A Study on the Intensity of Traffic Induced Noise on Traffic Police at Major Collector and Arterial Roads in Dhaka City.

A thesis submitted by

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Approval

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Declaration

It is hereby declared that this thesis/project report or any part of it has not been submitted elsewhere for the award of any Degree or Diploma.

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Abstract

The world is experiencing rapid economic growth and different pollutions are generated as its bi-product. Technological innovations and urbanization are taking place at a rapid pace, however, at the cost of bringing some negative impacts. The number of industries and automobiles have been increasing and so do noise. This noise is such a kind of pollution which damages the physical and mental state of people in a silent way without them realizing. Millions of people throughout the globe are being affected by noise pollution on a regular basis. Bangladesh, being a developing country, has somewhat moderate road system but the spike in recent traffic volume has made the situation worse as traffic congestion has made people daily life miserable and noise pollution is one of its by-products. Dhaka, the capital of Bangladesh, home to numerous educational and commercial institutions is a terribly noisy and raucous place. People of different ages regularly use the roads and fall in the exposure of the noise pollution. Among them, traffic police is a vulnerable community continuously exposed this traffic induced noise throughout their service life. This not only has physical and psychological adverse impact on their health but also affects the service they provide every day. Despite this detrimental effect of noise, their situation and health conditions are often ignored. As traffic policemen serve a great responsibility to maintain traffic management and road safety, evaluating the traffic generated noise at their workplace is absolute necessary.

This study aims to analyze the level of noise that the traffic policemen are exposed during their duty periods. Moreover, this research work will give an overview on the variation of noise level among different major arterial and collector roads at different time periods and different days of week. For collecting sample data, one Arterial Road (Mirpur) and two Collector Roads (Khamarbari and Gulshan) are selected inside Dhaka city. The noise level (dB) will be measured using Digital Noise Meter exactly where the traffic policemen are positioned. The required data will be collected during peak, off-peak and evening peak hours each day of the week. Unpaired T-test analysis will be carried out for both equal and unequal variances and significant differences will be observed by comparing the average noise levels.

The results will represent a typical day-to-day traffic noise pollution scenario around the workplace of traffic police which gives an understanding about the intensity and exposure of noise they encountered every day. Moreover, variation in average noise levels will be revealed based on the type of road in consideration with different days of week and different time periods. The outcome of this study will help the associated policy makers to take necessary measures that will reduce the long-term effects and sufferings of traffic policemen from adverse impact of noise pollution.

Keywords: Noise, Noise pollution, Traffic induced Noise, Traffic police, Health, Safety.

CHAPTER 1: INTRODUCTION

1.1 Background

Helen Keller, a famous educator, was born deaf and blind and she quoted, "Blindness cuts us off from things, but deafness cuts us off from people". We use our eyes to figure out how to reach where we want to go, but we use our ears to listen, talk, laugh, and learn from others who are already there. Sounds communicate to the brain far more quickly than sights. Hearing allows us to participate in and enjoy many of the activities that shape our quality of life. So, Sound is a blessing for us. For maintaining relationships and connections with friends and family, fully participating in team and community activities, and experiencing life events, ability to hear is required. However, sound levels that exceed human hearing limitations have detrimental repercussions for hearing ability, human health, wildlife, and the environment (Thacher et al., 2020).

The growing use of automobiles contributes significantly to pollution. Other modes of transportation, such as airplanes, buses, bikes, trucks, and others, are also included. People honk incessantly in traffic and listen to loud music while driving, causing excessive noise. As the world is turning to technology for their comfort, it is, at the same time, harming us. No matter how big or little, industries contribute to noise pollution. Compressors, exhaust fans, generators, and other equipment they employ generate a lot of noise. Furthermore, social activities such as weddings, parties, and religious functions in venues such as clubs, pubs, temples, halls, and others cause a great deal of annoyance in residential areas (Díaz et al., 2021).

Bangladesh is a developing country having a large population density and noise pollution is a regular phenomenon here. The word noise comes from the Latin word. Nausea meaning “seasickness “. Any unwanted sound is known as noise. From The DoE study of 2019 we see that, 11.7% of the population in Bangladesh Have lost their

hearing due to noise pollution (Environment, 2019). Again, from the report of WHO in 2018 we get to know that around 5% of the World Population is facing several kinds of health hazards due to complexities related to noise pollution (WHO, 2018). So, we understand that the intensity of the noise levels is uprising and so do their effects. The hearing system of human is being affected day by day.

Among all people of various types, traffic policemen are most affected because they are the ones who spend the majority of their time in an extreme environment where traffic-induced noise is abundant. Though traffic policemen serve a great responsibility to maintain traffic management and road safety, their situation and health conditions are unfairly ignored. So, in this research, we tried to understand the current situation of variation of noise level among different major arterial and collector roads in Dhaka city which will give an idea about the level of noise that the traffic policemen are exposed during their duty periods. This study will help to create awareness while helping in decision making for the Authorities in future regarding improvements in the Traffic System.

1.2 Introduction to the study

Noise pollution is one of the most serious environmental concerns in emerging countries like Bangladesh. Sadly, it is continuously increasing while this nation is progress toward development through technological improvement. In most areas of Dhaka, Bangladesh, noise pollution has reached dangerous levels. Because of its direct acute and chronic physiological and psychological consequences, noise pollution should be considered to be much more damaging than air and water pollution.

Traffic noise is an obnoxious sound produced by moving various kinds of motor vehicles on public roads. People require various types of motor vehicles to get from one location to another more quickly in order to keep up with their daily routines. It has

become an integral component of our daily routine. Our pain will be unfathomable if we don't have these motor vehicles. However, as a necessary evil, they have produced a slew of significant issues that are causing us a lot of troubles. They are the primary source of traffic noise pollution, which causes substantial environmental damage. They have a mental and physical impact on human health that is both long and short term detrimental (Rasool & Balwan, 2020).

Extreme consequences, such as deafness and mental disintegration, are not ruled out. It disrupts sleep, attention, conversation, and recreational activities. Noise monitoring at a few locations in Nanded has exceeded the permitted limit. Noise annoyance is a common side effect of transportation and a severe societal problem. People who live near existing urban highways have reduced quality of life and property values as a result of traffic noise. As a result of the population boom, fast industrialization, and the greatest rate of vehicle population increase, traffic problems have become more difficult (Kulkarni et al., 2017).

