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Evaluating Variations in Traffic Noise Levels Concurrently with Traffic Volume on Kpakungu-Gidan Kwano Road

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Abstract:- Transportation represents a fundamental pillar of a nation's economic and overall growth. While its importance cannot be overstated, it also brings about adverse effects on the environment and human health, with noise pollution being one such negative consequence. This research is centered on examining the relationship between traffic density and fluctuations in noise levels. The study took place in the Kpakungu area of Minna city. Noise levels were measured using a sound level meter, and traffic counts encompassed various vehicle types, including two-wheelers, three-wheelers, four-wheelers, buses, and trucks. The findings revealed that the average noise level stood at 77dBA, exceeding the permissible standards established by Nigeria's environmental regulations enforcement agency. The study highlights that an increase or decrease in the number of vehicles does not necessarily lead to a corresponding rise or fall in noise levels. This lack of direct correlation arises from various factors such as traffic flow, horn usage, lane discipline, unauthorized parking, and the diverse mix of vehicles on the road. Minna city's traffic is characterized by heterogeneity, and a lack of adherence to lane discipline often leads to congestion, resulting in frequent horn honking. Consequently, traffic noise levels do not consistently align with traffic counts, and they may exhibit erratic fluctuations due to the aforementioned factors.

Keywords:- *Traffic Noise, Leq, Heterogeneous, Traffic Flow, Noise Level, Distance.*

I. INTRODUCTION

Noise pollution has long been a significant environmental concern for humanity, classified as 'unwanted sound.' It naturally induces stress due to disturbances caused by daily human activities (Stansfeld S A & Matheson M P, 2003). Noise pollution primarily emanates from various sources, including transportation, industrial activities, and residential areas. Transportation noise encompasses a wide range of sources, such as motorcycles, automobiles, aircraft, and rail transport. As the number of vehicles on the road increases, road traffic noise has become a pivotal factor in societal development and economic growth (Banerjee D, Chakraborty SK, Bhattacharyya S, and Gangopadhyay A, 2008). It has also emerged as a growing public concern, dominating both urban and rural acoustic environments, as reported by the World Health Organization. Exposure to noise can result in hearing impairment, sleep disturbances, reduced performance, cardiovascular effects, and disruptions in social behavior, including heightened aggression, protest, and decreased helpfulness.

Among various environmental stressors, noise generated by traffic stands out as a key source of annoyance. Research conducted in Montreal has revealed a connection between noise levels, highway traffic disruption, and overall environmental noise levels (Filho JMA, Lenzi A, and Zannin PHT, 2004). Several factors influence this noise, including the distance from the noise source. The proximity to the main road and the road type significantly predict noise disturbances (Fyhri A and Aasvang GM, 2010). Noise levels are markedly affected by the proximity to the noise source, with noise levels generally decreasing as distance increases. Traffic noise can also hinder speech communication and provoke irritation. Furthermore, it affects property values, leading to decreased work performance for individuals affected by noise (Pirreera S, Valck ED, and Cluydts R, 2010). High economic costs associated with healthcare for individuals affected by noise have propelled communities to seek solutions to enhance their quality of life by mitigating traffic noise. According to previous research (Ouis D, 2001), as shown in Figure 1, 73% of respondents identified traffic noise as the primary contributor to urban noise pollution. Typically, noise intensity is characterized by sound pressure levels measured in decibels (dB). Sound pressure levels represent the air vibrations constituting sound, referenced to a standard pressure roughly corresponding to the hearing threshold at 1000 Hz. Hence, sound pressure levels indicate the extent to which measured sound exceeds this hearing threshold. Most noise sources exhibit variations in sound pressure levels over time. Therefore, when calculating certain noise parameters, the instantaneous pressure fluctuations must be integrated over a specific time interval. To approximate the integration time of the human hearing system, sound pressure meters utilize a standard Fast response time, equivalent to a time constant of 0.125 seconds. Consequently, all measurements of sound pressure levels and their temporal fluctuations should be conducted using the Fast response time setting.

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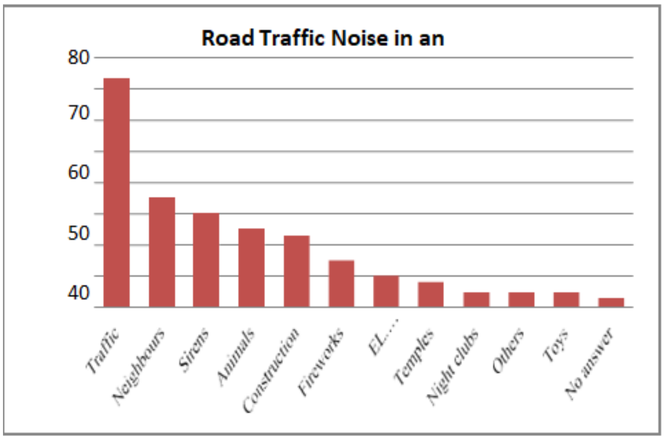

Fig 1 The Histogram of Road Traffic Noise in an Urban Setting

II. METHODOLOGY

➢ *Sound Level Meter*

A sound level meter is a fundamental requirement for measuring the noise levels. It is designed to estimate the sensitivity level of loudness for the human ear and gives the desired, reproducible measurements for the sound pressure level. To determine the frequency range, spectral weighting of sound, along with the function of time constants, and computation of the equivalent continuous level the sound level meter does more complex work. The block diagram of sound level meter is shown in Figure 3.2 which consists of a micro phone which acts as a transducer to convert the sound into its equivalent electrical signal. The magnitude of the electrical signal is small which comes out of the microphone and then this low electrical signal is amplified by a pre amplifier and output of which is connected to a frequency weighting network "A" or "C" and the output of filter is again amplified and is then given to an microcontroller which has an analog to digital converter which converts the analog signal to digital and then the output is given to a averaging system for data storage facility and then we have display unit which displays the desired noise levels in digital.

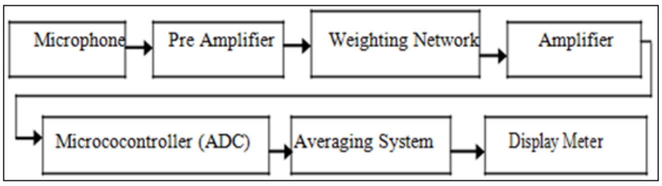

Fig 2 Block Diagram of Sound Level Meter

Fig 3 Installation of Sound Level Metre (SLM)

➢ *Methods*

Traffic flow and noise measurements were conducted simultaneously during the period from 07:30 AM to 07:30 PM, with measurements taken at 30-minute intervals. To minimize errors caused by sound reflections from the investigator's body, the sound level meter (SLM) was positioned at a height of 1.2 meters, close to the noise source, and placed at a distance of m from the roadside. An SLM, also known as a sound pressure level (SPL) meter, decibel (dB) meter, noise meter, or noise dosimeter, employs a microphone to capture sound. The device then assesses the sound and displays the measured sound values. The standard unit of sound measurement is the decibel (dB).

