Research Paper

International Journal of Research and Review
[Indexed, Peer-Reviewed Journal]
Volume 13; Issue: 7; July 2026
Website: www.ijrrjournal.com
E-ISSN: 2349-9788; P-ISSN: 2454-2237

Effect of Artificial Barrier Distance on Traffic Noise Levels along Ir. P. M. Noor Road, Sungai Ulin, Banjarbaru

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DOI: https://doi.org/10.52403/ijrr.20260736

ABSTRACT

Traffic noise is a pervasive form of environmental pollution along urban road corridors. This study evaluated the effect of artificial-barrier distance on traffic noise levels along Ir. P. M. Noor Road in Sungai Ulin, Banjarbaru. Field observations were conducted under two conditions—without a barrier and with a plywood barrier—at distances of 0, 10, 20, 30, and 40 m. Measurements were performed from 06:00 to 18:00 local time. Traffic volume was recorded simultaneously with A-weighted noise levels measured using a sound level meter. Descriptive statistics and regression analysis were used to compare noise attenuation and quantify the relationship between traffic volume and noise. Without a barrier, the mean noise levels at 0, 10, 20, 30, and 40 m were 78.49, 75.45, 72.88, 69.70, and 65.48 dB, respectively. With the barrier, the corresponding means decreased to 75.18, 72.36, 64.20, 63.45, and 55.51 dB. The 40 m configuration produced the lowest observed level and a reduction of 9.97 dB relative to the no-barrier condition at the same distance, or 19.67 dB relative to the barrier configuration at 0 m. The relationship between traffic volume and noise was strong, with coefficients of determination ranging from 0.848 to 0.856. These findings indicate that combining adequate separation distance with a solid artificial barrier can substantially reduce roadside noise exposure. A barrier distance of approximately 40 m is recommended where land availability and site conditions permit.

Keywords: traffic noise, artificial barrier, traffic volume, sound level meter, Banjarbaru

INTRODUCTION

Noise is generally defined as unwanted sound that, depending on its intensity and duration, may disturb human health, communication, concentration, rest, and environmental comfort. In urban areas, road-traffic noise is among the most frequently encountered environmental stressors because vehicle movements occur continuously and at high intensity throughout the day. Consequently, noise control is an important component of environmental-quality management in densely traveled corridors.

Motor vehicles generate noise through several mechanisms, including engine operation, tire–pavement interaction, acceleration and braking, horn use, and exhaust systems. The resulting roadside level is affected not only by the number of vehicles but also by vehicle class, engine characteristics, driver behavior, road-surface condition, and operating speed. Heavy vehicles generally emit greater acoustic energy, whereas a large motorcycle share increases the frequency of individual noise events.

Growing population mobility and economic activity increase travel demand and traffic volume on urban roads. Although this movement supports passenger mobility and freight distribution, it also produces externalities such as congestion, air pollution, crashes, and noise. On roads serving schools, offices, commercial areas, and residential neighborhoods, noise commonly increases during morning and evening peak periods. A reliable assessment therefore needs to consider both temporal variability and traffic volume.

Ir. P. M. Noor Road in Sungai Ulin, Banjarbaru, connects parts of North and South Banjarbaru and passes through areas characterized by residential and commercial activity. Buildings and roadside users are therefore directly exposed to fluctuating traffic flows. The road function, adjoining land use, and peak-hour demand make this corridor relevant for evaluating traffic-noise propagation and mitigation.

Preliminary measurements without a barrier indicated a mean level of 78.49 dB at the road edge. Levels remained high at 10 and 20 m, reaching 75.45 and 72.88 dB, respectively. Comparable roadside studies in Banjarmasin reported high near-road noise and a gradual decrease as the receiver moved farther from the traffic stream (Wulandari et al., 2017). Distance is therefore an important attenuation mechanism, although distance alone may be insufficient to achieve acceptable acoustic conditions.

