Source: *Department of Settlement and Regional Facilities, 2004*

III.RESEARCH METHODOLOGI

A. Research Location and Period

The research was conducted in the Banjar Wijaya Residential Area, located in Tirtayasa Village, Pinang District, Tangerang City, Banten Province. The study took place from July to November 2024. There are four housing clusters adjacent to the Kunciran Batu Ceper Cengkareng toll road, namely

1. Nusantara Cluster
2. Grasia Cluster,
3. Catleya Cluster,
4. Crisan Cluster.

These four clusters are separated by the housing road and the Kunciran - Batu Ceper - Cengkareng toll road. At this location, there is the Banjar Wijaya Residential located at Sta. 37+830 (Km. 11+500) crossing the housing road. The location of the Banjar Wijaya and the residential area adjacent to the Kunciran Batu Ceper Kunciran toll road can be seen in Figure 2.

Figure 2 Location of Banjar Wijaya

B. Data Collection Methods

The stages undertaken in this research are illustrated in the flowchart presented in Fig. 3.

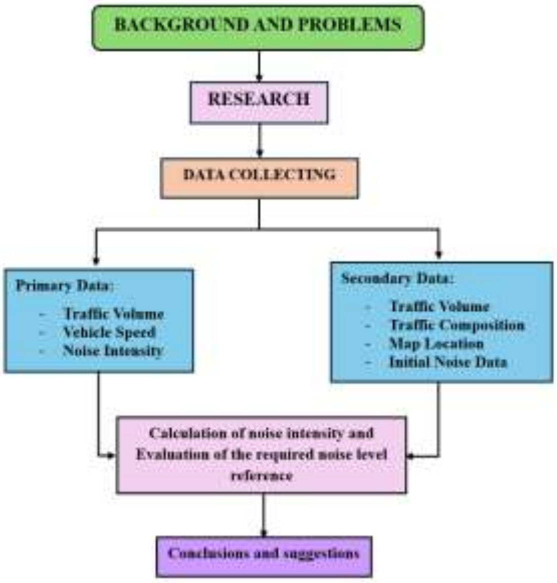

Figure 3 Research Flowchart

The data used in this article are grouped into primary data and secondary data. Primary data is data measured and observed in the field in the form of traffic volume, vehicle speed and noise intensity with a sound level meter. These data are calculated using the CoRTN Model equation to measure / predict the intensity of noise that occurs.

The secondary data comes from agencies related to the construction of the Kunciran - Batu Ceper - Cengkareng toll road, namely the construction drawings of the Kunciran - Batu Ceper - Cengkareng toll road, traffic volume from the Kunciran - Batu Ceper - Cengkareng BUJT, initial noise data.

The location of observation and data collection was sought in a safe location without disrupting toll road operations, namely at the Tirtayasa Over Pass which is approximately 1.25 km from the Banjar Wijaya, as seen in Figure 4.

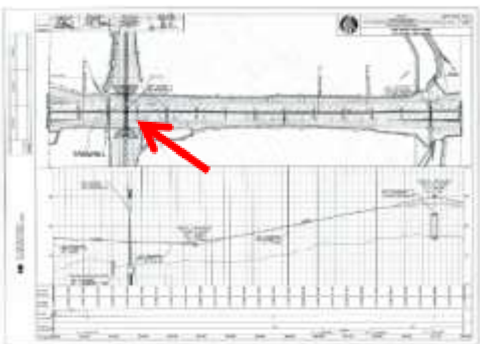

Figure 4 Observation Location of OP Tirtayasa 2

C. Vehicle volume

Vehicle volume measurement to determine the volume of vehicles that most often pass during the research. Volume measurement was carried out for seven days. Vehicle enumeration was carried out three times, morning, noon, and afternoon. Observation times are as follows:

a. Morning starts from 06.00 to 09.00 Western Indonesian Time,
b. Noon starts from 10.00 to 13.00 Western Indonesian Time,
c. Afternoon starts from 16.00 to 19.00 Western Indonesian Time.

D. Vehicle Speed

The vehicle speed measured was only heavy vehicles while light vehicles used the minimum speed limit according to the Minister of Transportation Regulation No. 111 of 2015, which is 60 km/hour [15].

The method used to observe vehicle speed in this research used the "follow the flow" or floating vehicle method, that is observation by following / mixing with the flow of vehicles. The vehicles observed in this speed measurement are only heavy vehicles, 2-axle trucks, and articulated trucks (> 3 axles).

