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Railway Noise at Gubeng Station: Assessing Sources, Levels, and Health Implications for Passengers

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ABSTRACT

Rail transportation is a preferred mode of transport for the public due to its various advantages; however, it creates environmental issues in the form of noise pollution, which has the potential to impact health and comfort. This study aimed to measure the noise levels at Gubeng Station in Surabaya and analyze their compliance with applicable quality standards. Using an observational quantitative method, measurements were taken at 10 representative points within the station on April 17, 2025, employing a Sound Level Meter (SLM) in accordance with SNI 8247:2017. The results indicate that noise levels varied, with the highest value of 89 dBA in the train engine area, exceeding the safe limit for an 8-hour work exposure stipulated by Minister of Manpower Regulation No. 13/MEN/X/2011. The majority of measurement points, such as the departure platform (78.5 dBA) and the waiting room (77 dBA), also surpassed the environmental quality standard of 60 dBA regulated by Minister of Health Regulation No. 2 of 2023, although they remained below the Threshold Limit Value (TLV) for workers. Only the Old Gubeng waiting room (58.2 dBA) met the Ministry of Health standard. This study concludes that while the noise at Gubeng Station remains safe for workers regarding short-term exposure, the conditions have the potential to cause discomfort and health risks for passengers and the general public. Comprehensive mitigation measures, including the installation of sound dampeners, waiting room zoning, and the use of Personal Protective Equipment (PPE), are required to create a healthier and more comfortable station environment.

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INTRODUCTION

Rail transportation is a favored mode of transport among the Indonesian public due to its advantages of relatively low and affordable ticket prices compared to other land-based transportation options [(1)]. However, alongside these advantages, a significant environmental issue persists: the noise generated by railway operations. The impact of this noise is most acutely felt in residential areas situated near railway tracks, particularly in regions with intensive train traffic [(2)].

Noise has been proven to affect humans both physiologically and psychologically. Research indicates a positive correlation between the perception of noise and the level of work-related stress among employees (3), where the intensity of the noise influences the degree of that stress (4). Furthermore, noise levels also have a significant relationship with non-auditory health disturbances (5). Exposure to noise above 40 dBA can cause discomfort, while exposure above 65 dBA has the potential to induce more serious health impacts (5).

National regulations have established noise limits and control measures. The Minister of Manpower and Transmigration Regulation No. PER.13/MEN/X/2011 defines noise as unwanted sound from production tools or work equipment that impacts hearing impairment, with classifications such as constant, fluctuating, continuous, intermittent, impulsive, random, and impact noise (6). Meanwhile, Minister of Health Regulation No. 2 of 2023 stipulates that any building or business activity generating noise is obligated to minimize its impact to remain within the permitted threshold limit (7).

The Surabaya Gubeng Baru Station, constructed in 1990, features six railway tracks and services economy, business, and executive class train travel (8). Passenger traffic at this station experienced a significant increase from 1,045 thousand in 2011 to 1,525 thousand in 2012, and was projected to reach 2,693 thousand by 2022 (9). As one of the busiest stations in East Java with a high track density, the potential for noise at Gubeng Station is considerable. Based on these conditions, this study aims to measure the noise levels at Gubeng Station, Surabaya, and analyze their compliance with applicable noise quality standards.

METHOD

This study employed a quantitative method with an observational approach through environmental noise level measurement, referring to SNI 8247:2017 concerning the Measurement of Environmental Noise Levels. The instrument used was a digital Sound Level Meter (SLM) with Type 2 specifications, a measurement range of 30–130 dB(A), and an accuracy of ±1.5 dB. The instrument was calibrated using an acoustic calibrator prior to use to ensure measurement accuracy.

Measurements were conducted on April 17, 2025, at Gubeng Station, Surabaya, during daytime hours, taking into account peak passenger operational periods. Ten measurement points were established across locations representing primary activity areas, including: the passenger waiting room, platforms, train arrival zones, areas near train engines, and areas where trains are stationary. The sound pressure level (dB(A)) was measured at each point for a duration of 10 minutes, with readings taken at 5-second intervals in accordance with the SNI standard (10). Measurement data were recorded on an observation sheet, and the Leq (Equivalent Noise Level) value was subsequently calculated for each point.

