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OVERVIEW OF MOTOR VEHICLE DENSITY IN RELATION TO NOISE LEVELS ON MALIOBORO STREET

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ABSTRACT

Overview of Motor Vehicle Density in Relation to Noise Levels on Malioboro Street. *Population growth can generate various activities that consequently lead to an increase in transportation facilities. This condition is closely associated with the high purchasing power of the community toward motor vehicles as a means of transportation. The increase in the number of motor vehicles has serious environmental impacts, particularly noise pollution. Noise is defined as unwanted sound generated by activities or operations at certain levels and durations that may cause disturbances, thereby interfering with and/or endangering human health. Traffic noise that exceeds permissible standards can result in negative impacts on people conducting activities around the noise source. In general, noise can adversely affect health, causing physiological, psychological, communication, balance disorders, and hearing-related effects. This study aimed to obtain information on noise levels along Malioboro Street in 2021. The research employed a descriptive observational survey design. The study was conducted along Malioboro Street, with samples collected at three observation points: Point I (Malioboro Sign Entrance Gate), Point II (in front of Taman Batik Terang Bulan Store), and Point III (Yogyakarta Zero Kilometer Point). Data collection was carried out for one week. The results showed that traffic density and noise intensity were directly proportional to the noise levels on Malioboro Street, with an average vehicle volume of 1,703.2 units/day and an average noise level of 70 dBA. The study concludes that most of the measurements exceeded the permissible noise standard for commercial and service areas, which is 70 dBA, across the three observation points per day.*

INTRODUCTION

The population of Yogyakarta City, based on the 2020 Population Census, was 373,589 people [(1)], with a population density of 388,627 people/km^2. Yogyakarta City serves as a center for various activities, including government administration, education, hospitality, tourism, and trade. Population growth can stimulate increased activities as well as the expansion of transportation facilities [(3)], which is closely associated with the high purchasing power of the community toward motor vehicles as a primary mode of transportation. Transportation demand can significantly affect the urban environment, particularly air pollution, while noise pollution becomes clearly evident during peak hours due to increased traffic flow and volume, namely in the morning (06:00–08:00) when people depart for their activities and in the afternoon (16:00–17:00) when they return home.

The increasing number of motor vehicles can have serious environmental impacts, especially noise pollution [4]. A rise in the number of passing vehicles leads to higher noise levels on road sections throughout Yogyakarta City. In addition to the number of vehicles, traffic volume also influences noise levels. This finding is consistent with previous research [5], which indicates that higher traffic volumes result in lower vehicle speeds, thereby generating higher noise levels, and vice versa.

During operation, motor vehicles generate various sounds, including engine noise emitted from exhaust systems, vehicle horns, and other sounds produced by mechanical activities of vehicle engines. At certain levels, these sounds can still be tolerated by the community, meaning they do not cause discomfort or other disturbances. However, at higher levels, the sounds produced by transportation vehicles can be classified as disturbances known as noise pollution.

Noise is defined as unwanted sound perceived by human hearing, characterized by multiple frequencies and amplitudes, and generally occurring at high frequencies [6]. Such noise can interfere with ongoing communication and may also cause psychological disturbances such as irritation, anxiety, and fear [7]. According to the Decree of the Minister of Environment of the Republic of Indonesia Number 48 of 1996 concerning noise quality standards, the permissible noise level for commercial and service areas is 70 dB. This regulation considers that one of the impacts of activities or operations that may disturb human health, other living organisms, and the environment is excessive noise exposure.

The high level of activity in Yogyakarta City, driven by increasing population mobility, contributes to noise pollution along various urban roads, including Malioboro Street. Noise frequently occurs on Malioboro Street because the Malioboro area is one of the main growth centers in Yogyakarta City and is considered the heart of the city [8]. The area is well known for its street vendors selling traditional Yogyakarta handicrafts, night-time food stalls offering local specialties such as gudeg, and as a gathering place for artists who express their talents through music performances, painting, happening art, pantomime, and other artistic activities [9]. Consequently, Malioboro has become one of the primary tourist destinations in Yogyakarta, attracting visitors both during the day and at night.

MATERIALS AND RESEARCH METHODS

This study employed a descriptive observational survey design, as no intervention was applied to the research object, using a cross-sectional approach. The study population comprised the entire stretch of Malioboro Street, which has an approximate length of 1.3 km and a road width of 11 m.

Figure 1. Sampling Point Locations

Source: Google Maps

The samples in this study were collected at three observation points, namely Point I (Malioboro Sign Entrance Gate), Point II (in front of Taman Batik Terang Bulan Store), and Point III (Yogyakarta Zero Kilometer Point). The study was conducted over a period of one week, with Monday to Friday representing weekdays and Saturday to Sunday representing weekends. Sampling was carried out at 07:00–09:00 representing morning hours, 09:00–11:00 representing midday hours, and 14:00–17:00 representing afternoon hours.
The research location covered the entire Malioboro Street area. The variables examined in this study were vehicle density and noise levels.