So, we understand that noise pollution is more than just an annoyance. Noise-induced hearing loss can occur at specific levels and durations of exposure, causing physical damage to the eardrum and sensitive hair cells of the inner ear and resulting in temporary or permanent hearing loss. Hearing loss does not normally develop at SPLs below 80 dBA (eight-hour exposure levels should be kept at 85 dBA), but most people who are regularly exposed to more than 105 dBA will experience some permanent hearing loss. Excessive noise exposure can elevate blood pressure and pulse rates, induce impatience, anxiety, and mental tiredness, and interfere with sleep, recreation, and personal communication, in addition to causing hearing loss.

Studies on traffic induced noise pollution have been conducted in many developed countries but, due to inadequate law enforcement, lack of knowledge and awareness, economic differences these studies are very rarely conducted. Traffic police play an essential part in Traffic enforcement and pedestrian and road safety, their circumstances and health are often neglected.

1.3 Objective of the Study

The main objectives of this study are –

- To study and compare ambient noise levels in different arterial and collector roads in different days of week.
- To compare the average noise level difference among different peak hours in a particular type of road.
- To study the variation of noise level and find possible reasons.

1.4 Scope of Research

- The study will examine the variation of noise level among different major arterial and collector roads in Dhaka city.

We will be able to compare the significance of sound level among

- Different types of road network
- Weekdays vs Weekend
- Morning peak vs Evening Peak vs Off peak

1.5 Significance of the Research

This study will contribute to the research literature in several ways:

- It will give an idea about the level of noise that the traffic policemen are exposed during their duty periods

- It will help to compare the noise levels with human tolerance level and understand the current situation
- It will help to know the importance of Personal Protective Equipment for the Traffic Police
- The finding of this study will help in decision making for the Authorities in future decisions regarding Traffic System

1.6 Outline of Thesis

Chapter 1: Introduction – Sound, Human hearing and the effects of Sound is described

Chapter 2: Literature Review – this chapter discusses about the past works on similar type of study and will give idea on how the work plan should be done.

Chapter 3: Methodology – in this chapter the procedural steps of the study will be described thoroughly.

Chapter 4: Results Analysis and Interpretation - analysis of the data collected from the models & obtaining results.

Chapter 5: Conclusions and Recommendations - this chapter will discuss the effectiveness of the study, recommendations & scopes of future studies.

CHAPTER 2: LITERATURE REVIEW

The literature review of the thesis will be structured around a few key points. First, the source and standard limits of noise, the effect of noise on human health will be discussed according to several published papers. Second, traffic induced noise and the influence of urban road networks on traffic induced noise. Third, relevant studies showing the situation of an important noise-exposed community- 'the traffic police' and the long-term effect of noise pollution on them will be incorporated. These discussions will bestow some context for the results in this study later on. Finally, the major findings of numerous related studies that were performed in developing countries will be summarized to assist readers gaining some insights about the topic of this study.

2.1 Noise and Noise Pollution

2.1.1 Sound and Human Hearing

A world without sound can only be envisaged with a mixture of fear and delight. However, the hellish conditions generated by unsound minds abusing God's magnificent gift are a cause of significant worry not just for this age but also for future generations (Rasool & Balwan, 2020). Sound is a physical phenomenon that activates the sensation of hearing. Hearing occurs in humans when vibrations of frequencies ranging from 15 to 20,000 hertz reach the inner ear (Kang & Moon, 2013). According to Niloofar Ziayi Ghahnavieh, Siamak Pourabdian and Farhad Forouharmajd, sound is essential to the human hearing system, which includes the outer ear, middle ear, inner ear, and associated nerves. The function of the outer ear is to receive sounds and transmit them to the middle ear via the ear canal and tympanic membrane (eardrum). Sound waves go to the inner ear through the malleus, incus, and stapes. Cochlea and semi-circular canals are found in the inner ear. The spiral organ of the cochlea contains hundreds of extremely thin hair cells (organ of Corti). The hair cell assists in the stimulation of sound waves when they enter the inner ear. Vibrations are converted into

electric impulses by hair cells, and waves are sent to the brain via hearing nerves. The brain converts the data into audible sounds. Sound causes spiral organ cells to break down. Acoustic input signals vibrate the detecting hair cells, and the mechanical vibrations are converted to an electric form before reaching the eighth brain nerve. The outer hair cells responsible for high-frequency noises (3–6 kHz) are largely damaged when exposed to loud sounds (above 85 dBA) (Ziayi Ghahnavieh et al., 2018).

The amount of air pressure fluctuation caused by the sound source is known as sound pressure. It's written in Pascal. A young individual in good health may hear sound pressures as low as 0.00002 Pa. Between the "threshold of hearing" and the "threshold of pain," people typically hear sounds. The pressure range is 20 μPa to 100 Pa (Kang & Moon, 2013). Seokhoon Kang and Hyuk Moon have also discussed about the Sound Pressure Level (SPL) which is the decibel scale conversion of sound pressure. The decibel (dB) is a unit of measurement for sound power, sound intensity, and sound pressure in environmental noise pollution (Kang & Moon, 2013).

dB Scale: **dB = 10* log (A/A0)**. The dB scale is logarithmic rather than linear; thus a 3 dB increase in sound intensity is perceived as twice as loud. A 10 dB rise makes the sound 10 times louder; add another 10 dB and the sound becomes 100 times louder (Wijianto, 2017).

2.1.2 Noise and It's Classification

Noise comes from the Latin word "nau- sea," which means "unwanted sound" or "loud, unpleasant, or unexpected sound". Therefore, all unwanted sound can be referred to as noise (Singh & Davar, 2004). All unpleasant sounds in our communities, with the exception of those that originate in the workplace, are referred to as environmental noise. A man's vocal cord, a running engine, a vibrating loudspeaker diaphragm, and an operating machine tool are just a few examples of items that may create noise. Idrobo-ávila et al. (2018) stated that there are various types of noise such as,

- Continuous noise

  Noise that is produced continuously without any interruption. Origin: factory equipment, engine noise, heating and ventilation systems, etc.