Data analysis was performed by comparing the measurement results against the Threshold Limit Value (TLV) stipulated in Minister of Manpower and Transmigration Regulation No. PER.13/MEN/X/2011 and Minister of Health Regulation No. 2 of 2023 on Environmental Health. The results were compared descriptively to determine the compliance level of the noise at the research locations with the applicable quality standards.

RESULTS AND DISCUSSIONS

Noise measurement at Gubeng Station, Surabaya, was conducted at 10 points representing passenger activity and train operational areas. In addition to sound from trains (engines, horns, wheel-rail friction), noise sources also originated from road traffic adjacent to the station and public announcement (PA) system speakers. The Threshold Limit Values (TLVs) applied refer to Minister of Health Regulation No. 2 of 2023, which stipulates 60 dBA for railway station areas and 70 dBA for commercial/service areas, as well as Minister of Manpower Regulation No. 13/MEN/X/2011, which sets a TLV of 85 dBA for workers with an exposure duration of 8 hours per day.

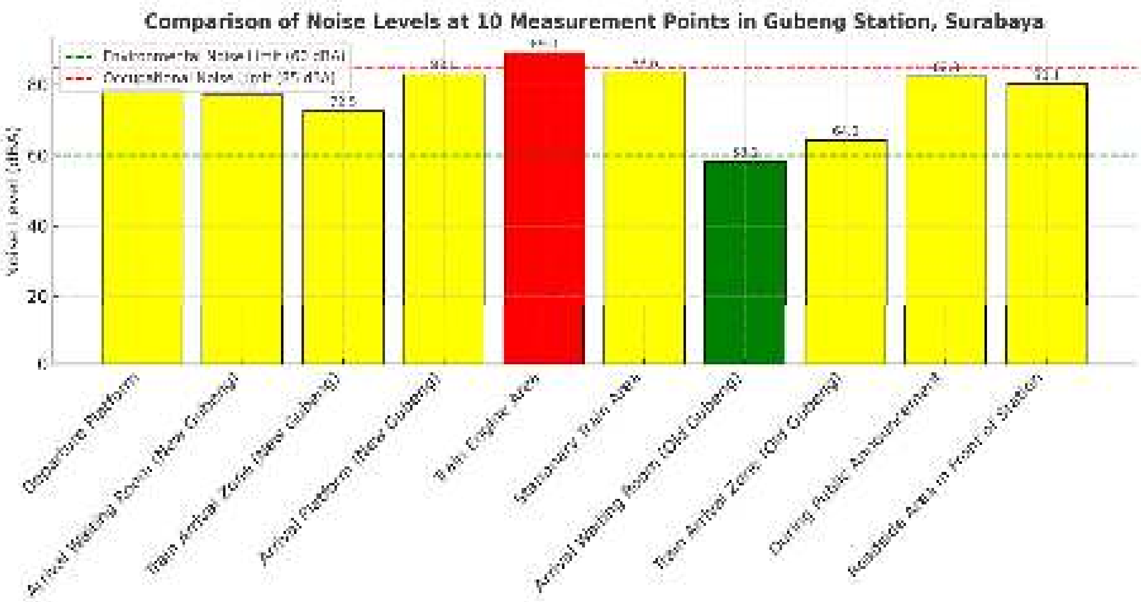
Table 1 Noise Levels at Gubeng Railway Station, Surabaya

No	Measurement Point	Noise Levels (dBA)
1	Departure Platform	78,5
2	Arrival Waiting Room (Gubeng Baru)	77,0
3	Train Arrival Zone (Gubeng Baru)	72,5
4	Arrival Platform (Gubeng Baru)	83,0
5	Train Engine Area	89,0
6	Stationary Train Area	83,6
7	Arrival Waiting Room (Gubeng Lama)	58,2
8	Train Arrival Zone (Gubeng Lama)	64,2
9	During Public Announcement	82,3
10	Roadside Area in Front of the Station	80,1

Source: Primary Data, 2025

As shown in Table 1, the train engine area recorded the highest noise level, reaching 89 dBA. This value has exceeded the safe exposure limit for an 8-hour work period as stipulated in occupational health regulations. Other areas with considerably high noise levels include the arrival platform and the stationary train area, each exceeding 83 dBA. In contrast, the arrival waiting room in Gubeng Lama was the quietest area, with a noise level of 58.2 dBA, which remains compliant with the permitted environmental standard for railway stations.