RESEARCH RESULTS AND DISCUSSION

Vehicle Volume

The calculation of the number of vehicles passing along Malioboro Street during the sampling period was distributed as follows:

Table 1. Number of Motor Vehicles Passing Along Malioboro Street

Day	Total Vehicles	Motorcycle (MC)	Light Vehicle (LV)	Heavy Vehicle (HV)
I	1.974	1.578	372	24
II	1.848	1.524	306	18
III	1.902	1.518	360	24
IV	1.848	1.434	396	18
V	1.848	1.416	414	18
VI	2.238	1.632	588	18
VII	2.046	1.464	570	12
Total	13.704	10.566	3.006	132
Average	1.957,71	1.509,5	429,4	18,85
SMP Mean Value	1.703,29	1.207,54	429,4	66,29

The number of vehicles passing along Malioboro Street during the sampling period showed a significant difference between weekdays and weekends. On the sixth and seventh days, representing the weekend, the number of passing vehicles exceeded 2,000 during the sampling times. Motorcycle traffic dominated, with a total of 10,566 vehicles passing during the observation period.

Noise Intensity

Table 2. Results of Noise Intensity Measurements on Malioboro Street

No	Day	Measurement Time	Point I	Point II	Point III	Average (dBA)
1.	I	07.00-09.00	68	69	67	70,78
		09.00-11.00	71	68	68	
		14.00-17.00	72	67	67	
2.	II	07.00-09.00	72	67	64	68,73
		09.00-11.00	80	66	69	
		14.00-17.00	-	70	68	
3.	III	07.00-09.00	67	70	67	71,78
		09.00-11.00	71	68	68	
		14.00-17.00	72	72	68	
4.	IV	07.00-09.00	68	68	68	71,69
		09.00-11.00	71	68	69	
		14.00-17.00	72	71	67	
5.	V	07.00-09.00	68	68	68	70,98
		09.00-11.00	69	69	69	
		14.00-17.00	69	70	69	
6.	VI	07.00-09.00	72	68	67	70,62
		09.00-11.00	72	71	67	
		14.00-17.00	72	71	68	
7.	VII	07.00-09.00	71	67	67	69,57
		09.00-11.00	71	71	69	
		14.00-17.00	71	71	68	
	Average		71,19	69,06	67,73	70,59

Based on the measurements presented in Table 3, the average noise intensity level on Malioboro Street was found to be 70.59 dBA per day.

Relationship Between Motor Vehicle Volume and Noise Intensity

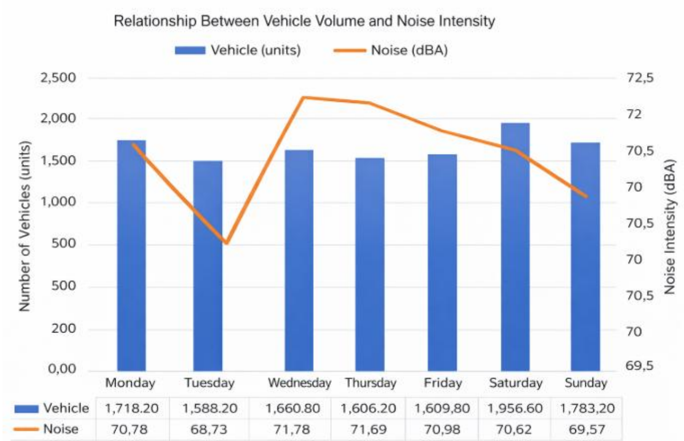

Figure 1. Graph of the Relationship Between Motor Vehicle Volume and Noise Intensity

Based on the information presented in Figure 1, the average number of vehicles passing along Malioboro Street was 1,703.2 units per day, consisting of motorcycles (MC) 1,207.5, light vehicles (LV) 429.4, and heavy vehicles (HV) 66.2 units/day. Traffic density and noise intensity on Malioboro Street were directly proportional, meaning that higher traffic volumes resulted in higher noise levels, and conversely, lower traffic volumes corresponded with lower noise levels.

Malioboro Street, based on its function, is classified as a local road serving local transportation, characterized by short-distance trips, low average speeds, and unrestricted access points [10]. The average daily vehicle volume of 1,703.2 units/day is considered lower than previous measurements on Malioboro Street due to data collection being conducted on non-holiday weekdays and during the COVID-19 pandemic, when large gatherings were restricted under the PSBB regulations.