Noise may be controlled at the source, along the propagation path, or at the receiver. Increasing the separation between the roadway and a sensitive receiver reduces the acoustic energy reaching the receiver in an open environment. A wall, fence, or other solid structure can further interrupt the direct sound path, causing diffraction and reflection before the sound reaches the protected area.

The performance of an artificial barrier depends on its position relative to the source and receiver, as well as its height, length, material, continuity, and surrounding geometry. Poorly configured barriers provide limited attenuation because sound can pass over the top, around the sides, or through gaps. This study therefore investigated how barrier distance influenced measured traffic noise along Ir. P. M. Noor Road and identified a practical configuration for roadside mitigation.

METHODS

Study Location and Observation Design

The study was conducted along Ir. P. M. Noor Road, Sungai Ulin, Banjarbaru. The observation segment was selected because it represented daily traffic conditions, had a relatively level horizontal alignment, and was not directly influenced by an intersection within the principal measurement zone. Data were collected on a weekday from 06:00 to 18:00, with observations recorded at 10-minute intervals. Two conditions were examined: an unobstructed condition and a condition with an artificial barrier positioned at 0, 10, 20, 30, and 40 m relative to the observation configuration.

Instruments and Variables

A sound level meter was used to measure A-weighted sound pressure levels in dB(A). Traffic was counted simultaneously and classified into motorcycles, light vehicles, and heavy vehicles, after which the counts were converted into passenger-car units per hour (pcu/h). The artificial barrier was a plywood panel measuring 1.20 × 2.40 m, 9 mm thick, supported by a timber frame. Barrier distance was treated as the independent variable, while the measured noise level was the dependent variable. Simultaneous traffic and acoustic observations enabled consistent interpretation of time-dependent variation (Sam, 2012; Heriyatna, 2017).

Data Analysis

Noise and traffic-volume data were tabulated by time interval and distance. Mean noise levels were calculated to compare unobstructed and barrier conditions. Several regression forms were evaluated to describe the relationship between traffic volume and noise, and the best-fitting model at each distance was selected using the highest coefficient of determination (R^2). Results were interpreted using the environmental reference values applied in the source study and the Indonesian noise-assessment guideline Kep-48/MENLH/11/1996.

Table 1. Data collection and analysis stages

Stage	Main activity	Output
1	Preliminary survey and selection of measurement points	Site conditions, geometry, and equipment layout
2	Traffic-volume recording	Vehicle counts by class and pcu/h
3	Simultaneous SLM and traffic survey	Noise level for each 10-minute interval
4	Barrier installation at different distances	Noise data for 0–40 m configurations
5	Descriptive and regression analysis	Noise-reduction comparison and traffic–noise models

RESULTS AND DISCUSSION

Road and Traffic Characteristics

The investigated segment was a two-lane, two-way undivided road (2/2 UD) with asphalt pavement in good condition. The surrounding environment contained moderate residential and commercial activity. Buildings located close to the road increase the need for traffic-noise control because receivers are exposed directly to the traffic stream (Doelle, 1990).

During the 12-hour unobstructed survey, 37,502 vehicles were recorded. Motorcycles accounted for approximately 61%, light vehicles for 28%, and heavy vehicles for 11%. The morning peak occurred at 07:10–07:20 with 470.7 pcu/h, whereas the highest afternoon volume occurred at 16:30–16:40 with 492.2 pcu/h. This pattern reflects school, commuting, and return-trip activity commonly observed in urban mobility systems (Adisasmita, 2012).

Table 2. Summary of traffic volume without a barrier

Period	Peak time	Volume (pcu/h)	Interpretation
Morning	07:10–07:20	470.7	School and work departure activity
Afternoon	16:30–16:40	492.2	Return trips and inter-area movement
Lowest	06:10–06:20	107.5	Before the main daily activity peak

Noise Levels without a Barrier

Noise levels remained high at every observation point under the unobstructed condition, although they declined as the receiver moved farther from the source. Mean levels at 0, 10, 20, 30, and 40 m were 78.49, 75.45, 72.88, 69.70, and 65.48 dB, respectively. The natural decrease of 13.01 dB between 0 and 40 m demonstrates the role of geometric spreading and propagation loss in open space (Saenz & Stephens, 1986). Nevertheless, the 40 m mean remained above the more stringent 55 dB benchmark adopted for sensitive environmental assessment.

