An Alternative System for Removing Vehicle-Generated Noise in the City of Dhaka, Bangladesh.

BY

Nayeema Ahmed Lia
ID: 213-25-049

This Report Presented in Partial Fulfillment of the Requirements for the Degree of Master of Science in Computer Science and Engineering

Supervised By

Dr. Moushumi Zaman Bonny
Assistant Professor
Department of CSE
Daffodil International University

DAFFODIL INTERNATIONAL UNIVERSITY

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APPROVAL

This thesis titled **“An Alternative System for Removing Vehicle-Generated Noise in the City of Dhaka, Bangladesh”**, submitted by Nayeema Ahmed Lia, ID No: 213-25-049 to the Department of Computer Science and Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of M.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 17-01-2023.

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City University

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We hereby declare that this thesis has been done by Nayeema Ahmed Lia under the supervision of Dr. Moushumi Zaman Bonny, Assistant Professor, Daffodil International University. We also declare that neither this thesis nor any part of this thesis has been submitted elsewhere for the award of any degree or diploma.

Supervised by:

Dr. Moushumi Zaman Bonny
Assistant Professor
Department of CSE
Daffodil International University

Submitted by:

Nayeema Ahmed Lia

Nayeema Ahmed Lia
ID: 213-25-049
Department of CSE
Daffodil International University

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ABSTRACT

There is a serious problem with noise pollution in most cities around the world. In its simplest form, noise can be described as unwanted sound. In addition to the noise that emanates from our workplace, environmental noise also encompasses all unwanted sounds that occur in our communities. Dhaka is plagued by noise pollution, which is a major contributor to the pollution of the environment. A significant amount of noise is present throughout the city at levels far exceeding the levels considered safe for hearing and health. The health effects of excessive noise are constantly aggravating and dangerous. Noise pollution is one of the most significant problems facing an affluent population. Noise pollution is a problem everywhere in these cities. The streets are filled with excessive noise pollution, wherever you walk or take public transport. It is possible to extend the problem to silence such as schools/colleges/universities or hospitals, where students or patients do not speak. This project has designed and developed necessary and urgent solutions to reduce its unhealthy and harmful effects on the human body. This solution addresses the problem from two different angles within the developing area. Raise awareness among the general public to encourage changes by measuring and displaying loud noise levels to reduce noise in quiet and create a system to regulate and reduce the use of honkers by drivers.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Dhaka, the capital of Bangladesh is now the city with the highest noise pollution in the world. Life is very busy here. City streets are the most crowded and there is excessive noise pollution as if no one has time to wait even for a moment. The whole city of Dhaka is now affected by noise pollution. According to doctors, a person's normal sound level should be 40 to 50 dB.

Figure 1.1: Noise pollution harming city life[15]

Various surveys have been conducted by government and non-government organizations. Show that the noise level in Dhaka city is two or three times higher than the acceptable level in almost all areas. The city is dominated by the noise of vehicles and their horns. However, the use of loud mics or sound systems at political, social, and religious events is another big reason.

1.2 Motivation

UNEP's Annual Frontier Report, 2022, has ranked Dhaka, Bangladesh's capital, as the world's most noise-polluted city. The maximum level of noise pollution in the city was recorded at 119 decibels in 2021. The Global Hearing Index was developed by Mimi Hearing Technologies GmbH, the founder of the digital hearing app. They tested 200,000 of their users, and then analyzed the hearing test results to come to this conclusion.

Noise levels frequently exceed acceptable levels in several parts of Dhaka city. In light of the current lack of existing projects within the city to address this problem, we are trying to develop a comprehensive project. This will definitely minimize noise pollution in developing countries. Moradabad in Uttar Pradesh placed second on the list with 114 decibels of noise pollution. Pakistan's capital Islamabad ranks third, with the highest noise pollution at 105 dB. 61 cities are ranked for noise pollution in the report, including Dhaka, which tops the list with 119 decibels.

61 cities worldwide suffer from severe noise pollution, according to a recent UNEP report. Health risks associated with noise frequencies above 70 decibels. A 55-dB value was recommended by the World Health Organization in its 1999 guidelines, while a 70-dB limit is recommended for traffic and business areas. Irbid, Lyon, Madrid, Stockholm and Belgrade are the quietest cities in the world.

Many areas of Dhaka city can become deaf with 60 decibels of sound, according to the World Health Organization (WHO). In view of the lack of projects taking place within the city to address this issue, we are trying to develop something creative. This will definitely reduce noise pollution in developing countries.

As urbanization, industrialization, and human activities increase, the problem of noise pollution in metropolitan cities, such as Dhaka, is becoming more acute. Dhaka's noise level is frequently exceeded in many parts of the city. Those living in cities like this are increasingly concerned about the effects of noise pollution.

Over 12 million people live in Dhaka and traffic jams are a regular occurrence almost everywhere. In traffic jams, most motor vehicles, including buses, mini-buses, and trucks, are equipped with hydraulic horns. Drivers are forced to honk continuously until space becomes available in front of them. Furthermore, drivers' lack of knowledge of the impact of noise pollution is another reason for honking, which contributes to noise pollution.

