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Evaluation of Noise Levels at AT-Taqwa Mosque in Beru, Sikka Regency, East Nusa Tenggara (NTT)

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ABSTRACT

In designing the function of a space, there are several important aspects to consider, one of which is acoustic quality that affects comfort and the building's resistance to sound. One type of building that requires good acoustic conditions is a mosque, as a place of worship for Muslims that needs a quiet atmosphere with low noise levels and even sound distribution, with a maximum noise limit of 55 dB. This study focuses on a mosque located in the city center of Maumere, which is used as the observation object to assess its acoustic quality. The sound sources observed are from outside the building and their influence inside the building. The method used in this study is a quantitative approach, through observation and measurement using a Sound Level Meter (SLM), which includes literature study, field observation, and analysis. The results of the observation and measurement show that the noise level in the mosque does not meet the standards set for places of worship. The lowest noise point was detected on the north side of the building, at 66.2 dB(A), caused by several walls that function as noise barriers and reduce the noise level compared to other points.

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1. INTRODUCTION

Noise pollution is an increasingly significant environmental issue, particularly in public spaces such as mosques. High noise levels can disrupt the comfort and concentration of worshippers during their prayers [1, 2]. This study aims to measure and analyze noise levels in the mosque and assess their impact on congregational comfort. Previous research indicates that noise can affect both mental and physical health, highlighting the importance of understanding and managing noise factors in places of worship [3, 4].

In the context of Masjid At-Taqwa Beru, multiple factors influence noise levels, including the mosque's location, surrounding community activities, and prayer times. Masjid At-Taqwa was selected as the case study due to its strategic position adjacent to Jalan Umur, a main road heavily trafficked by motor vehicles such as cars and motorcycles. This condition results in noise levels around the mosque that exceed the permissible noise standard for worship places, which is 55 dB(A). Elevated noise levels directly affect the comfort and solemnity of worshippers, especially in the main prayer hall, which ideally should remain quiet and peaceful.

Moreover, the mosque's structural design poses specific challenges to noise reduction. The use of walls and open iron fences approximately 2 meters high is insufficient to effectively dampen external noise from the road, providing an opportunity to examine how architectural and building engineering elements influence sound penetration from the highway into the prayer space.

This research presents significant novelty by conducting specific noise measurements and analyses at several strategic points within the mosque premises, including outside the fence, the terrace, and the main prayer hall. The study also highlights a direct correlation between traffic activity on the highway and the acoustic conditions inside the mosque, an aspect seldom explored in detail within local contexts.

Beyond technical measurements, the study adopts a multidisciplinary approach integrating civil engineering, architecture, and environmental science to provide practical and context-sensitive solutions to noise management in places of worship. This approach expands the scope beyond mere noise measurement to include environmental and architectural management tailored to real-world conditions.

Therefore, this research is highly relevant and crucial, aiming to contribute scientifically and practically toward addressing noise pollution at Masjid At-Taqwa. Ultimately, it is expected to enhance the comfort and devotion of worshippers amidst environmental challenges caused by heavy road traffic.

This study will implement systematic noise measurement methods to obtain accurate data. Previous research by Hossameldien [5] and Islam [6] demonstrates that noise at mosques can vary depending on the time and type of activity, so this study is anticipated to provide a clearer depiction of the situation in Sikka Regency.

The results are expected to offer recommendations for mosque managers and the surrounding community to create a more comfortable environment for worshippers. By understanding noise levels and influencing factors, mitigation measures can be developed to reduce the adverse effects of noise pollution. This study also contributes to the existing literature on noise in places of worship, as emphasized by Babere [7] and Ackah [8], who highlighted the importance of noise management to improve the quality of worship experiences.

According to the World Health Organization, prolonged exposure to noise exceeding 70 dB can cause hearing impairment and physiological stress [9, 10]. Meanwhile, the Indonesian Ministry of Environment and Forestry Regulation No. 56 of 2018 sets noise limits for residential areas at 55 dB during the day and 45 dB at night. Noise levels exceeding these thresholds may disturb community comfort [11].

Previous studies by Rinanti et al. [12] and others [13] show that noise from generators and public vehicles often constitutes external environmental noise. Additionally, other research finds that noise from industrial machinery and public buildings, including places of worship, can impact user and community comfort when poorly managed [14-16]. Research by Handoko et al. [17] confirms that soundproofing and appropriate room design can assist in reducing noise levels. Furthermore, studies in Makassar show that regular noise monitoring supports planning for noise control in public spaces [18].