Table 3. Mean noise level without a barrier

Distance from road edge (m)	Without barrier (dB)	Status relative to 55 dB
0	78.49	Above
10	75.45	Above
20	72.88	Above
30	69.70	Above
40	65.48	Above

Noise Levels with an Artificial Barrier

Installing the barrier reduced the mean level at every distance. The measured means were 75.18 dB at 0 m, 72.36 dB at 10 m, 64.20 dB at 20 m, 63.45 dB at 30 m, and 55.51 dB at 40 m. The larger decreases at 20 and 40 m suggest that the source–barrier–receiver geometry more effectively interrupted the direct sound path at these positions (Saenz & Stephens, 1986). Relative to the unobstructed condition at the same distance, the reductions were 3.31, 3.09, 8.68, 6.25, and 9.97 dB. The attenuation did not increase linearly with distance. This variability may reflect receiver position, diffraction, environmental reflections, and the vehicle mix during each measurement period (Suastawa, 2015).

Table 4. Mean noise level with an artificial barrier

Barrier distance (m)	With barrier (dB)	Reduction vs. no barrier (dB)	Status relative to 55 dB
0	75.18	3.31	Above
10	72.36	3.09	Above
20	64.20	8.68	Above
30	63.45	6.25	Above
40	55.51	9.97	Near benchmark

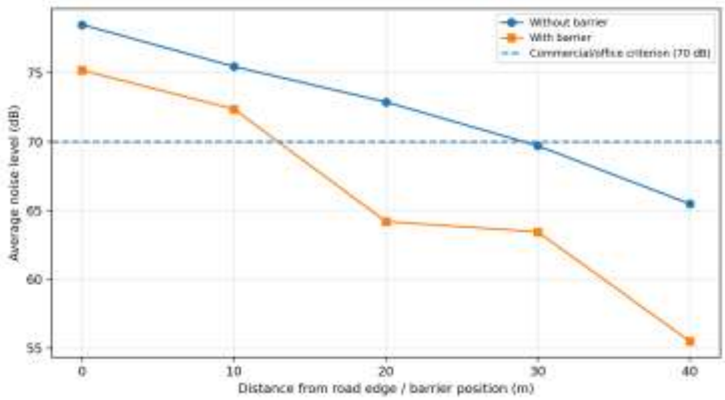

Figure 1. Comparison of mean noise levels without and with an artificial barrier.

Effect of Barrier Distance

Barrier positions at 0 and 10 m did not reduce the mean noise level below the stringent 55 dB benchmark. At 20 m, the level decreased markedly to 64.20 dB, but it still remained above 55 dB. The additional reduction from 20 to 30 m was only 0.75 dB, indicating that indirect propagation and reflections continued to influence the received sound.

The lowest mean level occurred at 40 m. The value of 55.51 dB was 19.67 dB lower than the barrier condition at 0 m and 7.94 dB lower than that at 30 m. Most hourly observations at 40 m were approximately 53–58 dB. Thus, this configuration approached the 55 dB target more closely than any other tested arrangement.

Relationship between Traffic Volume and Noise

Regression analysis showed a strong association between traffic volume and noise at every tested barrier distance. R^2 values ranged from 0.848 to 0.856, indicating that approximately 84.8–85.6% of the observed noise variation could be explained by changes in traffic volume. Similar relationships have been reported for other Indonesian road corridors (Sam, 2012). Remaining variability may be associated with vehicle composition, speed, pavement condition, meteorology, and surrounding building form (Doelle, 1990).