E. Noise Intensity

The noise intensity data used in this research was obtained from the following sources:

a. Baseline (Initial) noise data,
b. Environmental Monitoring Plan/ Rencana Pemantauan Lingkungan (RPL),
c. Noise Measurement conducted during the research. Noise intensity measurements during the research were carried out by the Environmental Laboratory using a Sound Level Meter (SLM)

IV. RESULTS AND DISCUSSION

A. Traffic Flow Pattern)

The JKC toll road connects the northern and southern regions of Tangerang City and Regency. The northern region of Tangerang has a warehouse area, factories, housing and Soekarno Hatta Airport, the southern region has a housing area, factories and material sources. These different geographical conditions affect the movement of traffic flow from morning, afternoon and evening.

From the volume of vehicles, the pattern / characteristics of vehicle movement during the research can be seen as follows

1. Kunciran–Cengkareng

Observation from 06.00–09.00 Western Indonesian Time

- At this time, the most dominant vehicles are light vehicles, passenger cars, heading to Soekarno Hatta Airport and to the workplace.
- Heavy vehicles are dominated by 3-axle dump trucks that transport embankment material from quarries to construction projects around Soekarno Hatta Airport.

Observation from 10.00–13.00 Western Indonesian Time

- Light vehicles, passenger cars, still dominate with destinations to Soekarno - Hatta Airport and to the workplace.
- Heavy vehicles consist of

a. 2-axle trucks with open and closed bodies (box),
b. 3-axle dump trucks that transport embankment material,
c. articulated trucks with more than 3 axles that transport containers and fuel.

Observation from 16.00–19.00 Western Indonesian Time
- Light vehicles consist of passenger cars, light goods transport vehicles in the form of box cars and open bodies.
- Heavy vehicles consist of
  a. 2-axle trucks with open and closed bodies (box),
  b. 3-axle dump trucks that transport embankment material and open and closed bodies trucks,
  c. articulated trucks with more than 3 axles carrying containers and transporting fuel.

2.Cengkareng-Kunciran

Observation from 06.00–09.00 Western Indonesian Time
- Light vehicles, passenger cars are estimated to be heading to work in Jakarta.
- Heavy vehicles, dominated by 3-axle dump trucks returning to the quarry after unloading at construction projects around Soekarno - Hatta Airport.

Observation from 10.00–13.00 Western Indonesian Time
- Light vehicles are dominated by passenger cars and light transport vehicles with closed (box) and open bodies (pick-up).
- Heavy vehicles consist of
  a. 2-axle trucks with open and closed bodies (box),
  b. 3-axle dump trucks returning to the quarry, and goods carriers with open and closed bodies,
  c. articulated trucks with more than 3 axles carrying containers and transporting fuel.

Observation from 16.00–19.00 Western Indonesian Time
- Light vehicles are dominated by passenger cars and light transport vehicles with closed (box) and open bodies (pick-up).
- Heavy vehicles consist of
  a. 2-axle trucks with open and closed bodies (box),
  b. articulated trucks with more than 3 axles carrying containers and transporting fuel.
  c. articulated trucks with more than 3 axles carrying containers and transporting fuel.

B. Evaluation of Noise Intensity

Evaluation of noise that occurs on the JKC toll road by measuring noise intensity based on:

a. Prediction of noise due to traffic with the CoRTN Model (Calculation of Road Traffic Noise),
b. Noise measurement with a Sound Level Meter:
   - Environmental monitoring plan / Rencana Pemantauan Lingkungan (RPL), and
   - Measurements carried out by the Environmental Laboratory.

The calculation of the Basic Noise Prediction, or Predicted Noise Level (PNL), for traffic noise prediction using the Calculation of Road Traffic Noise (CoRTN) model can be performed using the equation previously described in Section 2.

Vehicle volume is obtained from the enumeration of vehicle groups passing during the research and vehicle volume from the Toll Road Manager (BUJT), that is PT. Jasamarga Kunciran Cengkareng.

The results of the traffic volume survey conducted during the study are presented in Table 5 (Direction: Kunciran–Cengkareng) and Table 6 (Direction: Cengkareng–Kunciran).