Table 1.1: Noise levels in different areas of the city[5]

Area	Noise Level(decibels)
Sayedabad Bus Terminal	106
Bangla Motor	106
Sonargaon Hotel	104
Farmgate	104
Mohakhali Crossing	103
Moghbazar	103
Mowchak	103
Gabtoli	102
Jatrabari	100
Tejgaon Industrial Area	97
Mirpur-1	97
Kakrail	92
Gulistan	90
Sapla Chattar Motijheel	89
Sadarghat	87
Mirpur-10	86
BIRDEM Hospital	81
Dhanmondi Residential Area	78
Gulshan Residential Area	70
Banani and Baridhara Residential Area	68

WHO estimates that 60 dB of sound can cause deafness. There is evidence that the noise level in several areas of Dhaka city exceeds this threshold.

Moreover, 20 places in the city were selected for a study. Of these 20 places, namely Rampura and Dhanmondi were found to have the highest number of noise. In Nadda, Airport, House Building, Gulshan, Uttara have very high noise which exceeds the acceptable level.

Technology can help us reduce road noise to a manageable level if we take the proper steps. Due to all these factors, we were motivated to build a project to solve the problem and reduce sound pollution. Our plans to reduce noise levels on the road through the use of technology are detailed in the following sections.

1.3 Rational of the study

Pollution has become a curse in Bangladesh, especially in big cities like Dhaka. Pollution is a fear for Dhaka residents. It is becoming more and more intense as time marches on. Noise pollution is the silent killer. We are all affected by the horrors of noise pollution. One of the sources of noise pollution is cars. Noise pollution is increasing day by day with the increase of cars in the city. Vehicle hydraulic horns, road vehicles, rail and boat horns, malfunctioning vehicle noise, the ubiquitous use of microphones, political rallies, open concerts, and construction of buildings, generators, and factories are responsible for high noise pollution. Transport and Environment published a report in 2008 that noise pollution from rail and road transportation resulted in five lac heart attacks and two lac cardiovascular diseases.

We believe that noise pollution can be controlled through increased public awareness and the concerted efforts of government and non-governmental organizations. The current level of noise pollution is extremely high. It has emerged as a public health problem. We often say that this can't be solved because of our unconsciousness. But these problems are man-made. A touch of awareness can control this problem. For this, you have to be respectful of the law and tolerant of people. No excessive honking, avoid hydraulic horns, avoid loud music or playing instruments at social events. Maintain noise limits during construction. Behavioral changes can also reduce noise pollution.

1.4 Expected Output

Technology is used to create a hardware and application method. This involves the model and depiction of a turbulence pollution monitoring method that provides a solution to reduce unhealthy levels of noise in a city like Dhaka. Our main goal is to reduce the health risks caused by noise pollution and create safer roads in the long run.

We have 3 stages to this project. In the first stage, we will develop a device to measure overall sound at a specific location. This device will appear on a digital display on the roadside along with a message aimed at increasing public awareness. This episode particularly indicates that there is an obvious absence of knowledge among drivers about their bad contribution to noise contamination and the resulting detrimental payoff. We hope that, with knowledge before their eyes, they will be discouraged from using their horns excessively and unnecessarily.

Damage is greatest in designated quiet zones such as around schools/colleges/universities, hospitals, and places of worship. Horning is already prohibited in these areas by signs, but hardly anyone follows the rules. Therefore, in our second phase, we focused on developing a technical system to eliminate potential sources of excessive noise pollution from the unnecessary honking of vehicles in these areas. This will not only create intentional peace in these critical areas - but will certainly increase the level of concentration and focus among students and worshippers in religious places. Stress factors are also removed for hospital populations. Both hospital staff and patients already work in highly stressful environments. Moreover, patients are also critically ill and undergoing treatment. The resulting reduction in noise pollution improves the health conditions of youth and vulnerable physically weak patients in our educational institutions.

In stage 3, we account for emergencies in the silent zone. This is because we cannot guarantee that there will not be an event that we do not need a horn to avoid. As a result, our plan is to implement an emergency button/switch available in every vehicle. By pressing this button, the horn is available again for use in this aforementioned "silent zone" in case of emergency.

However, to prevent exploitation of this emergency switch, a counter in our device (included in each vehicle), is activated even after the hydraulic horn is reactivated. We aim to install these silencing devices in every vehicle, monitoring how often the horn is used, as well as the duration and level of the sound emitted. This information is stored and relayed to a remote team responsible for monitoring. Thresholds are defined as acceptable levels. When a driver crosses this limit within the silent zone, the silent device flags the vehicle concerned and notifies both the monitoring authorities as well as the offending driver. Then it will be easier to track offenders and give them appropriate penalties, such as lump sum fines, increased insurance costs, or license suspension. Thus, we are helping the authorities to control and monitor effectively through this technology. This eliminates points of corruption that can occur, thus eliminating human error.