Table 5. Best regression models for the traffic-volume–noise relationship

Distance (m)	Best model	R^2	Interpretation
0	Daytime polynomial: $y = 0.000092x^2 - 0.0166x + 70.302$	0.854	Very strong
10	Daytime polynomial: $y = 0.00019x^2 - 0.0899x + 79.366$	0.853	Very strong
20	Afternoon exponential: $y = 56.096e^{(0.0004x)}$	0.848	Very strong
30	Exponential: $y = 48.717e^{(0.001x)}$	0.856	Very strong
40	Exponential: $y = 45.873e^{(0.0006x)}$	0.850	Very strong

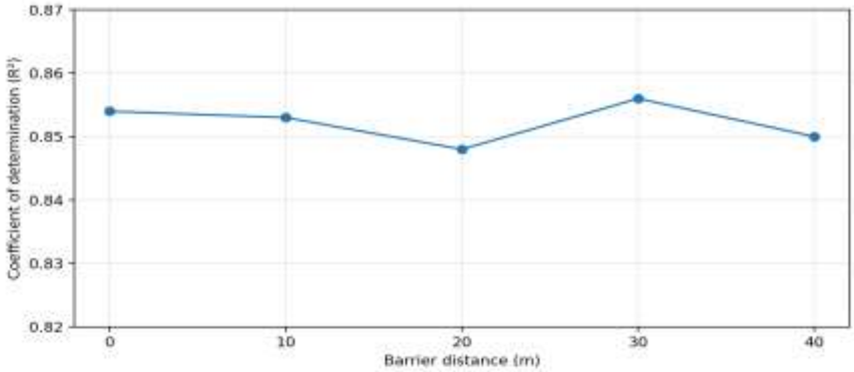

Figure 2. Coefficient of determination at the tested barrier distances.

The figures were developed from the survey data to summarize the magnitude of noise reduction, the temporal dynamics observed during the day, and the association between traffic volume and measured noise. Ten-minute observations were aggregated to support interpretation of the principal patterns.

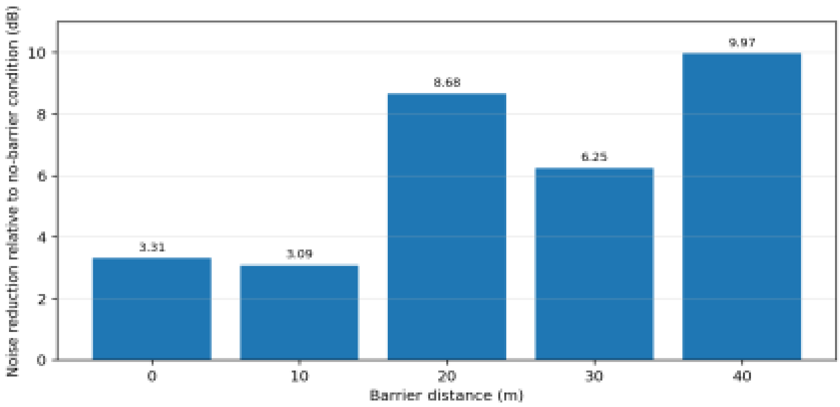

Figure 3. Noise reduction produced by the barrier at each tested distance.

Figure 3 shows that barrier-induced reduction generally increased with distance, although the trend was not linear. The largest reduction relative to the unobstructed condition at the same location occurred at 40 m (9.97 dB). This result is consistent with the principle that barrier effectiveness depends on source geometry, propagation path, and receiver position (Saenz & Stephens, 1986).