Fig 4 Location

Kpakungu is situated at latitude 9°35'55.00" N and longitude 6°32'00.00" E. Niger state is located between latitude 8°10' N and 10°30' N, and between longitude 3°30' E and 7°30' E. Kpakungu experiences a climate that combines characteristics of both dry and wet seasons, representing a hybrid of the climates typically found in northern and southern Nigeria. The region exhibits a gradual decrease in both the duration and amount of rainfall as one moves from the southern to the northern parts, with an average annual rainfall ranging from 110mm in the north to 1600mm in the south. The wet season varies in duration, spanning from 150 days in the north to 210 days in the south. Regarding air temperature, the area experiences relatively consistent conditions with seasonal variations. The mean temperature remains relatively stable throughout the year, but further information about the temperature was not provided.

III. RESULTS AND DISCUSSION

Based on the results of the traffic survey and noise level measurements conducted over a 12-hour observation period under normal weather conditions, the composition of vehicles in the study area was categorized into three main types: motorcycle vehicles (MC), light vehicles (LV), and heavy vehicles (HV). Furthermore, the traffic data has been processed into passenger car units per hour (pcu/hour), allowing us to describe the fluctuations in traffic flow, as illustrated in Figure 1.

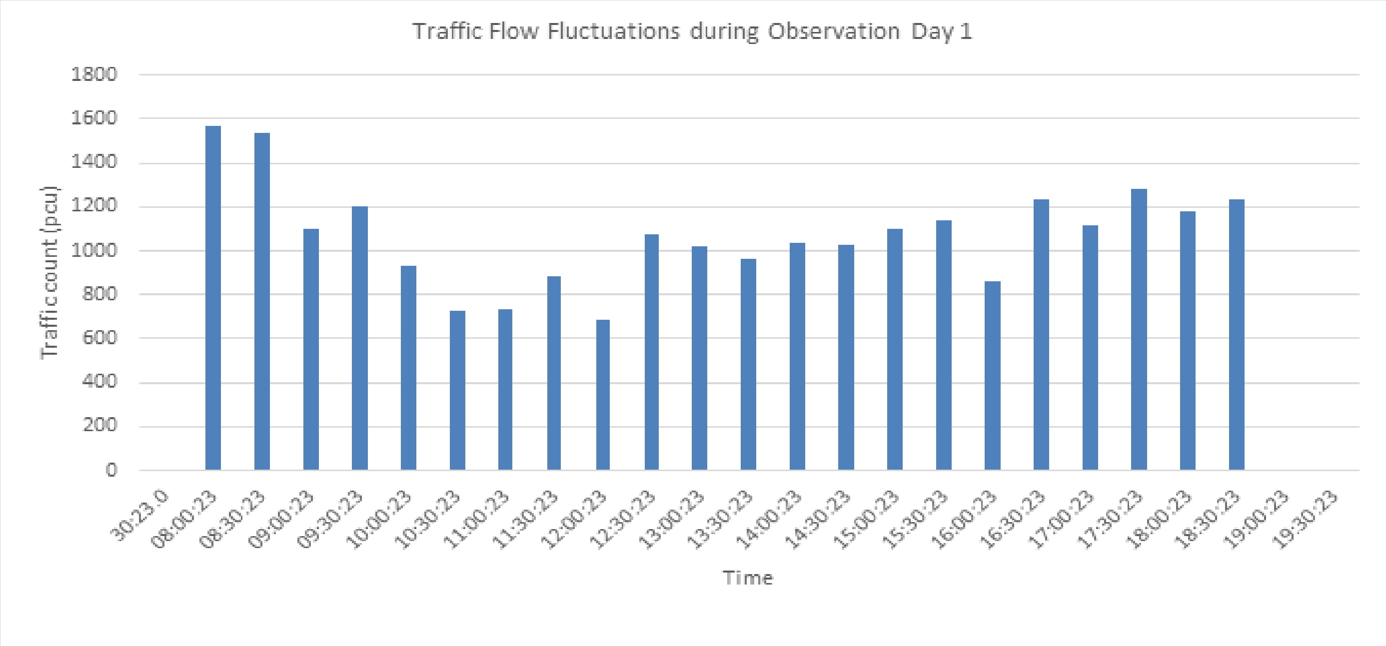

Fig 5 Traffic Count Against Time

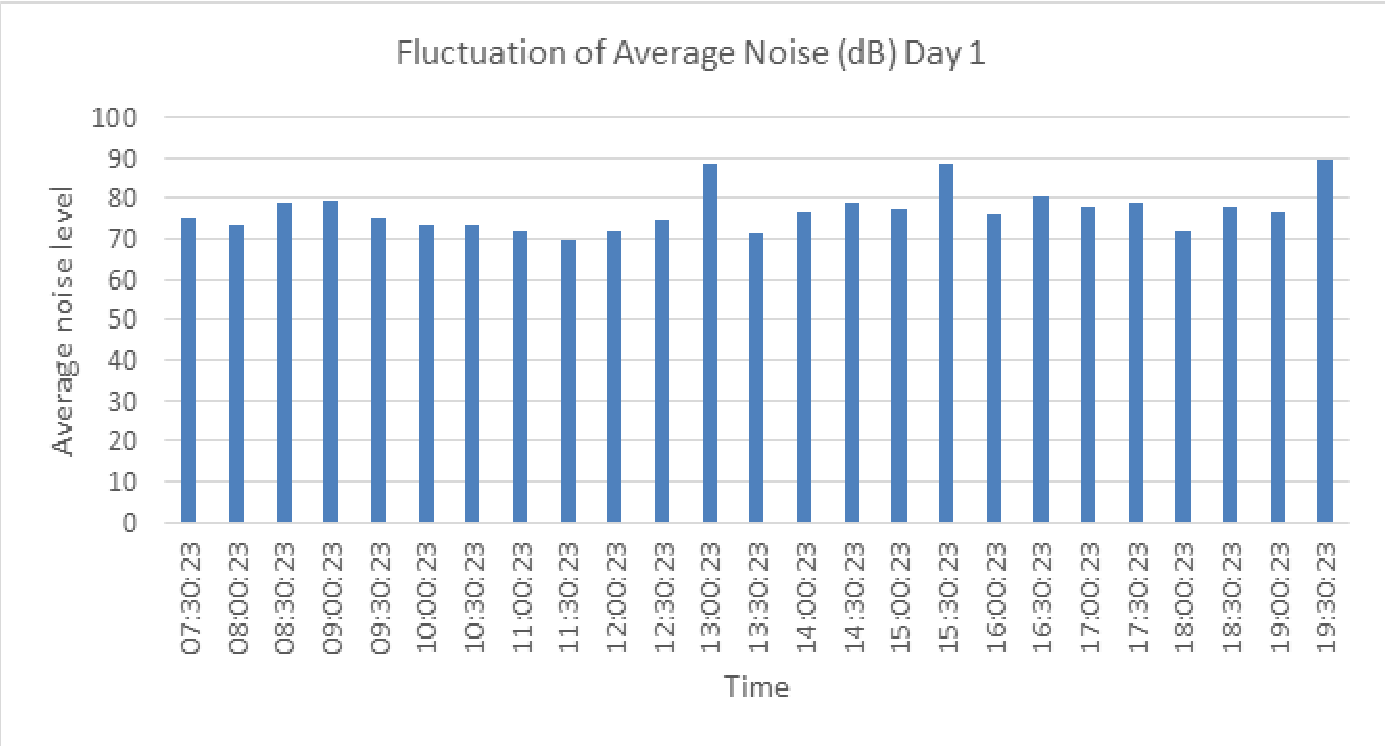

Fig 6 Average Noise Level Against Time