- Intermittent noise

  Noise that increases and decreases rapidly. Origin: a train passing by, factory equipment that operates in cycles, aircraft flying above house, etc.

- Impulsive noise

  This noise is mostly associated with the construction and demolition industry. These sudden bursts of noise can startle anyone by their fast and surprising nature. Origin: explosions or construction equipment such as pile drivers, explosions, drop forge
  impacts, and the discharge of firearms etc.

- Low-frequency noise

  Noise that has frequency range from about 10Hz to 200Hz, causes extreme distress to a
  number of people who are sensitive to its effects. Origin: Low background hum of a nearby power station, the roaring of large diesel engines, etc.

2.1.3 Standard Limit of Noise Level

The government of Bangladesh recommended a threshold of the acceptable noise level for different areas in dB unit which was acted with the governance of the Bangladesh Environment Conservation Act, 1997.

S/N	Category of areas	Standard determined at day (in dB)	Standard determined at night (in dB)
1	Silent zone	45	35

2	Residential area	50	40
3	Mixed area (mainly residential also used for commercial and industrial purposes)	60	50
4	Commercial area	70	60
5	Industrial area	75	70

Table 1: Limit of standard level of noise allowed by the Bangladesh Environmental Conservation act. 1997.

2.1.4 Sources of Noise Pollution

There are two types of noise pollution sources in metropolitan region (Quiñones-Bolaños et al., 2016). They are,

i. Stationary sources:
   This includes industrial, construction and demolition, commercial, domestic, recreational sources.

ii. Mobile source:
   This includes noise sources that are not static. Such as ground and air transportation. In urban areas, the engine and the exhaust system of automobiles, light trucks, buses, and motorcycles are an important source of noise, which constitutes a major environmental impact.

2.1.5 Noise Pollution and Related Health Hazard

Florence Nightingale identified noise as a health concern in 1859 when she wrote, "Unnecessary noise is the most cruel abuse of care which can be inflicted on either the sick or the well" (Hsu et al., 2012). With the exponential growth of the human population and the rapid increase in global urbanization noise pollution has become the second most harmful environmental stressor to humans (Lu et al., 2019a). However, unlike many other environmental issues, it is still becoming worse day by day. Noise pollution can be defined as an overabundance of sound that disturbs the typical environment in a specific region (Paiva et al., 2019).

Approximately 5% of the world's population is facing several kinds of health hazards due to complexities related to noise pollution (WHO, 2018). And, according to the study of department of environment, 11.7% of the population in Bangladesh have lost their hearing due to noise pollution (DoE study, 2017).

Noise pollution has been associated to a variety of non-auditory health consequences in a chronic exposure timeframe, including cardiovascular diseases (CVD), metabolic disorders, cognitive dysfunction, poor sleep, and mental health (Basner et al., 2014). Some other studies have also been performed regarding the detrimental effect of noise pollution. These studies suggest that noise can raise blood pressure and cause the release of endocrine hormones such adrenalin, noradrenaline, and cortisol, which produce vasoconstriction and have a cardiovascular effect (Auger et al., 2018; Hammer et al., 2014; Münzel et al., 2014). Some of the health impacts are very serious specially NIHL- Noise Induced Hearing Loss. Chronic noise exposure might result in persistent threshold changes and hearing loss in some frequency ranges. One of the most common causes of preventable hearing loss is noise induced hearing loss (NIHL). According to a study, approximately 10 million adults and 5.2 million children in the US are already suffering from irreversible noise induced hearing impairment and thirty million more are exposed to dangerous levels of noise each day (Seidman & Standring, 2010). Among all of these negative consequences, few major detrimental health hazards are as stated below:

2.1.5.1 Cardiovascular disturbance

Noise pollution affects a person's cardiovascular system directly. These effects appear after long-term daily exposure to noise levels above 65 dB or acute exposure to noise levels exceeding 80 to 85 dB. When exposed to noise for a short length of time, it produces temporary increases in blood pressure, heart rate, and vasoconstriction. According to research, those exposed to occupational or ambient noise had higher heart rates and peripheral resistance, higher blood pressure, higher blood viscosity and blood lipid levels, electrolyte changes, and higher levels of adrenaline, norepinephrine, and cortisol (Goines & Hagler, 2007).

2.1.5.2 Hearing impairment

It can also harm a person's hearing ability. Hearing loss does not occur until the sound intensity falls below 70 decibels. There is also universal agreement that sound levels more than 85 dB for more than 8 hours are potentially harmful; to put this in perspective, 85 dB is about equivalent to the volume of heavy truck traffic on a busy highway. Damage is proportional to sound pressure and exposure time when sound levels above 85 decibels (Passchier-Vermeer & Passchier, 2000).

2.1.5.3 Preeclampsia

Despite the likelihood that pregnant women are more vulnerable to environmental stressors, particularly those prone to hypertensive illnesses of pregnancy such as preeclampsia, few research have looked at the effect of noise on women. Preeclampsia is characterized as high blood pressure (140/90 mmHg or above) along with clinically substantial proteinuria or other end organ involvement and is linked to the development of hypertension later in life (Mol et al., 2016). According to another study, women who are exposed to ambient noise pollution are more likely to develop preeclampsia, especially more severe forms like severe and early onset preeclampsia (Auger et al., 2018).

2.1.5.4 Sleeping disturbance

Environmental noise is one of the most prevalent causes of sleep disruption. When sleep disruption becomes chronic, it leads to mood swings, poor performance, and other long-term health and well-being consequences. Many recent studies have focused on noise from airplanes, motorways, and trains. Continuous noise in excess of 30 dB, for example, is known to disrupt sleep (Goines & Hagler, 2007).

2.1.5.5 Disturbance of mental health

Noise pollution is expected to expedite and worsen the appearance of latent mental diseases, even though it is not thought to be a cause of mental illness. Noise pollution can cause or contribute to anxiety, nervousness, headaches, emotional instability, argumentativeness, mood swings, increased social conflicts, neurosis, hysteria, and psychosis, to name a few. When the noise level exceeds 80 dB, aggressive behavior increases and helpful behavior decreases (Basner et al., 2014).