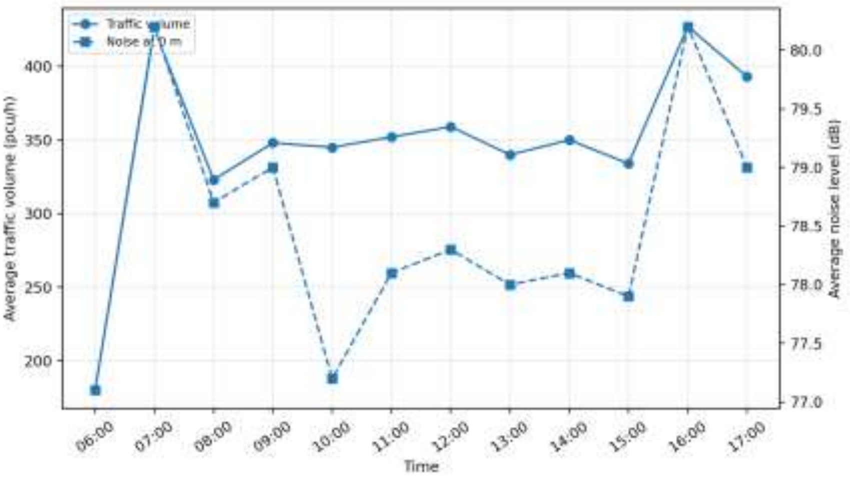

Figure 4. Temporal pattern of traffic volume and noise without a barrier.

The temporal comparison shows that increases in noise at the road edge generally coincided with higher traffic volume in the morning and afternoon. The most critical intervals were observed around 07:10–07:20 and 16:30–16:40. This pattern supports previous findings that traffic activity is the dominant driver of short-term road-noise variability (Balirante et al., 2020).

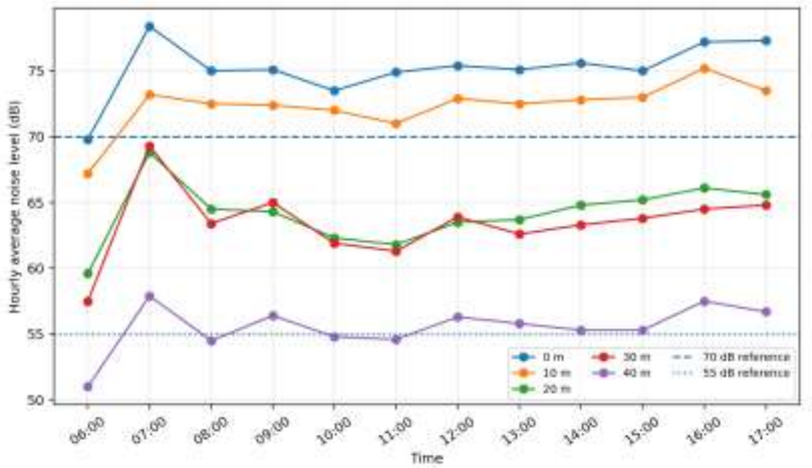

Figure 5. Hourly mean noise levels for the tested barrier distances.

Noise levels at 20, 30, and especially 40 m were lower than those at 0 and 10 m during most of the observation period. The contrast became more evident when traffic volume was high, indicating that a barrier can meaningfully reduce peak-hour exposure. For greater attenuation, a solid barrier should be integrated with the local site configuration and, where appropriate, vegetation and building-envelope measures (Suastawa, 2015).

Integrated Interpretation of Distance and Barrier Effects

Distance and a physical barrier acted as complementary control mechanisms. Without a barrier, the mean noise level decreased from 78.49 dB at 0 m to 65.48 dB at 40 m, a natural attenuation of 13.01 dB. With a barrier at 40 m, the mean decreased further to 55.51 dB. This combined effect is consistent with outdoor sound-propagation theory, in which the direct path is interrupted and the receiver is farther from the source (Saenz & Stephens, 1986).

At 0 and 10 m, the mean levels with a barrier remained 75.18 and 72.36 dB, respectively. These values indicate that placing the tested barrier very close to the road was insufficient to achieve a low-noise environment. A pronounced improvement occurred at 20 m, and the 40 m configuration yielded the greatest overall benefit.

The findings are comparable with those reported for Belitung Darat Road in Banjarmasin, where high roadside noise declined with increasing receiver distance (Wulandari et al., 2017). Similar urban characteristics in South Kalimantan make the comparison relevant and emphasize the need for a transition zone or setback between heavily traveled roads and sensitive buildings.