Table 5 JKC Toll Traffic Volume

No.	Date	Vehicle Type		Total (Vehicle/Hour)	Heavy Vehicle Percentage (%)
		Heavy Vehicle per Hour	Light Vehicle per Hour		
1	5-Aug	124	605	729	16.98
2	6-Aug	108	576	684	15.84
3	7-Aug	113	611	724	15.56
4	8-Aug	137	687	824	16.61
5	9-Aug	121	651	772	15.63
6	10-Aug	102	463	565	18.04
7	11-Aug	58	358	416	13.95

***Source:** Research*

Table 6 Traffic Volume During Research

No.	Date	Vehicle Type		Total (Vehicle/Hour)	Heavy Vehicle Percentage (%)
		Heavy Vehicle per Hour	Light Vehicle per Hour		
1	5-Aug	113	689	802	14.09
2	6-Aug	111	673	784	14.13
3	7-Aug	108	715	823	13.07
4	8-Aug	114	795	909	12.56
5	9-Aug	113	720	833	13.53
6	10-Aug	101	610	711	14.20
7	11-Aug	54	441	495	10.95

***Source**: Research*

The traffic volume data during the research is presented in Fig. 5 Graph of Traffic Volume during research.

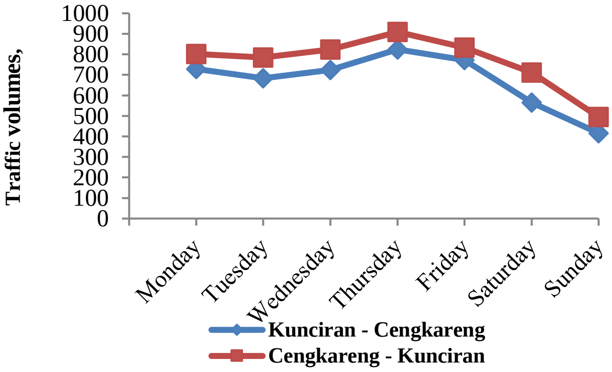

Figure 5 Graph of Traffic Volume During Research

The highest traffic volume during the research on August 8, was:

a. Kunciran – Cengkareng route: 824 vehicles/hour

b. Cengkareng – Kunciran route: 909 vehicles/hour

The traffic volume obtained from the Toll Road Manager (BUJT), that is PT. Jasamarga Kunciran Cengkareng is secondary data compiled in Table 7 and Table 8.

Table 7 KC Toll Traffic Volume

Direction: Cengkareng – Kunciran.

No.	Date	Vehicle Type		Total (Vehicle/Hour)	Heavy Vehicle Percentage (%)
		Heavy Vehicle per Hour	Light Vehicle per Hour		
1	5-Aug	91	572	663	13.73
2	6-Aug	98	576	674	14.54
3	7-Aug	94	624	718	13.09
4	8-Aug	98	639	737	13.30
5	9-Aug	100	655	755	13.25
6	10-Aug	86	549	635	13.54
7	11-Aug	58	400	458	12.66

Source: *PT. Jasamarga Kunciran Cengkareng*

Table 8 JKC Toll Road Traffic Volume

Direction: Kunciran – Cengkareng

No.	Date	Vehicle Type		Total (Vehicle/Hour)	Heavy Vehicle Percentage (%)
		Heavy Vehicle per Hour	Light Vehicle per Hour		
1	5-Aug	117	670	787	14.87
2	6-Aug	118	682	800	14.75
3	7-Aug	112	686	798	14.04
4	8-Aug	111	686	797	13.93
5	9-Aug	124	721	845	14.67
6	10-Aug	99	584	683	14.49
7	11-Aug	64	462	526	12.17

Source: *PT. Jasamarga Kunciran Cengkareng*

JKC toll road traffic volume data is presented in Fig. 6 Graph of JKC Toll Road Traffic Volume as follows.

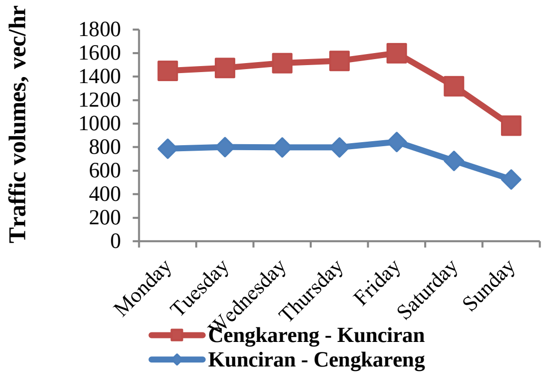

Figure 6 Graph of JKC Toll Road Traffic Volume

The highest traffic volume from the Kunciran Cengkareng BUJT data on August 9, was:

a. Cengkareng – Kunciran route = 755 vehicles/hour

b. Kunciran – Cengkareng route = 845 vehicles/hour

The vehicle speed used is the average speed of vehicles passing on the toll road, that is the speed of light vehicles and the speed of heavy vehicles. Light vehicles use the minimum speed limit is 60 km/hour [15].