2.1.5.6 Negative social behavior

Noise exposure has a complex, subtle, and indirect social and behavioral impact, including changes in daily activity. Noise is not thought to generate aggressive behavior on its own. When mixed with provocation, pre-existing anger or animosity, alcohol, or other psychotropic drugs, noise can trigger violent behavior. Long-term exposure to a lot of noise can cause this (Passchier-Vermeer & Passchier, 2000).

Annoyance, a sensation of aggravation is associated with any agent or event that an individual feels will have a negative influence on him or her. Noise has been used as a noxious stimulus in a lot of studies since it has the same effects as other stressors. The level of discomfort increases considerably when noise is accompanied by vibration or low frequency components (Basner et al., 2014).

2.2 Traffic Induced Noise

The annoying sound created by driving various types of motor vehicles on public roadways is known as traffic noise. In order to keep up with their daily activities, people require various sorts of motor vehicles to go from one point to another more quickly. However, as a necessary evil, they have resulted in a plethora of major concerns that are giving us a great deal of grief. They are the main source of traffic noise pollution, which has serious consequences for the environment. They have long-term and short-term negative mental and physical effects on human health as well (Rasool & Balwan, 2020).

Epidemiologic researches on the association between transportation noise and ischemic heart disease reveal an increased risk of myocardial infarction in patients exposed to high levels of traffic noise (Babisch et al., 2005). Many other studies have found evidence that living closer to major roadways is associated with cardiovascular disease (Babisch et al., 2005; Brunekreef et al., 2009; Hoek et al., 2001). Decreased pulmonary function has been reported among children who live less than 300 m away from freeways (Gauderman et al., 2007). Gauderman et al. (2007) also stated that local traffic exposure has been linked to negative respiratory impacts in children, including higher incidence of asthma and other respiratory illnesses.

2.2.1 Factors affecting traffic induced noise

Traffic noise is influenced by a variety of factors, one of which is traffic flow. The distribution of traffic flow in an urban environment is determined by the road network, which has an impact on driver behavior (Lu et al., 2019b), which further affects noise levels. As a result, urban traffic noise control focuses on municipal-scale urban road networks as well as block-scale road characteristics (D'Alessandro et al., 2014; Ruiz-Padillo et al., 2014). However, in summary, we get various factors that have impact on traffic noise. They are

- Road network pattern (arterial, collector or highway)
- Day time or night time

- Human factors
- Land-use pattern
- Vehicle factors (how many heavy vehicles run along that road)

2.3 The Situation of Traffic Police in Bangladesh

Dhaka, the capital city of Bangladesh is one of the world's most densely inhabited cities, with a population density of 23,234 people per square kilometer spread across 300 square kilometers. Traffic noise might be a major source of total sound pollution (RİYAD et al., 2020). The traffic police have to go through such noises throughout his entire service life. Yet, their situation is remaining ignored by the authority. However, a questionnaire survey in a developing country (Iraq) showed that 100% of the selected traffic policemen were suffering daily from exhaustion after finishing their work, while headache, nervous and sleep disturbance were coming in the second place in which 80% of them having a daily suffering from them, anxiety came in the third place (Tahir & Khaled, 2015).

Another questionnaire-based study was carried out among 110 traffic policemen in Dhaka city, which demonstrates that the majority of the respondents (93.6%) feel noise has an impact on their health. Noise pollution was cited by 78.2% of respondents as an occupational danger. 59.1 percent of traffic cops said their workplace is noisy (27.3 percent) to extremely noisy (31.8 percent), causing a variety of hearing difficulties and prompting them to seek medical attention. In the previous 12 months, 35.5 percent of the participants had seen a doctor for an ear injury complaint or hearing difficulty. As a result, formal and non-formal education should be used to raise awareness (Majumder, 2018). Majumder (2018) also studied that 15.5 percent of responders stated they generally miss a lot of dialogue when chatting on the phone, while 25.5 percent of traffic cops claimed the same thing happens when talking to someone in a crowded or noisy environment. 19.1 percent stated that they like to keep the sound louder while watching television in order to hear well. On the one hand, 29.1 percent said that their friends and relatives regularly told them that they (traffic cops) were talking too loudly, while 33.6 percent said that people normally chatted with them loudly enough for them

to hear correctly. Regular vertigo was blamed by 8.2 percent, whereas 57.3 percent reported working time vertigo and only experienced it at work.

2.3.1 Use of personal protective equipment (PPE) among the traffic police

According to questionnaire research performed in Dhaka city, just 13% of traffic cops seldom wear earplugs out of 100. Again, 25% of traffic cops wear masks on a regular basis while on duty, however 50% of the respondents reported that the authority did not offer PPEs. However, 29% of research participants did not wear PPEs because they were uncomfortable, and 21% did not use PPEs because they were unaware. Other PPE tactics mentioned by some traffic cops include covering their ears, using cotton balls, and so on. This suggests that the PPE supply should be sufficient, and that additional effort should be made to make the equipment more pleasant and accessible (Sultana et al., n.d.). A study displays the distribution of responses based on whether or not they use personal protection equipment such as earplugs or earmuffs. Only 7.3 percent used those very few times, and only 5.5 percent used those very few times. Only 1.8 percent of the city's traffic cops wear ear plugs on a regular basis throughout their shift. Personal protection equipment (PPEs) is not always accessible for traffic cops in our country's situation, which is the most prevalent cause for their non-use, according to 49.1% of them. However, other reasons for non-use included personal dislike (22.2 percent), distress (13.9 percent), various physical problems such as headache, sweating, and allergy caused by its use (8.3 percent), and being poorly fit (6.5 percent), and 77.3 percent of the respondents did not use anything to reduce noise exposure, while the rest used fingers (2.7 percent), hands (8.2 percent), and cotton (11.8 percent) (Majumder, 2018).

CHAPTER 3: METHODOLOGY

3.1 Analysis Method:

- Two sample T-test
- Equal and Unequal Variance

3.2 T-test

A t-test is an inferential statistic that determines whether or not there is a statistically significant difference between the means of two groups that may be connected in some features. The purpose of this test is to determine whether or not there is a correlation between the two groups. The t-test is a tool for evaluating hypotheses that permits the investigation of an assumption that is applicable to a population.