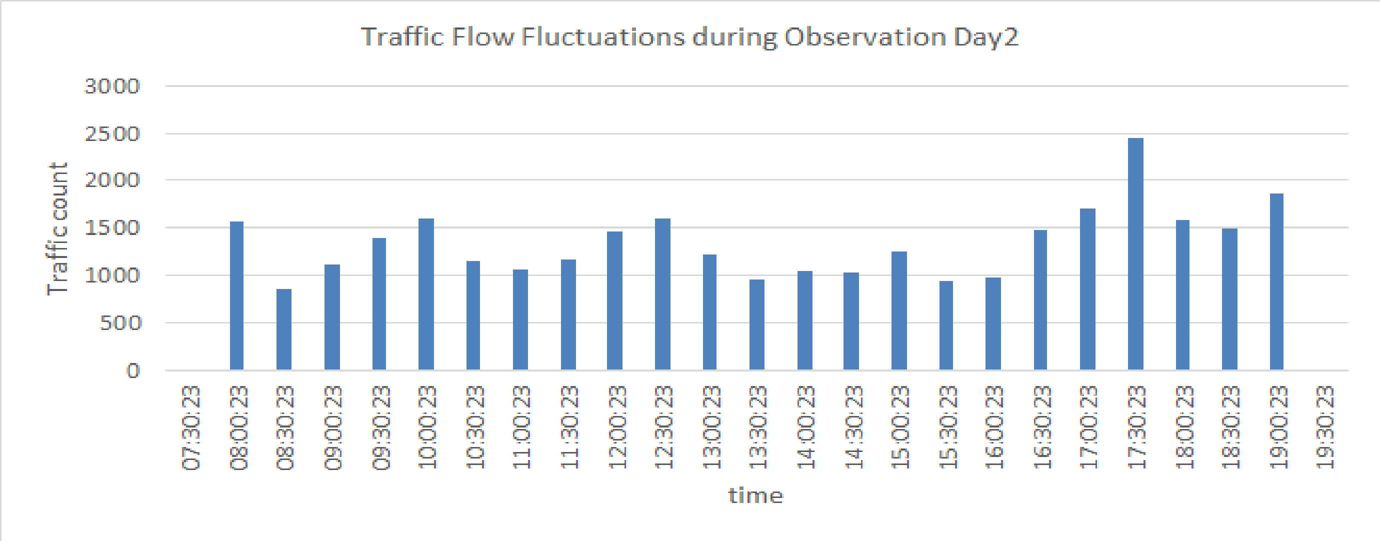

Fig 7 Trafic Count Against Time

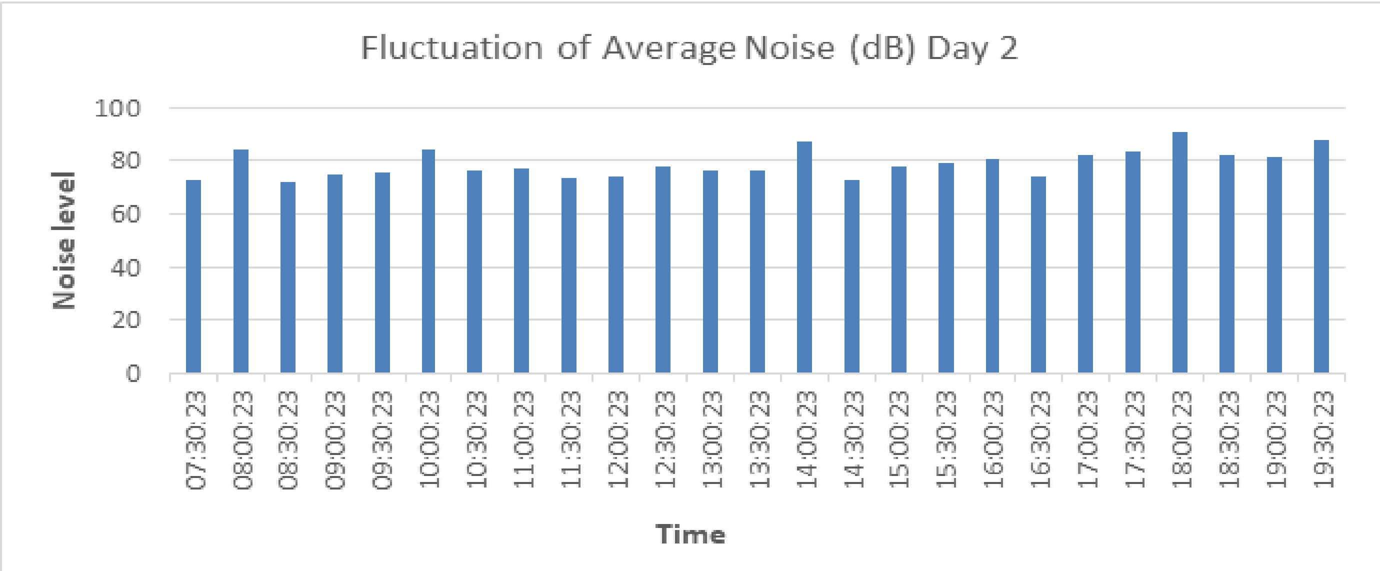

Fig 8 Average Noise Level Against Time

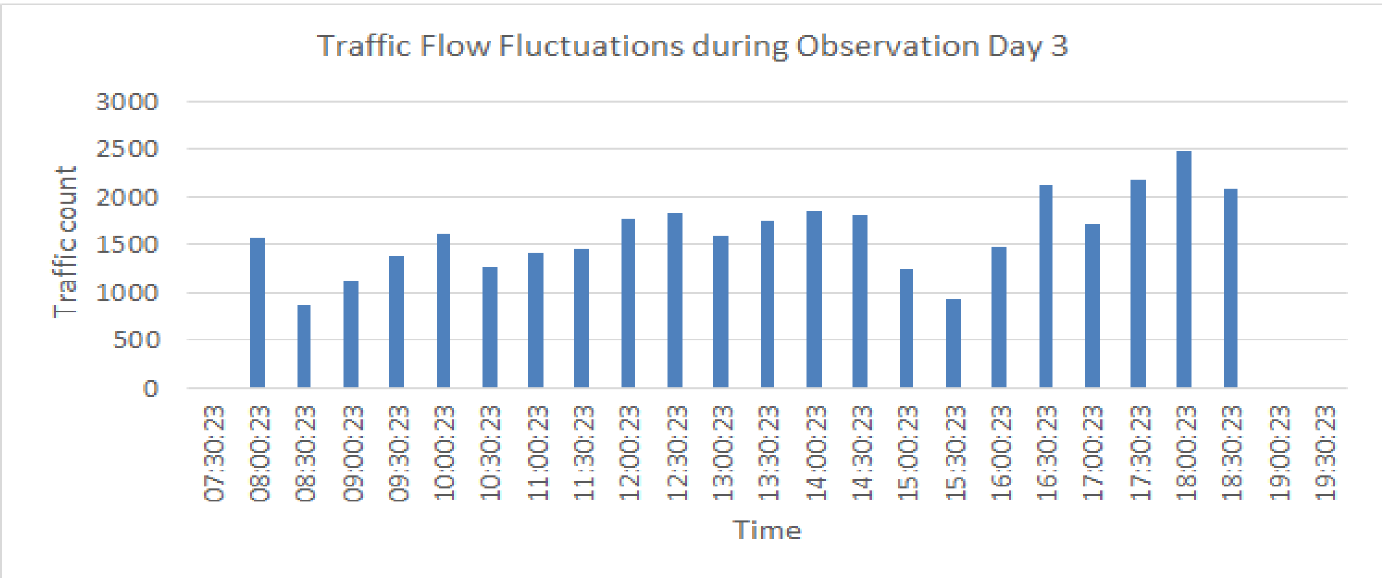

Fig 9 Traffic Count Against Time

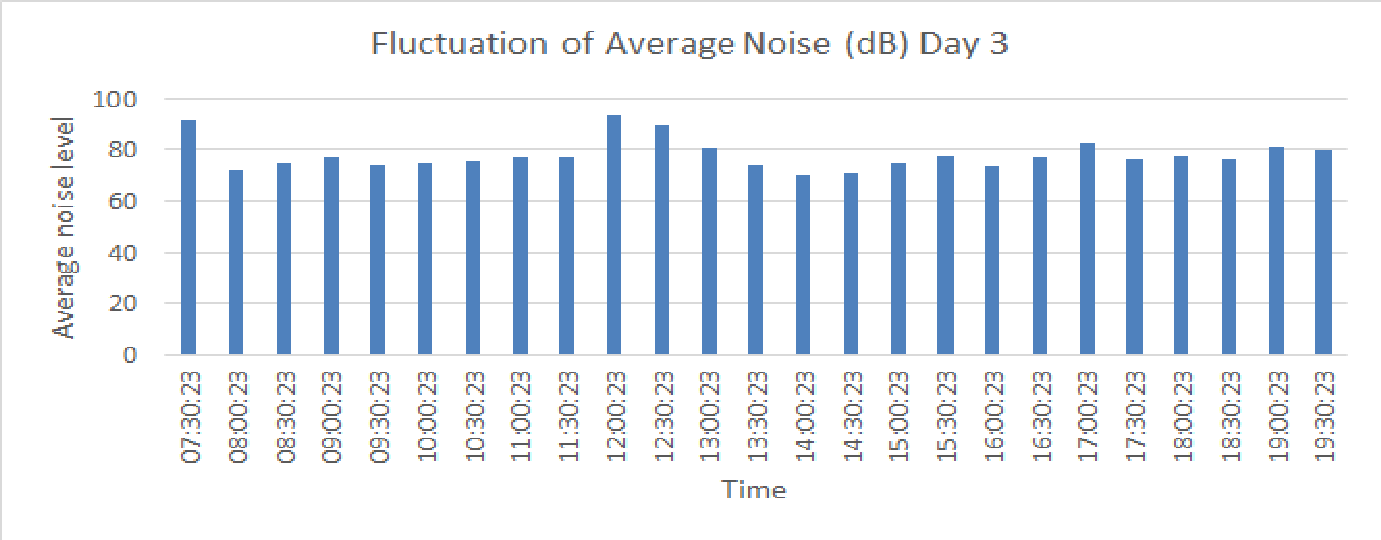

Fig 10 Average Noise Level Against Time

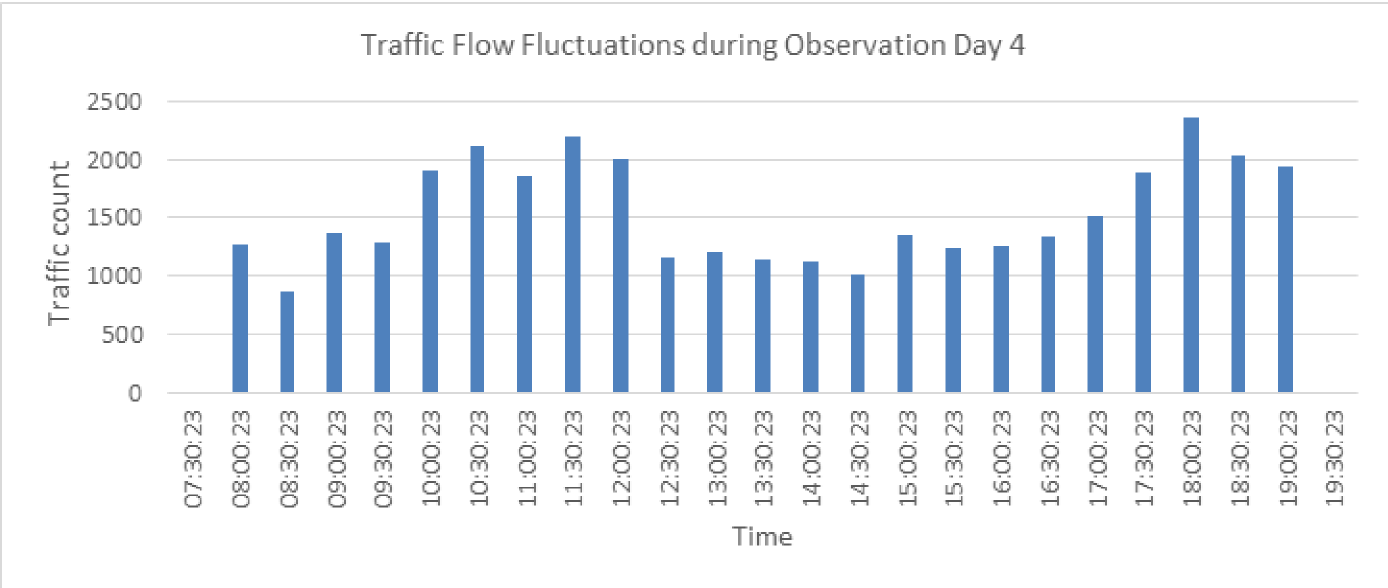

Fig 11 Traffic Count Against Time

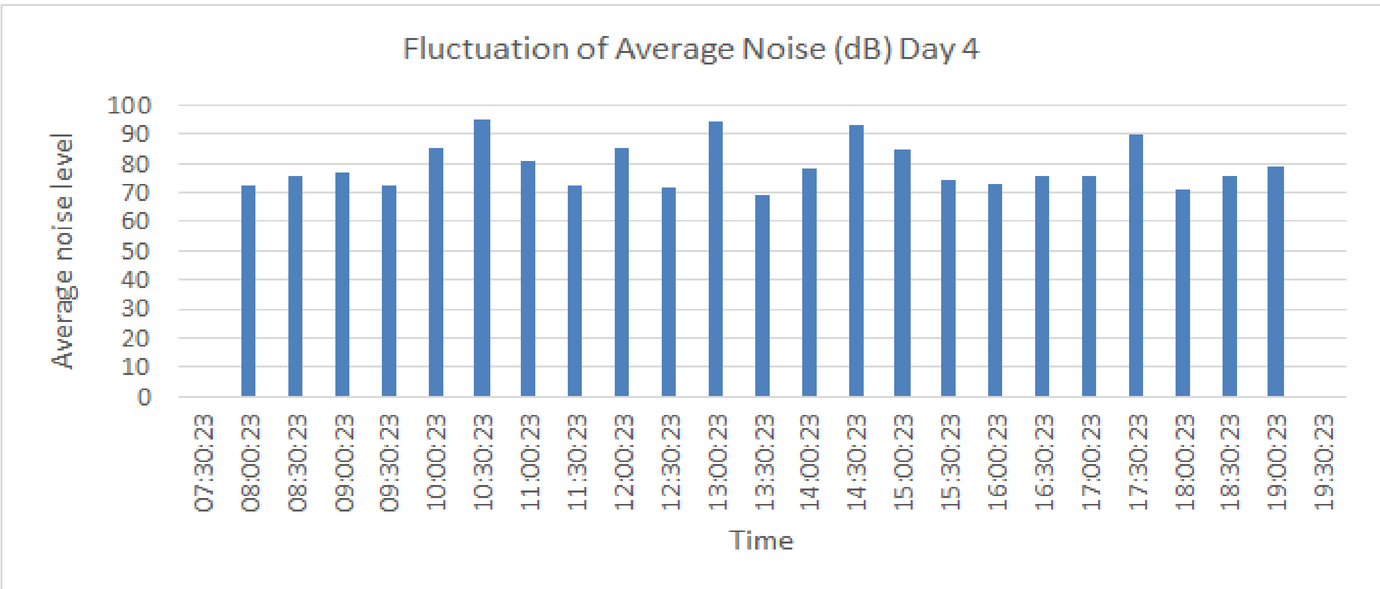

Fig 12 Average Noise Level Against Time

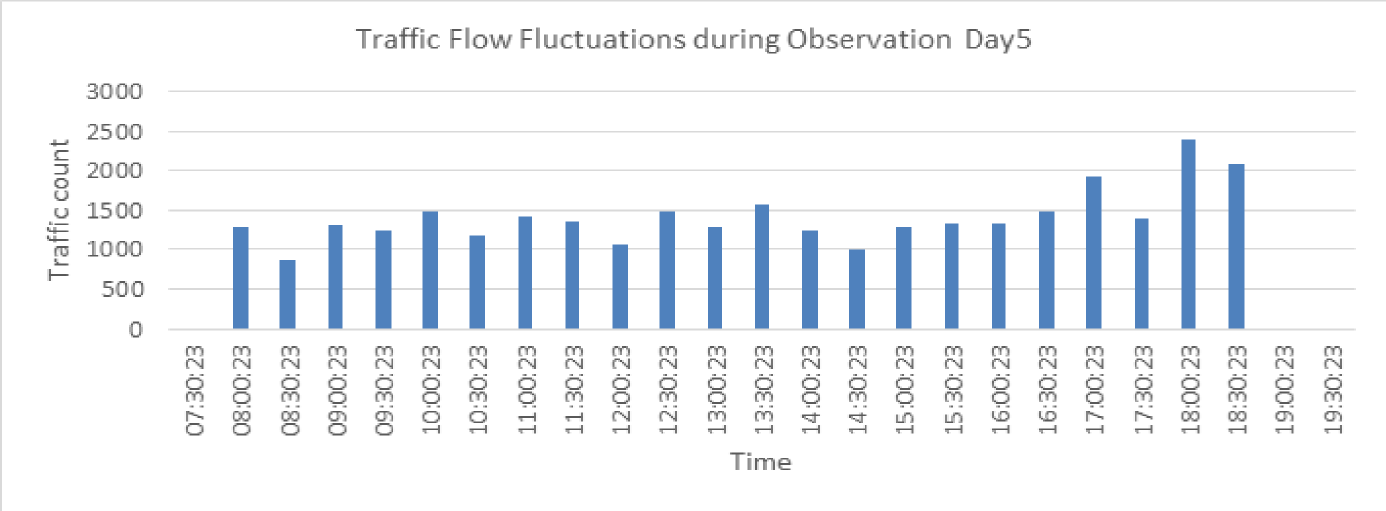

Fig 13 Trafic Count Against Time.