Traffic Composition, Peak Periods, and Noise

Under the unobstructed condition, motorcycles dominated the 37,502 vehicles observed over 12 hours. Frequent acceleration, braking, and exhaust events from motorcycles contributed to a high rate of acoustic events (Pristianto, 2016). Light and heavy vehicles also generated noise through engine output, tire–pavement interaction, and gear changes (Balirante et al., 2020).

The regression coefficients were consistently high: 0.854 at 0 m, 0.853 at 10 m, 0.848 at 20 m, 0.856 at 30 m, and 0.850 at 40 m. A barrier reduced the level reaching the receiver but did not remove the traffic source itself. This distinction explains why the temporal pattern remained visible at all distances.

Two critical peaks were identified. The morning peak occurred at 07:10–07:20 with 470.7 pcu/h, and the afternoon peak occurred at 16:30–16:40 with 492.2 pcu/h. Source-oriented measures—such as speed management, heavy-vehicle restrictions, enforcement against non-compliant exhaust systems, and horn-use control—could complement the physical barrier, particularly during these periods (Pristianto, 2016; Sam, 2012).

Barrier Effectiveness and Design Implications

The non-linear reduction pattern indicates that distance alone does not determine performance. Barrier location, diffraction around the edges, indirect sound paths, local reflections, and traffic composition can all modify the measured outcome. The 20 and 40 m configurations performed particularly well relative to the immediately adjacent distances.

The results support the provision of wider setbacks or transition zones between the road and noise-sensitive buildings. A distance of about 20 m may provide a substantial initial reduction, but the measured mean remained above 55 dB. For residential buildings or other uses requiring higher acoustic comfort, a larger separation approaching 40 m combined with a solid barrier is preferable where feasible.

In established areas where a 40 m setback cannot be provided, receiver-side strategies are required. These include more massive exterior walls, double-glazed windows, controlled openings oriented away from the road, and placement of bedrooms, classrooms, or workspaces on the protected side of the building. Dense vegetation can improve visual quality and function as a transition element, but it should not be treated as a complete substitute for a continuous solid barrier.

Limitations and Further Research

The results should be interpreted in relation to the specific site, measurement period, and barrier material used. Barrier height and length, material absorption, wind direction and speed, air temperature, humidity, vehicle speed, and surrounding building geometry were not isolated as independent variables. Further research should test additional dimensions and materials, combine walls with vegetation, and integrate meteorological and vehicle-composition data into predictive models.

Table 6. Barrier effectiveness based on the field data

Distance (m)	Without barrier (dB)	With barrier (dB)	Reduction (dB)	Interpretation
0	78.49	75.18	3.31	Above 55 dB
10	75.45	72.36	3.09	Above 55 dB
20	72.88	64.20	8.68	Above 55 dB
30	69.70	63.45	6.25	Above 55 dB
40	65.48	55.51	9.97	Closest to 55 dB

Integrated Mitigation Strategy

The strong and consistent traffic–noise relationship indicates that physical barriers should be combined with traffic management. Appropriate measures include speed control, heavy-vehicle restrictions, disciplined horn use, vehicle-roadworthiness enforcement, and route diversion during the busiest periods (Sam, 2012).

In developed corridors, a wall or a wall–vegetation combination may be installed along the boundary of residential areas (Umiati, 2012). The 40 m configuration in this study produced the best overall result and may inform setback planning and the placement of sensitive rooms farther from the roadway.

Any 40 m recommendation must be adapted to local land availability, access requirements, drainage, sight distance, road safety, and building morphology. Where this distance is impractical, increasing barrier height, using higher-insulation materials, installing double glazing, and improving internal room arrangement may provide supplementary protection.

The experiment covered one field setting and one barrier type. Future studies should compare barrier height, length, thickness, surface density, and absorptive treatment and should explicitly model speed and the contribution of each vehicle class.