The T-test is a method of statistical analysis that allows us to compare the average values of two distinct sets of data to determine whether or not they are from the same population. In the previous examples, if we took a group of students from class A and another sample from class B, we wouldn't expect their means and standard deviations to be exactly the same. We wouldn't expect them to be the same because their means and standard deviations come from different groups of people. This is due to the fact that it is highly likely that the two groups will have different means and standard deviations. In a similar fashion, the mean and standard deviation of the samples that were obtained from the group that was given a placebo as a control and the group that was given the medicine should be slightly different from one another.

3.2.1 Significance of T value-

Greater t-values, which are often referred to as t-scores, show that there is a statistically significant gap between the two sample groups. The t-value serves as a measure of the degree to which two sample groups are comparable to one another. A t-score that is significant suggests that the groups are distinct from one another. If the t-score is low, it indicates that the groups are similar to one another.

3.2.2 Significance of P value-

If the p-value is less than 0.05, then the data can be interpreted as having statistical significance (usually 0.05). This presents significant evidence in opposition to the null hypothesis, as there is a possibility that is less than five percent that the null is accurate. As a consequence of this, we are able to reach the conclusion that the competing hypothesis is accurate, whereas the null hypothesis is unreliable. If the p-value is lower than the significance threshold that you have selected, it is permissible for you to reject the null hypothesis (which is typically set at p 0.05). On the other hand, the fact that you are not prohibited from doing so does not automatically suggest that the alternative hypothesis is correct with a probability of 95 percent. It is not important to the question of whether or not the alternative hypothesis is right, even if the significance of the p-value is contingent on the correctness of the null hypothesis and depends on its validity. If the p-value for the experiment is higher than 0.05, then it cannot be said that the experiment produced statistically significant results. On the other hand, this does suggest that the counterfactual hypothesis does not have enough evidence to back it up, which means that we cannot completely exclude the likelihood that it is the true hypothesis. As a consequence of this, we are in a position to arrive at the verdict that the null hypothesis is true, whilst the alternative hypothesis is not accurate. It is absolutely necessary to keep in mind that the null hypothesis cannot be accepted; rather, in order to proceed, we must either fail to reject it or do so successfully. Keeping this in mind is important. Even if a discovery has a high level of statistical significance, that does not mean that it is sufficient evidence to indicate that a study hypothesis is accurate

(as this implies 100 percent certainty). Instead, we may remark that our findings either "provide support for" or "give evidence for" the study hypothesis that we were working with at the time (since there is still a small chance that the data occurred by coincidence and that the null hypothesis was true - less than 5 percent).

3.3 Two sample T-test

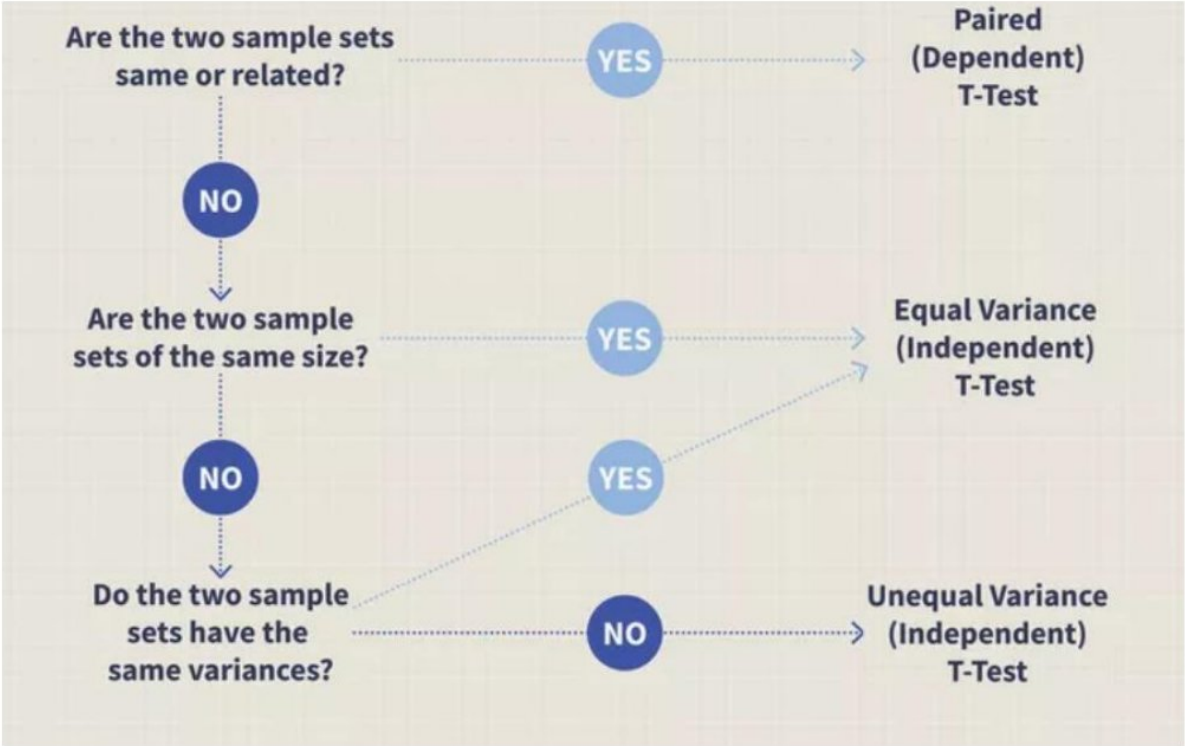

Figure 1: Two sample T-test procedure

3.4 Testing Differences between Two Means: Equal Variance:

The equal variance t-test is performed when there is an equal number of samples in each group or when the variance of the two different sets of data is comparable to one another. When conducting a t-test with an equal variance, the following formula is utilized to determine the t-value and the degrees of freedom:

H_0: $\mu_1 - \mu_2 = 0$

H_1: $\mu_1 - \mu_2 \neq 0$

A test statistic for a difference between two population means with equal variances is given by,

$$t^* = \frac{(\overline{x_1} - \overline{x_2}) - (\mu_1 - \mu_2)}{\sqrt{s_p^2 \left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

where,

($\mu 1$ - $\mu 2$) = the difference between $\mu 1$ and $\mu 2$ under the null hypothesis.

n1 = sample size of population 1

n2 = sample size of population 2

(n1 + n2 - 2) = The degrees of freedom of the test statistic in this equation

$sp2$ = population variance

$$s_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_1 - 2}$$

The confidence interval for a difference in population means is based on the t distribution
with (n1-n2 + 2) degrees of freedom.