Graph 1 Comparison of Noise Levels at 10 Measurement Points in Gubeng Station, Surabaya



The measurement results reveal significant variations in noise levels across different station zones, which can be classified into operational and public areas. The zone with the highest noise levels was the operational area, particularly at the train engine point, which reached 89 dBA. This value directly exceeds the safe threshold for an 8-hour daily noise exposure, permitting a maximum of only 2 hours per day at such intensity levels [(6)]. Consistent exposure to noise above 85 dBA has been conclusively demonstrated to carry a high risk of causing permanent hearing damage or noise-induced hearing loss [(4)]. For technicians and train engineers working near train engines, this risk is particularly acute, given their recurrent exposure and extended work durations. Intense noise also triggers physiological and psychological responses such as increased heart rate, elevated blood pressure, and the release of stress hormones [(3, 4)], adversely affecting health and work productivity [(11)].

In the arrival platform area and when the train is stationary, the noise levels were also exceedingly high, reaching 83 dBA and 83.6 dBA, respectively. These values are very close to the Noise Exposure Limit (NEL) of 85 dBA for an 8-hour exposure period, indicating that station personnel and passengers waiting in this area are subjected to potentially hazardous noise levels during prolonged exposure. The elevated noise levels on this platform are attributed to a combination of sources, including the sound of idling train engines, wheel-rail friction, and braking noises. A similar study conducted at Tugu Railway Station in the Special Region of Yogyakarta also identified the platform and operational areas as the points with the most extreme noise levels, underscoring that this is a systemic issue pervasive throughout Indonesian railway transportation infrastructure [(14)].

Meanwhile, in public zones, such as waiting rooms and the departure platform, the noise levels also registered concerning figures. The departure platform recorded 78.5 dBA, while the Gubeng Baru arrival waiting room registered 77.0 dBA. Both of these values significantly exceed the 60 dBA threshold established by the Indonesian Ministry of Health Regulation (Permenkes). Noise at this level not only causes discomfort but also interferes with verbal communication, both among passengers and between passengers and station personnel. This phenomenon, known as the masking effect, renders important public announcements delivered via loudspeakers difficult to hear, potentially leading to confusion and even safety risks.

A striking contrast is observed in the Gubeng Lama arrival waiting room, which recorded the lowest noise level of 58.2 dBA. This value stands as the only one that remains within the permissible limit set by the Ministry of Health Regulation. This condition may be attributed to several factors, such as the station's differing architectural design, a greater distance from the railway tracks or primary noise sources, and the potential presence of natural or artificial barriers that function as sound dampeners. This finding serves as empirical evidence that noise control in a station environment is an achievable objective, and the existence of the Gubeng Lama waiting room can be used as a benchmark for the redevelopment of other areas.

The findings of this study have broad implications for health, safety, and comfort. The health impacts of noise, as explained by previous research, are not limited to hearing impairment. Exposure to noise above 40 dBA can trigger discomfort, while levels exceeding 65 dBA have the potential to induce more serious health effects [(5)]. The findings at Gubeng Station, where most areas exceed 65 dBA, confirm that all station users passengers, personnel, and vendors are at risk. A study by Hermawan (2020) indicated that exposure to railway operational noise carries a 3.47 times greater risk of causing health impairments compared to other noise sources [13]. This finding underscores the urgency for immediate mitigation measures.

From a safety perspective, the high noise levels, particularly on the platforms, can disrupt communication between the train engineer and station personnel. Furthermore, the sound of public announcements reaching 82.3 dBA indicates an existing effort to overcome the ambient noise. In accordance with the Indonesian Minister of Transportation Regulation No. 7 of 2022, the announcement volume must be 10 dB higher than the ambient noise level to ensure clarity. If the platform noise reaches 78.5 dBA, the announcement volume should ideally be increased to 88 dBA to be effective [12]. However, increasing the volume in this manner would also contribute to the overall noise burden, creating a vicious cycle of noise that is difficult to break. Consequently, more holistic solutions, such as noise suppression at the source, become more relevant than merely raising the volume of announcements.