Temporal Pattern and Peak-Hour Periods

Daily noise variation followed traffic-volume fluctuation. School and work trips began to increase after approximately 06:30, reached a morning peak between 07:00 and 08:00, and rose again in the late afternoon because of return trips, commercial activity, and inter-area movement.

Without a barrier, noise responded directly to higher traffic volume, and the road-edge point recorded the largest levels during the busiest periods. During the early morning and mid-day, levels were lower but remained dominated by motor-vehicle activity.

The temporal pattern was still visible with the barrier, but its magnitude was reduced, especially at distances of 20 m or more. The barrier therefore functioned as passive attenuation rather than source elimination and should be paired with measures that reduce noise generation at peak times.

Table 7. Interpretation of noise patterns by period and barrier distance

Observation condition	Morning (06:00–08:00)	Mid-day (08:00–15:00)	Afternoon (15:00–18:00)
Without barrier	Early peak; high near-road noise	Relatively stable volume; noise remains measurable	Highest peak; return-trip contribution
Barrier at 0–10 m	Limited reduction	Frequently high	Peak-related increase remains visible
Barrier at 20–30 m	Substantial reduction, but above 55 dB	More stable than near-road points	Peak periods still require attention
Barrier at 40 m	Lowest and most stable values	Noise is comparatively controlled	Approaches the 55 dB benchmark

Evaluation of Noise Reduction by Configuration

Moving the barrier from 10 to 20 m produced the largest intermediate improvement (8.16 dB), whereas the change from 20 to 30 m produced only 0.75 dB. The 40 m configuration produced another major improvement of 7.94 dB relative to

30 m. These changes confirm that attenuation depends on the relative source–barrier–receiver geometry and on diffraction and reflection, not merely on a uniform increase in distance.

The 40 m configuration yielded the most substantial improvement and the lowest modeled background level. This finding supports locating sensitive land uses farther from major traffic flows when new road corridors or developments are planned.

Table 8. Change in noise level between successive barrier distances

Comparison	Noise-level change (dB)	Technical note
0 to 10 m	−2.82	Initial reduction; still well above 55 dB
10 to 20 m	−8.16	Largest intermediate decrease
20 to 30 m	−0.75	Transition zone; added distance provides limited benefit
30 to 40 m	−7.94	Most effective final configuration
0 to 40 m	−19.67	Largest overall reduction

Compliance with Environmental Reference Values

The assessment used 55 dB as a stringent environmental benchmark, while 70 dB was retained in the original comparative chart as the commercial/office criterion. Under the no-barrier condition, every distance remained above 55 dB. With the barrier, levels at 20 and 30 m were reduced substantially but remained above 55 dB, whereas the 40 m mean of 55.51 dB was very close to the benchmark.

For residential and other sensitive uses, reliance on a single mitigation measure is not advisable. A combined strategy involving a solid barrier, vegetation, setback distance, building orientation, controlled openings, and façade insulation will provide more reliable indoor and outdoor protection (Doelle, 1990; Suastawa, 2015).

Table 9. Mean noise levels relative to the 55 dB benchmark

Condition	Mean value (dB)	55 dB assessment	Implication
No barrier, 0 m	78.49	Not compliant	Highest exposure; priority mitigation required
No barrier, 20 m	72.88	Not compliant	Natural distance alone is insufficient
Barrier, 20 m	64.20	Not compliant	Substantial reduction, but additional control is needed
Barrier, 30 m	63.45	Not compliant	Improved protection outside the busiest periods
Barrier, 40 m	55.51	Near compliance	Best tested option; close to sensitive-use target

Recommended Barrier Application

An artificial barrier should be positioned at approximately 40 m where technical conditions and land availability allow. The design must account for safety, pedestrian accessibility, drainage, property access, and driver sight distance. In high-density areas, vegetation may be combined with the barrier to improve visual quality and the local microenvironment without replacing the primary acoustic function of the solid structure.