A (1-α) 100% confidence interval for the difference between two population means (μ1 - μ2),

Assuming equal population variances is,

$$\overline{x_1} - \overline{x_2} \pm \sqrt{s_p^2 \left(\frac{1}{n_1} + \frac{1}{n_2}\right)}$$

3.5 Testing Differences Between Two Means: Unequal Variance

The t-test for unequal variance is utilized in situations in which the number of samples present in each group varies, as does the variance of the two distinct data sets being compared. This test is sometimes referred to as the Welch's t-test in some circles. For a t-test with unequal variance, the t-value and degrees of freedom are calculated with the following formula:

H_0: $\mu_1 - \mu_2 = 0$

H_1: $\mu_1 - \mu_2 \neq 0$

A test statistic for a difference between two population means with unequal population variances is given by

$$t^* = \frac{(\overline{x_1} - \overline{x_2}) - (\mu_1 - \mu_2)}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}}$$

where,

(X1 - X2) = the average sample difference between the observation 1 and observation 2

s1 and s2 = the sample standard deviations of these differences, and

n1= the sample size,

n2 = the number of unpaired observations of sample 1 and sample 2 respectively.

t -distribution with degrees of freedom given by,

$$df = \frac{(\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2})^2}{\frac{(\frac{s_1^2}{n_1})^2}{n_1-1}+\frac{(\frac{s_2^2}{n_2})^2}{n_2-1}}$$

A (1- α) 100% confidence interval for the mean difference (μ1-μ2) is

$$\overline{x_1} - \overline{x_2} \pm t_{\frac{\alpha}{2}}\sqrt{(\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2})}$$

3.6 Site Selection

Considering individual road characteristics, land use pattern of adjacent area, availability of traffic police at a particular location throughout the day we selected 1 Arterial and 2 Collector roads. They are-

1. Collector Road (Khamarbari Road)

Figure 2: Khamarbari Road

2. Collector Road (Gulshan Road)

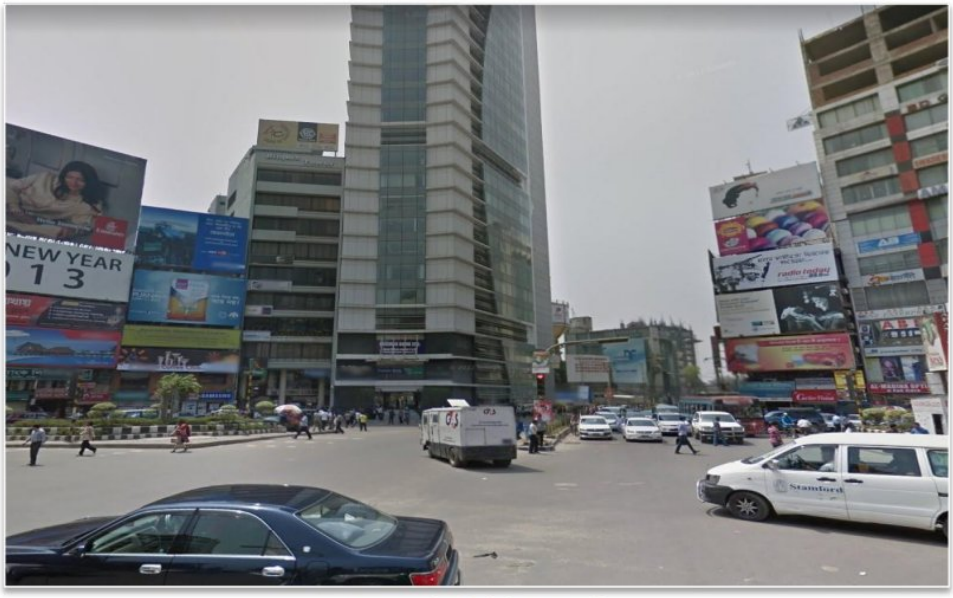

Figure 3: Gulshan Road

3. Arterial Road (Mirpur Road)

Figure 4: Mirpur Road

3.7 Data collection steps:

- Three times a day:

  1.Morning Peak (8:00 am – 09:00 am)
  2.Off Peak (02:00 pm -03:00 pm)
  3.Evening Peak (6:00 pm -7:00 pm)

- Seven days in a week

3.8 Data Collection Equipment:

Noise Meter was used as our Data Collection Equipment.

Figure 5: Noise Meter

The noise meter / sound meter is ideal for noise pollution measurements in industrial, health, safety, and environmental monitoring applications. The logger function on the noise meter / sound meter allows for the saving of up to 32,700 measured values.

CHAPTER 4: RESULT ANALYSIS & INTERPRETATION

4.1 Introduction

We used a t test to compare sound level data collected from three distinct places in this experiment. Only variables with a 95% confidence level have been kept in the model. The goal of this research is to determine the sound intensity at three places in Dhaka at various times. The noise levels on different days were compared (weekdays and weekends). To obtain both of the p-value & t-value, we utilized the noise value. We have mainly considered p-values for the result. Due to several factors and a lack of time, this experiment may not provide us with an exact result.

4.2 Result Analysis

STaTa was utilized to analyze the results. Stata is a sophisticated statistical program that allows users to examine, manage, and view the data graphically. It is largely used to study data trends by academics in the domains of economics, health, and political science. It comes with both a command line and a graphical user interface, making it easier to use. The result analysis is divided into three segments, and they are: "Comparison of noise level among different types of roads", "Comparison of noise level among different types of roads in the weekdays and weekends" & "Comparison of noise level in different peak hours". The results are given below with the tables.

4.3 Result related to road types

The numbers marked in red color indicates the significant differences which was found from the result analysis using STaTa software.