The speed of heavy vehicles is observed by following (blending) from behind the observed vehicle for 1000 to 2000 m. The heavy vehicles whose speed is measured are heavy vehicles 2-axle trucks, 3-axle trucks and trucks with more than 3 axles.

The average speed of heavy vehicles and light vehicles passing in two directions as in Table 9.

Table 9 Vehicle Speed Average

No.	Traffic Direction	Vehicle Speed, km/hour			
		Monday	Wedbesday	Friday	Average
1	Kunciran - Cengkareng	60	55	60	58,33
2	Cengkareng - Kunciran	55	60	60	58,33

Source: *Research*

The results of the calculation of the Percentage of Heavy Vehicles (PHV) during the research can be seen in Table 5 and Table 6, data from BUJT Kunciran Cengkareng can be seen in Table 7 and Table 8.

The toll road route that overlaps with the Banjar Wijaya residensial has a Banjar Wijaya bridge (overpass). The road gradient is 0.3 – 3%. The gradient correction used is 3% because at this gradient Heavy Vehicles (HV) with full loads can still move without having to lose significant speed (without using low gear). From the calculation of the C_2 gradient correction of 0.9 dB (A).

The pavement of the Kunciran Batu Ceper Kuncirant toll road section uses rigid pavement. From Table 3 Pavement Surface Correction, the correction value for rigid pavement (portland cement concrete) is 1 dB (A).

The result of the horizontal distance correction calculation with a horizontal distance from the effective sound source position of 10 meters and a height of the sound receiver point of 2 meters, the horizontal distance correction (C_4) is obtained as - 0.05 dB(A).

The toll road is a freeway that is not disturbed by vehicles entering and exiting carelessly and people crossing in random places.

The guardrail that overlaps with the Banjar Wijaya residensial area is built of concrete slabs. Based on Table 4 Reflection Effect Correction, the correction value for continuous walls on the left and right sides of the road is + 1 dB(A).

B. Basic Noise Prediction, Predicted Noise Level (PNL)

After the noise correction factors are known using the excel program, the basic noise prediction (PNL) is known. The summary of the basic noise prediction can be seen in Table 10.

Table 10. PNL Summary

Traffic direction: Cengkareng – Kunciran

No.	Date	PNL	
		Research	BUJT JKC Data
1	5-Aug	48.74	49.41
2	6-Aug	48.72	49.55
3	7-Aug	48.59	48.33
4	8-Aug	48.53	49.38
5	9-Aug	48.75	49.38
6	10-Aug	48.72	49.36
7	11-Aug	48.93	49.06

Source: *Processing data result*

Table 11. PNL Summary

Traffic direction: Kunciran – Cengkareng

No.	Date	PNL	
		Research	BUJT JKC Data
1	5-Aug	50.04	49.68
2	6-Aug	49.92	49.66
3	7-Aug	49.91	49.54
4	8-Aug	50.09	49.52
5	9-Aug	50.02	49.67
6	10-Aug	50.04	49.54
7	11-Aug	49.37	49.03

Source: *Processing data result*

From Table 10 and Table 11, it is known that the highest basic noise predictions occurred:

a. Cengkareng – Kunciran
- Field measurement (Research): August 11, 48.93 dB(A)
- BUJT JKC data: August 6, 49.55 dB(A)

b. Kunciran – Cengkareng
- Research: August 8, 50.09 dB(A)
- BUJT JKC data: August 5, 49.68 dB(A)

C. Noise Intensity Measurement with a Sound Level Meter

Noise intensity measurements with a Sound Level Meter are carried out at the time of:

- Environmental Monitoring Plan (RPL),
- Noise measurement by the Environmental Laboratory.

1. Noise intensity measurement during the Environmental Monitoring Plan (RPL)

Ambient air quality monitoring during the operational activities of the Kunciran - Batu Ceper - Cengkareng toll road has been carried out twice:

- July 25, after 54 days of the toll road operating,
- September 13, after 166 days of the toll road operating.

The ambient air quality observed includes noise, dust particles, carbon monoxide (CO), Hydrocarbon (HC), Nitrogen Dioxide (NO_2), Sulfur Dioxide (SO_2), Oxidants (O_2) and Lead (Pb). Ambient air quality testing was carried out at six sample test locations, there are Cipete, Banjar Wijaya, Pembangunan, Belendung, Halim PK and Box AMD.

The results of ambient air quality noise during the Initial and Environmental Monitoring Plan (RPL) are as in Table 12.