Further investigations by Agustia [19] and Agus [20] reveal that excessive noise disturbs religious activities, especially prayers and other religious events. Other studies suggest that using sound-absorbing materials in worship space construction helps minimize noise effects from machinery [21, 22]. Therefore, this study will measure the noise levels at Masjid At-Taqwa Beru, Sikka Regency, NTT, to provide appropriate noise management recommendations suited to the surrounding conditions.

2. METHOD

This study uses a quantitative approach to evaluate the noise levels at the AT-Taqwa Mosque in Beru, Sikka Regency, NTT [23]. The research was conducted with field measurements using a Sound Level Meter (SLM).

Figure 1. Sound Level Meter was used as the measuring device (source: author)

The research procedure began with determining the measurement points and times, where noise measurements were conducted at specific hours, especially during worship activities, to obtain representative data.

Figure 2. The condition of the AT-Taqwa Mosque in Beru, Sikka Regency (source: author)

The AT-Taqwa Mosque in Beru is one of the Muslim places of worship located in Sikka Regency, precisely on Sultan Hasanudin Street, Beru Subdistrict, Maumere City, East Nusa Tenggara. This mosque stands majestically on a land area of 2,400 m², providing ample space for various religious and social activities of the local community.

The main building of the mosque covers an area of 288 m², which includes the main prayer area, the imam's room, and other supporting facilities. With a simple yet functional architectural design, the mosque can accommodate a considerable number of worshippers, especially during Friday prayers and religious holidays.

The AT-Taqwa Mosque building faces significant challenges regarding noise, particularly originating from the south side, which is the main road (Jalan Umur) that is a busy motor vehicle route. The mosque's location right on the edge of this busy road causes vehicle sounds, such as the roar of motorcycles and cars, to easily enter the mosque area, especially during peak hours. Although a permanent fence approximately 2 meters high has been built at the front, consisting of a combination of wall and iron, the fence does not significantly reduce noise because gaps in the iron still allow sound to pass freely, and the wall materials used are not designed as soundproofing. Noise from the east and west sides is relatively lower because it is blocked by a fairly massive school building, which serves as a natural barrier. However, in general, the materials and design of the fence, as well as the mosque's position facing directly onto the main road, make the interior area of the mosque still vulnerable to external noise disturbances, which can reduce the solemnity of worship, especially during congregational prayers and other religious activities (see Figure 2).

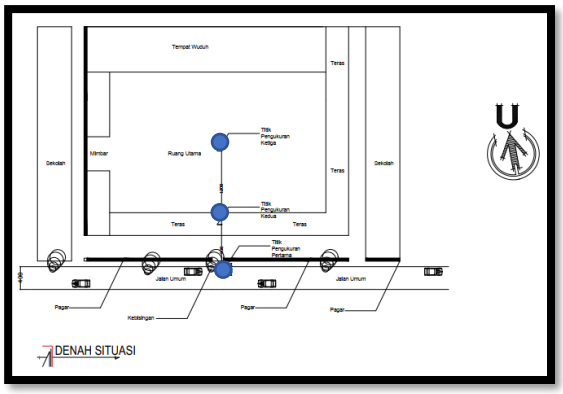

Figure 3. Designated measurement points (source: author)

Based on the situational layout of the AT-Taqwa Mosque in Beru, it can be explained that noise measurements were conducted at three strategic points to obtain a comprehensive picture of the sound intensity entering the mosque area, especially during busy times such as 14:00 WITA and peak traffic activity periods [24].

- Point 1 – In Front of the Fence (Outside the Mosque Fence Area)
  This point is located just outside the mosque fence facing south, towards Jalan Umur, which is a main road with quite heavy traffic. This point represents the external noise level from motor vehicles, including horn sounds, engines, and other street activities. Measurement here is important to understand the initial noise level before any barriers such as fences or buildings.
- Point 2 – Terrace Area (Inner Yard Near the Mosque Entrance)
  The second point is inside the mosque area, on the terrace or front yard directly adjacent to the main prayer room. This point represents the noise that has passed through the fence and shows how much

sound from outside manages to enter and be heard by worshippers in the mosque's open area. It also illustrates the effectiveness of the fence in dampening external noise.

- Point 3 – Main Prayer Room of the Mosque
  The third measurement point is inside the main prayer room of the mosque, where congregational prayers are held. This point is the most important because it shows the noise level that truly disturbs the solemnity of worship.

3. RESULTS AND DISCUSSION

Based on the noise measurements at three points in the vicinity of the AT-Taqwa Mosque in Beru, it can be concluded that the noise levels generally exceed the threshold limits set for places of worship. Referring to the noise quality standards table, which stipulates a maximum limit of 55 dB(A) for places of worship, all measurements taken at 14:00 WITA, coinciding with peak traffic hours, have surpassed this threshold.