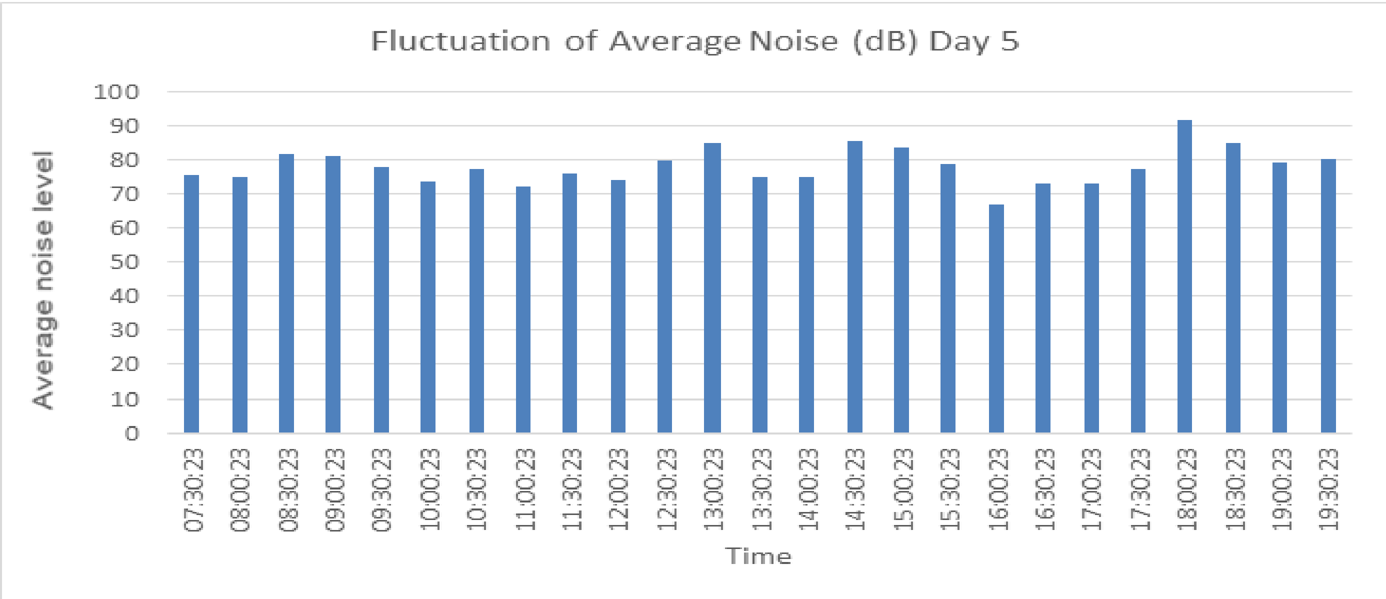

Fig 14 Average Noise Level Against Time

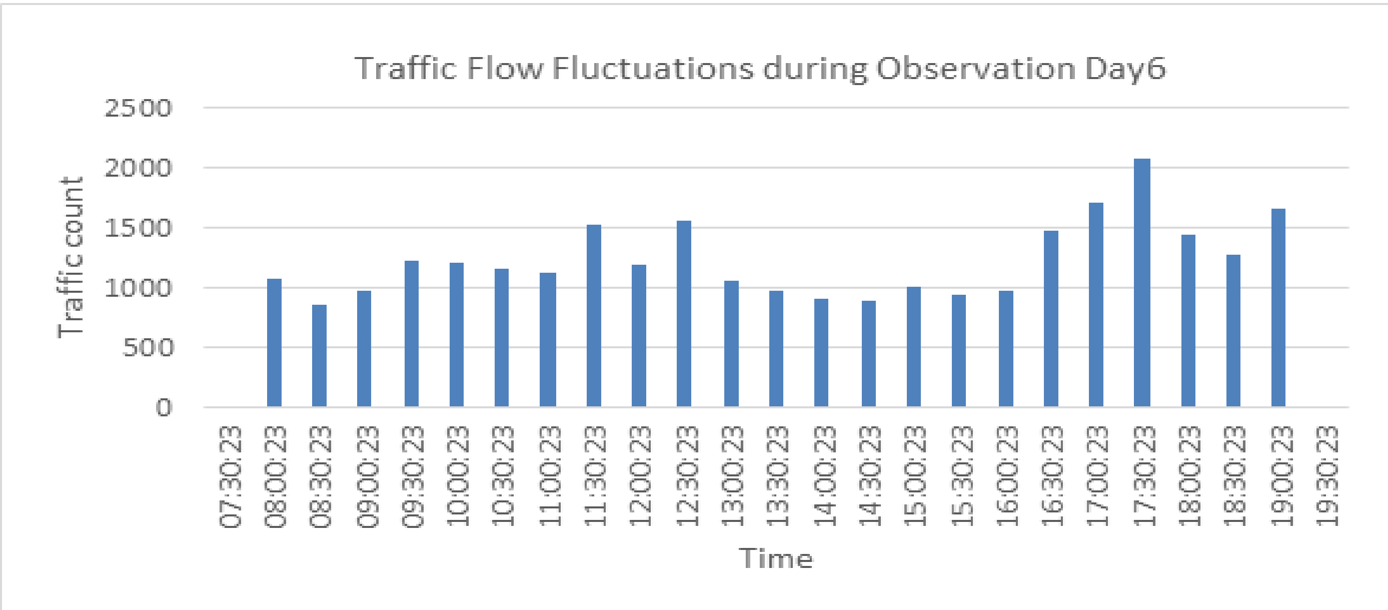

Fig 15 Trafic Count Against Time

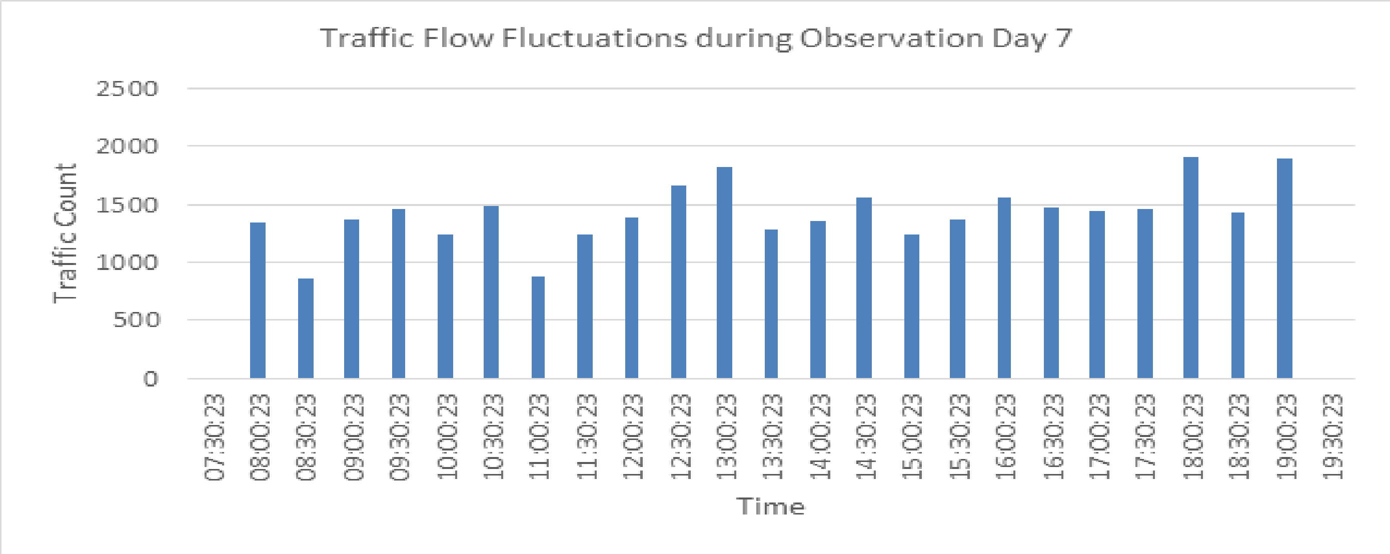

Fig 16 Trafic Count Against Time