Beyond merely being an issue of environmental health and safety, noise also impacts the overall user experience. Acoustic discomfort within the station can diminish the perceived service quality and passenger satisfaction. This has the potential to adversely affect the reputation of rail transport as a mode of travel. Conversely, for workers, constant noise can elevate job-related stress levels, which may ultimately impact their productivity and the quality of service they provide. A study by [Author's Name] found a positive correlation between the perception of noise and work-related stress levels, indicating that a higher degree of noise is directly proportional to an increased level of stress [3, 4]. This condition is directly experienced by personnel at Gubeng Station, particularly those assigned to platform duties and areas near the engine zone.

Based on the measurement results and the discussion presented, a series of systematic measures is required to control noise at Gubeng Station in Surabaya, as follows:

1. Noise Control at the Source

   Implementation of train engine silencers. As the point with the highest noise levels, the train engine must be a priority. Sound insulation technology and vibration dampers on engines can significantly reduce noise intensity. Modern sound-absorbing materials based on polymers or metal composites can be installed on engine cover panels without interfering with the cooling system.

   Implementation of rail and wheel dampers. Friction between the wheels and rails is a primary noise source. Technologies such as rail dampers or vibration-damping materials installed beneath the rails can absorb vibrational energy before it becomes sound, reducing noise by 5-10 dBA. Furthermore, regular maintenance of tracks and train wheels to ensure smooth surfaces can also mitigate noise.

2. Station Infrastructure Modifications

   Installation of Sound Barriers. The installation of sound barriers, such as solid concrete walls, along the railway tracks adjacent to passenger waiting areas and residential neighborhoods can be an effective solution. Concrete material is chosen due to its ease of construction, high sound-damping capability, and relatively low maintenance cost and durability [15].

Rearrangement of Waiting Rooms. Implementing a noise zoning concept by providing soundproof waiting rooms (quiet zones) in areas farther from the platforms can drastically improve passenger comfort. This design could emulate the success of the Gubeng Lama waiting room by incorporating acoustic materials on the walls and ceilings to absorb sound reflections.

Adaptive Public Announcement System. To address the masking effect issue, the public announcement system should employ adaptive technology capable of detecting real-time ambient noise levels and automatically adjusting the audio volume. This ensures information is heard clearly on the platforms without being overly disruptive in quieter waiting areas.

3. Operational Policies and Regulations

   Job Rotation and Use of PPE. For personnel working in noisy areas such as platforms and engine zones, station management must implement job rotation to limit noise exposure duration. Furthermore, the use of Personal Protective Equipment (PPE) in the form of earplugs or earmuffs should be mandatory and strictly enforced to protect their hearing [14].

   Periodic Monitoring and Auditing. A program for periodic noise monitoring across all station areas is essential to ensure that noise levels remain within safe limits and to evaluate the effectiveness of the mitigation measures that have been implemented.

Overall, the findings of this study not only identify the noise problem at Gubeng Station, Surabaya, but also provide a robust scientific foundation for formulating targeted solutions. The multifaceted impact of noise—ranging from hearing impairment and work-related stress to passenger discomfort—demands a comprehensive approach involving technology, infrastructure design, and operational policies. The implementation of these recommendations would contribute significantly to creating a healthier, safer, and more comfortable station environment, thereby supporting the sustainability of railway transportation in the future.

CONCLUSION

Based on the research findings, the noise levels at Gubeng Station in Surabaya generally still comply with the Threshold Limit Value (TLV) regulated by the Indonesian Minister of Manpower Regulation No. 13/MEN/X/2011, which is 85 dBA for a daily exposure of 8 working hours. However, although they remain below this occupational limit, most areas of the station exceed the 60 dBA environmental quality standard for station areas set by the Indonesian Minister of Health Regulation No. 2 of 2023, and even surpass the 70 dBA threshold for commercial and service zones. This indicates that while the noise may be considered safe for workers regarding short-term exposure, the overall conditions are not ideal and hold the potential to cause significant discomfort and health risks for passengers and the general public who spend extended periods in this environment. This study successfully identified the primary noise sources at Gubeng Station Surabaya and compared them against applicable standards, thereby providing an accurate depiction of the acoustic conditions in a high-activity station. Its primary contribution lies in providing specific and up-to-date empirical data to serve as a scientific basis for formulating noise mitigation policies and technical recommendations. The proposed solutions such as the implementation of sound dampeners, waiting room zoning, the use of Personal Protective Equipment (PPE), and periodic noise monitoring are expected to serve as a practical reference for creating a healthier, safer, and more comfortable station environment for all users in the future.

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