Table 1. Noise Quality Standards Table

Land Use / Activity Environment	**Noise Level Limit (dBA)**
Land Use	
Residential and Housing	55
Trade and Services	70
Offices and Trade	65
Green Open Space	50
Industry	70
Government and Public Facilities	60
Recreation	70
Special:	
1. Airport*	
2. Train Station*	
3. Seaport	70
Activity Environment	
Hospital or similar	55
School or similar	55
Place of Worship or similar	55

At the first point, which is in front of the mosque fence, the noise level was recorded at 71.9 dB(A). This value is very high and comparable to the noise levels in trade and service areas or industrial zones according to the reference table, which are indeed characterized by dense traffic and high activity. This level indicates that the environment outside the mosque, especially the area directly adjacent to the public road, has a high sound intensity due to vehicle traffic [6, 25]. The noise penetrates into the mosque area despite the presence of a permanent fence 2 meters high. However, the fence is not effective enough in dampening the sound because most of its material is open iron, which actually allows sound waves to pass through easily [26, 27].

Figure 4. The condition of the Fence at the Mosque (source: author)

At the second point, which is the mosque terrace, the noise level decreased slightly to 70.9 dB(A), representing only a 1 dB reduction from the point outside the fence. This indicates that the fence material and the open terrace area do not play a significant role in sound attenuation. Additionally, the terrace's semi-open position without acoustic barriers allows external noise to enter with little obstruction [28]. The mosque terrace, which should ideally serve as a quiet transitional area before entering the prayer room, is still heavily affected by external noise [29, 30].

Figure 5. The condition of the terrace and materials used on the mosque terrace (source: author)

Meanwhile, the third point, located inside the main prayer hall of the mosque, shows a noise level of 66.2 dB(A). Although lower than the previous two points, this value still far exceeds the maximum threshold of 55 dB(A) for places of worship. Such noise levels can directly affect the concentration and solemnity of worshippers during prayers, sermons, or religious studies. According to references from the WHO and the Ministry of Environment, noise levels above 60 dB in worship spaces can cause mild psychological disturbances such as stress and difficulty concentrating, especially if experienced for prolonged and repeated durations [31].

The reduction in noise level measured at the third point, inside the main prayer hall, is due to the presence of structural elements such as walls that act as sound barriers. These walls can minimize the intensity of external noise, especially from the direction of the highway on the south side of the mosque. This sound attenuation function is more effective because the wall materials have sufficient mass and density to absorb and block sound waves from outside before they reach the interior space [32].

Additionally, the distance between the noise source and the measurement point inside the main hall also influences the noise level that enters. The farther the distance from the noise source, the weaker the sound energy reaching the interior due to wave attenuation during travel. Therefore, the combination of physical barriers in the form of walls and the distance from the noise source plays an important role in reducing noise levels entering the mosque's prayer space, making the interior atmosphere relatively quieter compared to the outside area [33].

From this analysis, acoustic treatment is very important to implement, including architectural and material interventions. Several references such as the Ministry of Environment Regulation No. 48 of 1996, WHO Environmental Noise Guidelines (1999), and studies from journals like Applied Acoustics and Building and Environment recommend the use of additional soundproofing elements such as vertical vegetation (green barriers), installation of acoustic glass, or ventilation improvements to prevent external noise from entering directly. Furthermore, rerouting heavy vehicle traffic or imposing speed limits in front of the mosque could be long-term policies advocated to local governments.

In conclusion, although the AT-Taqwa Mosque in Beru is strategically located in the center of a residential area and easily accessible to the community, its proximity to the main road negatively impacts the acoustic quality of the worship environment. The three measurement points show noise levels far exceeding acceptable limits for places of worship. This requires follow-up actions in the form of noise mitigation planning based on architectural design and environmental policies to maintain comfort and solemnity during worship at the mosque. If not addressed promptly, this noise disturbance could have long-term psychological and social effects on worshippers and the surrounding community.

4. CONCLUSION

From the analysis, acoustic treatment is very important to implement, including through architectural and material interventions. Several references such as the Ministry of Environment Regulation No. 48 of 1996, WHO Environmental Noise Guidelines (1999), and studies from journals like Applied Acoustics and Building and Environment recommend the use of additional soundproofing elements such as vertical vegetation (green barriers), installation of acoustic glass, or ventilation improvements to prevent external noise from entering directly. Furthermore, rerouting heavy vehicle traffic or imposing speed limits in front of the mosque could be long-term policies advocated to local governments to help reduce the noise levels.

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