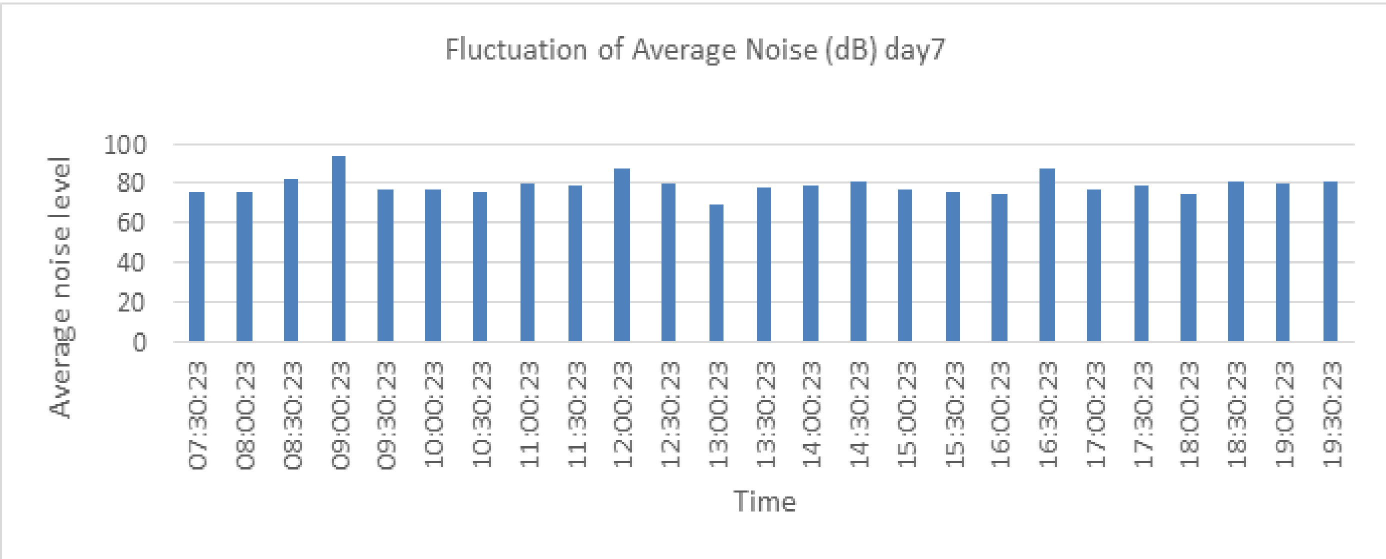

Fig 17 Average Noise Level Against Time

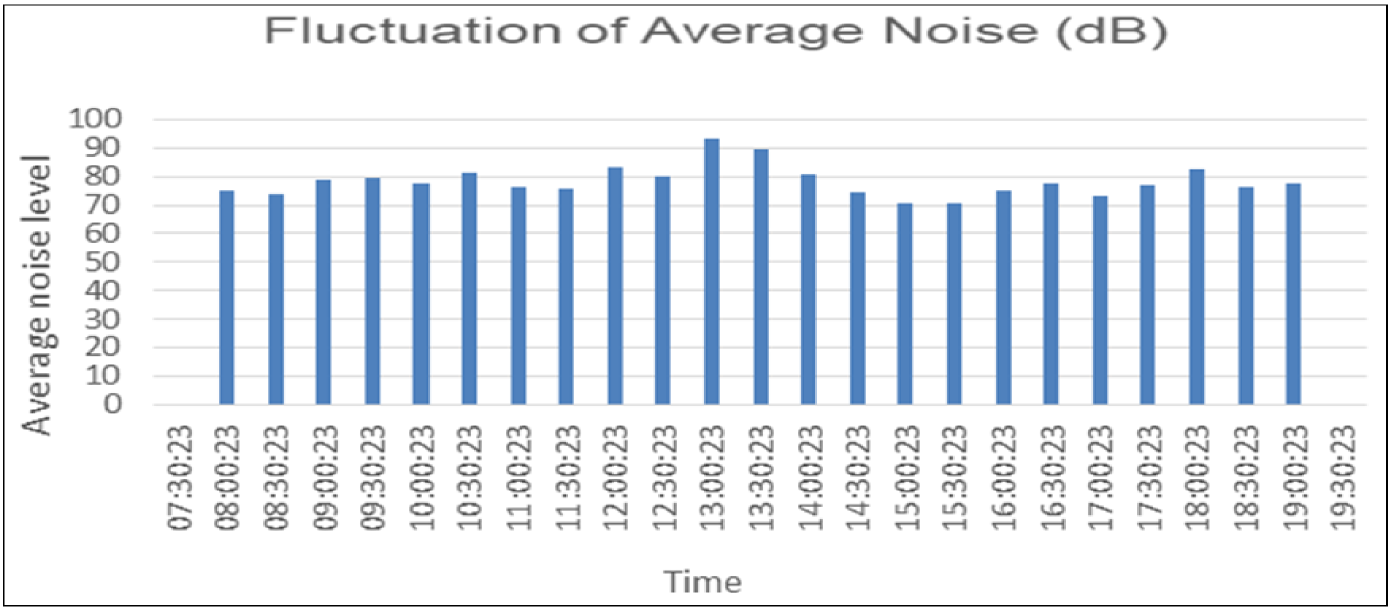

Fig 18 Average Noise Level Against Time

Figure.5 to Figure.18 shows LAeq over 12 hour's period of sampling locations.