Time of the Day	P- Value for Equal Variance (T- value)			P- Value for Unequal Variance (T- value)		
	Arterial(M) vs Collector(K)	Arterial(M) vs Collector(G)	Collector(K) vs Collector(G)	Arterial(M) vs Collector(K)	Arterial(M) vs Collector(G)	Collector(K) vs Collector(G)
M	0.0000 (21.9486)	0.0000 (9.3132)	0.0000 (-15.6776)	0.0000 (19.052)	0.0000 (11.038)	0.0000 (-9.2097)
O	0.0000 (26.0567)	0.0000 (-8.0987)	0.0000 (-21.4030)	0.0000 (20.5666)	0.0000 (5.9334)	0.0000 (-14.7986)
E	0.0000 (-5.0287)	0.0000 (10.456)	0.0000 (6.980)	0.3498 (-0.9387)	0.1336 (-1.5104)	0.4762 (0.7146)

Table 2: COMPARISON OF NOISE LEVEL AMONG DIFFERENT TYPES OF ROADS

As seen in the table, there is a large noise differential between arterial and collector roads at both morning peak and off peak. The noise level appears to be less variable at the evening peak than it is during other peak hours. It is also seen from the data that, the arterial road (Mirpur Road) has more average noise level (76.9 dB) than the collector roads (Gulshan-76.6 dB, Khamarbari-73.77 dB). For the morning peak and off peak, almost there are 100% significance in difference of noise level. But for the evening peak, the difference happens in 50% times. Though Gulshan and Khamarbari both are the collector roads, they have significant difference between them in terms of noise level. It is normal to have significant difference with the arterial road (Mirpur road), but there are some characteristics that makes a difference between two collector roads.

4.3.1 Possible causes for road types

There can be a bunch of reasons responsible for the result. We cannot say something for sure, but we can identify some possible causes which are responsible for this result. The possible causes for the difference in noise level among the road types can be:

- Number of heavy and light vehicles running in the road.
- Land use pattern.

- Road type itself.
- Number of schools, colleges, offices in the area.

4.4 Result related to weekdays and weekends

The numbers marked in red color indicates the significant differences which was found from the result analysis using STaTa software.

Time of the Day	P- Value for Equal Variance (T- value)			P- Value for Unequal Variance (T- value)		
	Arterial(M) vs Collector(K)	Arterial(M) vs Collector(G)	Collector(K) vs Collector(G)	Arterial(M) vs Collector(K)	Arterial(M) vs Collector(G)	Collector(K) vs Collector(G)
Weekdays	0.0035 (-8.8047)	0.076 (-9.127)	0.0376 (4.169)	0.7257 (-0.3516)	0.0000 (5.1369)	0.6235 (-0.4922)
Weekend	0.0254 (-2.2634)	0.0008 (3.4283)	0.0059 (-2.8047)	0.0000 (17.5295)	0.6797 (-0.4134)	0.0000 (18.7438)

Table 3: COMPARISON OF NOISE LEVEL AMONG DIFFERENT TYPES OF ROAD IN WEEKDAYS & WEEKENDS

From the table, we can clearly exclude that there are no notable difference in noise levels amongst the road networks on weekdays. On the other hand, on weekends, we see considerable changes in the roadways. As we can see, almost 50% time there is significantly difference seen in weekdays, where as it is almost 83.33% in weekends. This indicates there is a huge noise level difference among the three roads (Mirpur, Gulshan and Khamarbari) in weekends than weekdays.

4.4.1 Possible causes for the weekdays and weekends

The facts that can be possibly responsible for this differences mainly are:

- Difference in vehicle types.
- Difference between the number of people staying in those areas.
- Land use patterns.
- People's tendency to visit recreational places in the weekends.
- Number of shopping malls in the areas.

4.5 Result related to the peak hours

The numbers marked in red color indicates the significant differences which was found from the result analysis using STaTa software.

		T- Value for Equal Variance (P- value)						
Khamar-bari	Peak Difference	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	Morning vs Off	4.6067 (0.0000)	9.8556 (0.0000)	6.3902 (0.0000)	5.9360 (0.0000)	6.4053 (0.0000)	-4.4707 (0.0000)	1.0536 (0.2942)
	Evening vs Off	2.1217 (0.0359)	1.1068 (0.2706)	13.1753 (0.000)	3.8526 (0.0002)	10.5916 (0.0000)	2.4960 (0.0139)	11.1712 (0.0000)
	Morning vs Evening	-1.7844 (0.0769)	-1.0294 (0.3054)	-5.4378 (0.0000)	-0.1838 (0.8545)	-3.9771 (0.0001)	-13.7070 (0.0000)	-7.8808 (0.0000)
Mirpur	Morning vs Off	-5.7800 (0.0000)	14.0364 (0.0000)	4.6209 (0.0000)	4.4088 (0.0000)	10.1379 (0.0000)	-5.9119 (0.0000)	2.5444 (0.0122)
	Evening vs Off	6.2375 (0.0000)	12.2335 (0.0000)	8.1685 (0.0000)	4.5312 (0.0000)	11.1823 (0.0000)	-0.6211 (0.5357)	3.0523 (0.0028)
	Morning vs Evening	-11.590 (0.0000)	1.8180 (0.0716)	-2.1089 (0.0371)	0.4357 (0.6639)	-0.0082 (0.9934)	-5.7015 (0.0000)	-0.2504 (0.8027)
Gulshan	Morning vs Off	1.9938 (0.0485)	-0.0491 (0.9609)	1.9828 (0.0497)	-4.3930 (0.0000)	1.9674 (0.0515)	3.3700 (0.0010)	0.5598 (0.5767)
	Evening vs Off	12.4300 (0.0000)	6.4274 (0.0000)	10.2870 (0.0000)	4.3957 (0.0000)	9.4615 (0.0000)	10.4458 (0.0000)	8.4173 (0.0000)
	Morning vs Evening	-12.3644 (0.0000)	-7.4700 (0.0000)	-7.2765 (0.0000	-8.5582 (0.0000)	-7.7117 (0.0000)	-6.8410 (0.0000)	-10.6309 (0.0000)

Table 4: COMPARISON BETWEEN NOISE LEVEL IN DIFFERENT PEAK HOURS (EQUAL VARIANCE)