Table 12. Noise Intensity at RPL

No.	Location	Initial Hue dB (A)	July 25		September 13	
			Test 1 dB (A)	Test 2 dB (A)	Test 1 dB (A)	Test 2 dB (A)
1	Cipete	54,3 - 79,8	72,5	72,7	70,5	70,9
2	Banjar Wijaya		72,5	72,4	72,2	72,5
3	Pembangunan		71,0	71,4	70,4	70,6
4	Belendung		71,4	71,6	62,5	62,5
5	Halim PK		74,8	74,8	73,6	73,6
6	Box AMD		68,1	68,6	63,4	63,5

***Source:*:** *RKL/RPL Toll Road Kunciran-Cengkareng Jasamarga Project*

2. Noise measurement by Environmental Laboratory

Noise intensity measurement during the research was conducted by the Environmental Laboratory as a comparison of noise measurements that had been carried out previously with noise predictions/forecasts using the CoRTN model and air quality monitoring during the Environmental Monitoring Plan (RPL) after the toll road was operational.

The measurement was carried out by the environmental laboratory of PT. Envirolab Nusantara which is certified by KAN No. LP-744-IDN. Field data collection was carried out for 24 hours starting at 07.00 Western Indonesian Time on November 4, until 07.00 Western Indonesian Time on November 5. The location of the noise collection was outside the toll road at Sta. 38+630 or Km. 12+750. The results of noise intensity measurements carried out by the Environmental Laboratory are as in Table 13.

Table 13. Noise Intensity based on Measurement of Environmental Laboratory

No.	Time	Cengkareng - Kunciran dB (A)	Kunciran - Cengkareng dB (A)
1	07.00 - 09.00	78,40	84,10
2	10.00 - 14.00	77,30	83,40
3	15.00 - 19.00	82,10	80,70
4	20.00 - 22.00	81,20	82,40
5	23.00 - 24.00	82,00	84,10
6	01.00 - 03.00	62,40	64,10
7	04.00 - 07.00	52,80	57,40
Noise Intensity Average		73,74	76,60

Source: *Research*

3. Comparison of Noise Intensity Measurement Results

The results of noise intensity measurements carried out using the CoRTN model and the Sound Level Meter tool obtained different results due to possible meteorological factors, there are wind speed and wind direction which can affect propagation factors and other possibilities that can affect the data collection process with direct calculations using a Sound Level Meter (SLM).

The sound captured by the SLM is not only the sound coming from motor vehicles but all sounds that can be captured by the sensor on the SLM. This is certainly different from the noise prediction of the CoRTN model which only predicts sounds coming from motor vehicles while meteorological factors are ignored. Comparison of noise intensity measurement results as in Table 14.

Table 14. Comparison of Noise Intensity

No.	Description	Initial Hue dB (A)	Noise Intensity	
			Cengkareng - Kunciran dB (A)	Kunciran - Cengkareng dB (A)
1	**Model CoRTN**	54,3 - 79,8		
	a. Research		48,93	50,09
	b. BUJT Kun - Ceng Data		49,55	49,68
2	**Sound Level Meter**			
	a. RPL. Banjar Wijaya		72,20	72,50
	b. Enviromental Laboratory		73,74	76,60

Source: *Research*

D. Noise Barrier Construction Evaluation

The measurement of noise intensity with the CoRTN model resulted in smaller results compared to measurements with the Sound Level Meter. The measurement of noise intensity during the Environmental Monitoring Plan (RPL) was not much different from the research (Environmental Laboratory), which was an average of above 72 dB (A).

Based on the Decree of the Minister of Environment no. KEP-48/MENLH/11/1996 and the Regulation of the Minister of Health no. 718/MENKES/PER/XI/1987 starting that the noise level for housing and settlement areas is 55 dB (A), then the existence/procurement of noise barrier construction that coincides with the Banjar Wijaya Residential on the Jasamarga Kunciran Batu Ceper Cengkareng toll road is appropriate.

CONCLUSIONS

Based on the analysis of the research findings, the following conclusions can be drawn:

1. The pattern of vehicle movement on the JKC toll road varies between morning, afternoon, and evening, due to differences in travel purposes, time-related needs, and the types of goods being transported.
2. The noise intensity values predicted using the CoRTN model are lower than those obtained through direct measurements using a Sound Level Meter (SLM).
3. The installation of noise barriers along the Jasamarga Kunciran–Batu Ceper–Cengkareng toll road, particularly near the Banjar Wijaya residential area, is considered appropriate.

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