Figures 5 to 18 depict the hourly variations in traffic volume and the average noise levels over a span of 21 days, spanning from 7:30 a.m. to 7:30 p.m. During our analysis, it became evident that motorcycles consistently dominated the traffic during most time intervals. The high density of motorcycles contributed to traffic congestion, leading to frequent horn honking and subsequently elevated noise levels in the area. The composition of traffic in this region is characterized by its heterogeneity. Two-wheelers typically constituted 68% to 70% of the total traffic, while three-wheelers made up 18% to 20%. This mix of different vehicle types, combined with a lack of lane discipline among vehicle users, frequently resulted in traffic bottlenecks and, consequently, increased horn usage. Such congestion is particularly prevalent during peak hours, leading to higher noise levels. Unauthorized parking emerged as a significant contributor to traffic congestion in the area. People often park their vehicles along the roadside, reducing the available space for the smooth flow of traffic. This reduction in space ultimately exacerbates traffic congestion and leads to more horn honking, further elevating noise levels**.**.

Figures 5 to 18 illustrate the fluctuations in noise levels corresponding to simultaneous traffic counts at 30-minute intervals. Vehicle counts are presented on a regular integer scale, while noise levels are represented on a logarithmic scale. This logarithmic scale signifies that even a one or two-decibel change in noise level can be considered significant. One key observation from these figures is that an increase in the number of vehicles does not consistently lead to a simultaneous increase in noise levels. In some instances, noise levels rise concurrently with increased traffic counts during specific hours, such as at 9:30 AM and 11:30 AM on Day 2, between 11 AM and 12:30 PM on Day 3, and from 9:30 AM to 11:30 AM on Day 4, among others. However, often, similar noise levels are observed at different traffic counts within the same hour, like 11:30 AM and 12:30 PM on Day 2, 11 AM and 11:30 AM on Day 3, and so on. Interestingly, in some cases, noise levels decrease as traffic counts increase, for example, from 4:30 PM to 9:30 PM on Day 3, from 10:30 AM to 12:00 PM on Day 4, and from 4:30 PM to 5:30 PM on Day 6. Several factors contribute to these noise level fluctuations. The primary factor is the honking of horns. During non-peak hours, unauthorized parking can disrupt the flow of traffic, leading to congestion. This, in turn, prompts drivers to honk their horns, resulting in increased noise levels, even at lower vehicle counts.

Another contributing factor is lane indiscipline on the roads. Drivers sometimes switch lanes to overtake other vehicles, leaving their designated lanes, which can cause congestion and, consequently, increased horn honking, further fluctuating noise levels.

Additionally, the heterogeneity of traffic in Nigeria plays a significant role. Unlike in developed countries where traffic is predominantly composed of four-wheelers, Nigeria has a higher number of two-wheelers and three-wheelers compared to four-wheelers. This diversity in vehicle types, coupled with a lack of driving discipline among two and three-wheeler operators, contributes to noise level increases even at lower traffic counts.

IV. CONCLUSION

Many prior studies, particularly in developed nations, have demonstrated that an increase in traffic count is typically associated with a corresponding increase in noise levels. This phenomenon holds true in developed countries where traffic is homogenous, and drivers adhere to lane discipline, avoiding unnecessary horn usage. However, for the conditions observed on the Kpakungu-Gidan Kwano road, this direct correlation does not always apply due to several factors. The heterogeneous nature of traffic in this area, along with the lack of lane discipline among vehicle users, frequently leads to traffic congestion. This congestion, especially during peak hours, results in heightened horn honking, which in turn elevates noise levels. Unauthorized parking along the roadside also emerges as a significant contributor to traffic congestion in the region. Given these observed factors in the study area, it can be concluded that traffic noise levels do not consistently exhibit a linear relationship with traffic counts. Instead, they may fluctuate quite unpredictably due to the reasons mentioned above. Consequently, it is suggested that an evolutionary computing-based noise prediction mathematical model be developed to account for the unique conditions of heterogeneous traffic in developing countries like Nigeria. Such a model would provide a more accurate representation of the noise dynamics in these contexts, where factors such as lane discipline, vehicle diversity, and honking behavior differ significantly from those in homogeneous traffic environments typically found in developed nations.

REFERENCES

[1]. Stansfeld S A & Matheson M P 2003 Noise pollution: non-auditory effects on health. *British medical bulletin*, *68*(1), 243-257

[2]. Chandratilake SR, Dias W P S 2013 ―Sustainability rating systems for buildings: Comparisons and Correlations‖ Department of Civil Engineering, University of Moratuwa, Moratuwa, Sri Lanka

[3]. Banerjee D, Chakraborty SK, Bhattacharyya S, and Gangopadhyay A (2008). Modelling of road traffic noise in the industrial town of Asansol, India. Transportation research part D 13 (8), pp. 539-541.

[4]. Calixto A, Diniz FB, and Zannin PHT (2003). The statistical modeling of road traffic noise in an urban setting. Cities 20 (1), pp. 23-29.

[5]. Cho D S and Mun S (2008). Development of a highway traffic noise prediction model that considers various road surface types. Applied Acoustics 69 (11), pp. 1120-1128.

[6]. Clayden AD, Culley RWD, and Marsh PS (1975). Modeling traffic noise mathematically: Applied Acoustics 8 (1), pp. 1-12.

[7]. El-Fadel M, Shazbak S, Baaj MH, and Saliby E (2002). Parametric sensitivity analysis of noise impact of multihighways in urban areas. Environmental Impact Assessment Review 22 (2), pp. 145-162.
[8]. Filho JMA, Lenzi A, and Zannin PHT (2004). Effects of traffic composition on road noise: a case study.Transportation research part D 9(1), pp. 75-80.
[9]. Fyhri A and Aasvang GM (2010). Noise sleep and poor health: Modeling the relationship between road traffic noise and cardiovascular problems. Science of total environment 408 (21), pp. 4935-4942
[10]. Pirreera S, Valck ED, and Cluydts R (2010). Nocturnal road traffic noise: A review on its assessment and consequences on sleep and health. Environment International 36 (5), pp. 492-498.
[11]. Radwan MM and Oldham DJ (1987). The prediction of noise from urban traffic under interrupted flow conditions. Applied Acoustics 21 (2), pp. 163-185.
[12]. Rawat K, Katiyar VK and Pratibha (2009). Modeling of single lane traffic flow using Cellular Automata. International Journal of Applied Mathematics and Mechanics 6(5), pp. 46-57.
[13]. Rylander R (2004). Physiological aspects of noise-induced stress and annoyance. Journal of Sound and Vibration 277 (3), pp. 471-478.
[14]. Ouis D 2001 Annoyance from road traffic noise: a review *Journal of environmental psychology.*21(1), 101-120.