Where space is constrained, a 20 m separation may be adopted as a compromise because it provides a meaningful reduction, although the mean remains above 55 dB. Additional receiver-side protection is therefore necessary for housing, schools, health facilities, and workspaces that require high concentration.

Table 10. Technical noise-control recommendations by site condition

Site condition	Recommended strategy	Objective
Adequate land	Barrier at about 40 m with supporting vegetation	Achieve the largest tested reduction
Limited land	Barrier at about 20 m plus acoustically improved façade	Compensate for remaining exposure

Roadside housing	Orient sensitive rooms away from the road and control openings	Reduce exposure in bedrooms and study areas
High peak-hour demand	Barrier plus traffic management	Reduce both source emission and transmission
New development	Establish setbacks and acoustic land-use zoning	Prevent exposure at the planning stage

Planning and Infrastructure Implications

Traffic composition data can support targeted restrictions on heavy vehicles, logistics schedules, and alternative routes. Barrier performance will be more effective when source emissions are also managed through traffic operations.

For new development, a wider setback between the carriageway and buildings can serve as an acoustic buffer. The intervening area may accommodate green space, parking, pedestrian paths, drainage, and landscape elements. Vegetation is most effective when combined with a continuous solid barrier that blocks the direct sound path.

In existing built-up areas, improved building construction provides an important alternative. More massive external walls, better-controlled openings, and placement of primary rooms on the sheltered side can reduce exposure. Pavement maintenance and enforcement of vehicle-noise standards may also reduce noise at the source.

The recommendations must be adapted to the geometry and land use of each site. Results from Ir. P. M. Noor Road should not be generalized without local evaluation. Nevertheless, the study consistently shows that traffic-volume growth increases noise, whereas distance and a properly positioned barrier substantially reduce receiver exposure.

Roadside buildings directly facing the traffic corridor are at greatest risk. The measured 78.49 dB at 0 m demonstrates the need to prioritize physical protection and building-envelope design near the road. At intermediate distances, a barrier–vegetation transition zone can be applied, while farther locations can use open-space planning to enhance natural attenuation.

Noise-control planning should be integrated with road safety, accessibility, air quality, thermal comfort, pedestrian facilities, drainage, and lighting. Commercial buildings may place display areas toward the road and workspaces toward the rear, while residential buildings should avoid locating bedrooms and study rooms directly on the exposed façade.

Vehicle maintenance and pavement condition remain important. Damaged surfaces, non-compliant exhaust systems, and aggressive driving can increase noise even when traffic volume is unchanged. Effective urban-corridor management therefore requires an integrated combination of traffic engineering, vehicle enforcement, road maintenance, barrier design, and environmental planning.

CONCLUSION

Traffic noise along Ir. P. M. Noor Road was influenced by both receiver distance and the presence of an artificial barrier. Without a barrier, mean levels at 0, 10, 20, 30, and 40 m were 78.49, 75.45, 72.88, 69.70, and 65.48 dB, respectively. With the barrier, the corresponding means decreased to 75.18, 72.36, 64.20, 63.45, and 55.51 dB. Traffic volume had a strong relationship with noise, with R^2 values of 0.848–0.856. The barrier configuration at 40 m produced the lowest measured level and the largest overall attenuation, making it the most effective tested option. Where a 40 m setback is not feasible, a shorter separation should be combined with traffic management, an improved building envelope, and appropriate land-use planning to achieve better acoustic protection.

Declaration by Authors

Acknowledgement: None

Source of Funding: None

Conflict of Interest: No conflicts of interest declared.

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How to cite this article: Muhammad Syarif Syahputera, Muhammad Arsyad. Effect of artificial barrier distance on traffic noise levels along Ir. P. M. Noor Road, Sungai Ulin, Banjarbaru. *International Journal of Research and Review*. 2026; 13(7): 335-345. DOI: *https://doi.org/10.52403/ijrr.20260736*

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