		T- Value for Unequal Variance (P- value)						
Khamar-bari	Peak difference	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	Morning vs Off	4.6046 (0.0000)	9.0536 (0.0000)	6.5235 (0.0000)	6.2386 (0.0000)	5.8687 (0.0000)	-4.2576 (0.0116)	1.0978 (0.2734)
	Evening vs Off	2.1501 (0.0336)	1.1075 (0.273)	13.2001 (0.0000)	3.9818 (0.0001)	10.2009 (0.0000)	2.5522 (0.0000)	10.4024 (0.0000)
	Morning vs Evening	-1.77 (0.0793)	-1.0303 (0.3050)	-4.8434 (0.0000)	-0.1941 (0.8463)	-4.0055 (0.0001)	-12.5587 (0.0000)	-8.1318 (0.0000)
Mirpur	Morning vs Off	-5.9492 (0.0000)	13.3627 (0.0000)	4.7975 (0.0000)	4.6433 (0.0000)	9.847 (0.0000)	-5.9352 (0.0000)	2.5488 (0.0115)
	Evening vs Off	6.3617 (0.0000)	12.3396 (0.0000)	7.9665 (0.0000)	4.492 (0.0000)	11.0598 (0.0000)	-0.6181 (0.5371)	3.194 (0.0016)
	Morning vs Evening	-12.4501 (0.0000)	1.7573 (0.0802)	-1.9796 (0.0490)	0.4385 (0.6615)	-0.0083 (0.9934)	-5.4745 (0.0000)	-0.2381 (0.8120)
Gulshan	Morning vs Off	1.9180 (0.0567)	-0.0472 (0.9624)	1.9800 (0.0489)	-4.0836 (0.0001)	1.9703 (0.0500)	3.2825 (0.0012)	0.5572 (0.5781)
	Evening vs Off	11.4253 (0.0000)	6.8485 (0.0000)	9.574 (0.0000)	3.8979 (0.0001)	9.3886 (0.0000)	10.2259 (0.0002)	8.3774 (0.0000)
	Morning vs Evening	-12.2304 (0.0000)	-7.0471 (0.0000)	-7.7214 (0.0000)	-8.1208 (0.0000)	-7.0353 (0.0000)	-6.8228 (0.0000)	-10.4818 (0.0000)

Table 5: COMPARISON BETWEEN NOISE LEVEL IN DIFFERENT PEAK HOURS (UNEQUAL VARIANCE)

The difference in noise levels between the morning and evening peak in a specific road network is minimal. When comparing them to the off peak, though, a substantial difference is visible. From the data, it is found that in the evening peak hours, the average noise level is highest (78.1 dB). And the average noise level is lowest in the off peak hours (74.04 dB). For the Khamarbari and Mirpur road, the difference between morning peak and evening peak is always not that significant, but the difference between off peak and both morning & evening peak, is always significant. But there is a different scenario in the case of Gulshan. The difference between morning peak and evening peak is always significant. But in comparison between morning peak and off peak hours, the noise level difference is not that significant. As a result, in terms of comparing peak hours, Gulshan road is distinct from the other two.

4.5.1 Possible causes for the peak hours

Possible causes that can be responsible for this differences can be:

- Land use pattern.
- Less number of vehicle operating in the off peak hours.
- Increased number of heavy vehicles in evening peak hours.

CHAPTER 5: CONCLUSION & RECOMMENDATION

5.1 Introduction

This chapter summarizes the key results of the study and makes realistic conclusions and suggestions. Policymakers may find the outlined recommendations and consequences useful. The local authorities can also consider taking some necessary steps to comfort the suffering of traffic police from the results and recommendations of this study. At last, some limitations and future scopes of our study was included.

5.2 Key findings of the study

Throughout the study and result analysis, we have found some key findings that helps to identify all the necessary points. They are:

- Land use pattern plays a very important role in the field of noise level.
- The noise level of weekdays and weekends are totally different,
- It can also differ from one peak hour to other.
- Road type plays an important role.
- Vehicle type can also effect the noise in large scale.
- Numbers of school, colleges and shopping mall has a huge impact.

5.3 Recommendations & Implications

This research was carried out in order to get a sense of what a traffic policemen might be like. Because of their occupation, he is subjected to a great deal of noise pollution every day. The study's purpose was to identify particular findings that might contribute to the reduction of their suffering. The policy makers can use these findings of our study to detect the noisiest area of the city. We have performed it for arterial and collector

roads, but they can use it for the highway intersections and local roads too to find which road or intersection has most noise pollution. Then they can take necessary measures to prevent it or to help to reduce the suffering of traffic policemen. They can use different types of signs to prevent excessive horning some areas (like: no horns allowed). They can take some immediate steps to reduce the suffering of traffic police like providing them with sound proof earbuds, personal protective equipment (PPE) etc. Also, some long term measures can also be considered. Policy makers and local authorities can arrange multiple shifts in the time of working hours of traffic policemen. They can increase the number of traffic police in the city and arrange them to work in different shift so that they don't have to stay in a noisy place for a long time. These are some necessary steps that should be taken by the policy makers to reduce the suffering of traffic policemen.

5.4 Limitations

We have some limitations in our study. The main limitation was lack of time. Due to insufficient time, we couldn't study more roads and intersections. We have just taken 3 places which was easy for us to access. If there was more time, more places could be considered for the study. That would make the result analysis more accurate. Also, more time is needed to perform the data collection method in one road. We have taken the data of 7 days. If we could take more than that, the clear characteristics of a road could appear.

There was corona pandemic situation going on while performing our study. We have also considered that as one of our limitations. It also reduced our movement to different types of places. If the situation was good enough and there was enough time, we could've performed the study well and create almost a flawless result.

5.5 Future Scopes

There are also some future scopes that can be considered for this study. We just collected the data and analyzed it to get an image of the noisy roads. For future study, this can be performed with more time and more roads like the highway intersections and the local roads to get a clear image of the situation of traffic policemen. Also, this

can be performed district wise to determine which has the most noise pollution and take necessary measures for that. Also, a model can be developed by using necessary data for a particular road or intersection along to understand how it will work. Some questionnaire surveys can be performed to measure the suffering levels of a traffic policeman. All of these can be applied to reduce the suffering of a traffic policeman which is the goal of our study.

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