In addition, noise on Malioboro Street is not solely generated by motor vehicles (engines, transmissions, exhausts, horns); other sources such as environmental noise, music, and commercial activities also contribute to the overall noise level, affecting the relationship between the noise source (road) and the receiver (nearby buildings). Environmental factors, including air temperature, humidity, and turbulence, also influence noise intensity.

As illustrated in Figure 1, the graph of traffic density and noise intensity indicates a clear relationship between vehicle volume and noise levels on Malioboro Street. When traffic volume decreases, noise intensity also decreases, and vice versa. This is consistent with the findings of Rahmatunnisa, F. G. (2017), which stated that higher traffic volume reduces vehicle speed, thereby producing higher noise levels. However, according to the graph, on Saturdays and Sundays, traffic density tends to be high, while noise levels are relatively lower compared to previous weekdays. This discrepancy may be due to the calculation method for daytime noise, which produces results that differ from the raw average noise data, where Saturday and Sunday noise levels were generally higher than other days.

Field observations showed that motorcycles (MC) were the most dominant type of vehicle on Malioboro Street, whereas light vehicles (LV) had the most significant impact on noise levels. This occurs because light vehicles (LV) affect traffic flow, causing congestion. Higher vehicle volume reduces speed and increases noise intensity, whereas lower vehicle volume allows higher speeds and lower noise intensity, as traffic density is directly proportional to noise levels. During peak hours, increased traffic volume also leads to higher noise levels.

In addition to light vehicles (LV), motorcycles (MC) also influence noise levels on Malioboro Street. When motorcycle volume increases, noise intensity rises, and vice versa [5]. The use of non-standard exhaust systems (e.g., racing mufflers) further increases noise levels. Conversely, heavy vehicles (HV) do not significantly affect noise intensity; even when HV volume increases, noise levels do not rise sharply. This is because heavy vehicles are relatively few and infrequent on Malioboro Street, mostly consisting of public transport buses (TransJogja), garbage trucks, and similar vehicles. Eddy Heriyatna (2017) also reported that the distance of measurement affects noise levels: at 0 meters, light vehicles (LV) influence noise more than motorcycles (MC), whereas at 17.5 meters, motorcycles (MC) have a greater impact than light vehicles (LV) [11].

Improving transportation infrastructure, such as prioritizing public transport, can reduce congestion and noise levels, keeping them below the noise standard. This allows Malioboro Street to have lower traffic density and reduced noise levels, while still providing access to visitors without requiring them to walk by using public transport. Urban planning improvements, such as evenly distributed vegetation or trees, can also serve as natural noise reduction alternatives. The type of vegetation matters; plants with thick, rigid leaves and dense foliage can effectively block sound propagation.

Effective noise-reducing plants can decrease noise levels by 10–15 dBA [13–14]. Examples include ground cover such as grass and legumes (Leguminosae), shrubs such as bamboo (Bambusa sp.), li kuan yu (Vernonia elliptica), Duranta repens, Ixora sp., Ficus pumila, Heliconia sp., and Durante species, as well as trees such as Acacia mangium, Casia siamea, and other dense, low-branched species [15–22]. Certain plants reduce noise by absorbing sound waves through leaves, branches, and twigs. Trees or shrubs with dense, thick canopies are the most effective, such as Felicium desipiens, Acalypha sp., Codiaeum variegatum, Oleina syzygium, Hibiscus rosa-sinensis, Bougainvillea sp., and Nerium oleander [15–22].

This is evident from data collection at Points 1, 2, and 3, where the highest vehicle density occurred at Point 3, yet the recorded noise level was lower than at Points 1 and 2. Point 3 has relatively more vegetation and trees than Points 1 and 2, demonstrating that vegetation can serve as an environmentally friendly noise-reduction alternative, providing aesthetic benefits while absorbing and dissipating sound energy. Plants arranged in dense, continuous rows can significantly reduce noise levels [23–27].

At Point 1, in addition to vehicle noise, train traffic near the station also contributed to noise levels. At Point 2, aside from passing vehicles, music and commercial activities contributed to the measured noise intensity.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results and discussion of the study on motor vehicle density and noise levels on Malioboro Street, Yogyakarta, it can be concluded that most noise measurements exceeded the environmental quality standard set by KepmenLH No.48/MENLH/11/1996. Out of three daily measurement points, noise levels in commercial and service areas reached 70 dBA, surpassing the allowable limit. Therefore, it is recommended that local authorities implement noise reduction measures, such as traffic flow management and restrictions on heavy vehicles in high-density areas, while ongoing monitoring and public awareness programs should be conducted to minimize the negative impacts of noise pollution on residents and visitors.

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