1.5 Report Layout

First, the purpose for the research is discussed inside the preface (Chapter 1), which is what drove the author to tackle this particular issue statement in the first place. In this section, we will talk briefly about the goals of this study as well as an overview behind the work.

In the second part of the article, which is the existing literature portion (Chapter 2), we went over other works from the computer science field that dealt with the same kinds of problems. In addition to that, the background investigation was conducted with the intention of determining the deficiencies that were present in earlier research.

The data collecting and conversion procedure that will be utilized in this project has been detailed in the data Methodology phase, which can be found in Chapter 3. This part also involves the extraction of features and comprehensive research on how each feature contributes to the overall conclusion. In Chapter 4 of the book, "Implementation and Model Selection," we explore the different forms of data, as well as which technique is superior for the various portions of patient data, and then we choose the appropriate algorithm.

In addition, the proposed models and a comparison analysis of the prediction rate among the various models were presented in the chapter titled "Results and Analysis." A presentation also serves to summarize the results of the study.

CHAPTER 2

BACKGROUND STUDIES

2.1 Introduction

Although the work conducted in the 1st stage of our project already exists and many researchers work with noise levels, we are trying to build our project in a completely different way. Here we are attaching a couple of links to works that aren't exactly like our whole project but share similarities in scope:

In Bangladesh, none of these solutions really exist – the only measure we have are alert signs displaying "no honking" that are rarely followed, except in areas of stricter regulation like in Cantonment.

Figure 2.1: Noise Pollution caused by vehicles.[16]

Outside of Bangladesh, in recent years, vibration and acoustic noise control in industrial applications like the automotive industry have been receiving attention. This has contributed to the reduction of environmental and sound pollution in large metropolitan cities. With passive approaches, structural geometry is modified and dampening materials are applied. A structural acoustic control system can also reduce unwanted structural vibrations while not excessively increasing structural weight. However, neither of these solutions addresses the hydraulic horns; they directly affect the noise of the engines themselves.

Other initiatives include health and safety initiatives such as “Buy Quiet”, in America - to selectively purchase power tools and machinery that emit the lowest noise. Organizations complying with the Buy Quiet initiative create workplaces and environments with no harmful noise.

Additionally, there are innovative technologies in architecture, such as greening the building envelope to provide external and internal sound insulation. All these green systems act as noise barriers. In America, both Sound Fighter and Acoustical Solutions provide several solutions, but only for soundproofing static enclosed spaces, nothing targeting noise on the roads.

2.2 Related Work

Noise pollution affects millions of people daily. Dhaka is now the world's top city in terms of noise pollution. This information has emerged in the latest report of the United Nations Environment Program (UNEP)[1]. In recent years, commercial development, industrial production and social activities have increased the amount of noise in the environment[2]. A standard for safe indoor noise levels is 55 decibels (dB), while a standard for outdoor noise levels is 70 decibels (dB)[3,4]. Studying 20 locations in Dhaka revealed that the noise levels in all of these locations were above 60 decibels, with residential areas such as Banani and Baridhara averaging 68 decibels, Jatrabari 100 decibels, and industrial areas such as Sayedabad Bus Terminal and Bangla Motor reaching 106 decibels[5].

Noise pollution is acknowledged as a serious behavior facing the world today. The Department of Environment (DOE) has conducted a survey on noise pollution at 70 points in Dhaka city with alarming results. In many places, the noise level is up to 120-130dB which is almost twice the permissible limit. [4] WHO has declared that noise is a hazardous agent that affects human health and the environment.[6,7] In addition to hearing loss, noise pollution causes both health and behavioral problems for humans. Unnecessary and excessive noise can greatly affect a person's physical and mental normal functioning. 80 percent of Dhaka's noise pollution originates from vehicles. The city has about 1.6 million vehicles including eight lakh motorbikes.

But with only five thousand traffic police to handle them, it has become very cumbersome to advise traffic in the city.[8]

Many cities have high-rise structures with busy paths full of traffic. In Tehran, it has been studied that the noise from the roadside has the worst impact on the buildings facing the front, where the noise impact occurs the most compared to all other buildings. [9].

The CDC and Prevention have established that noise levels above 85 dB can slowly but surely cause hearing loss, while noise below 70 dB is considered safe[10]. Bangladesh has also conducted a number of studies on this topic. A silent zone is defined by the ECA-1995 and the ECR-1997. Up to a radius of 100 meters, a standard noise limit of 45 dB is set during the day[11]. Hospitals, schools, colleges, and universities are most affected by noise pollution during the five-day workweek. Many educational institutions in Dhaka are prone to constant noise due to the poor location of the city's main roads. On a regular basis, actual sound levels exceed 45dB to 75dB[11]. Such loud noise levels not only ransack the concentration of young students but can be harmful to health if continued on a regular basis.

Noise pollution is becoming difficult to deal with in daily life. As a result, people become irritable, angry, and frustrated, which affects their daily social and work life[10]. WHO recommends that noise levels in hospitals be below 35 decibels a day. For critical care unit patients, a noisy environment may be their most significant stressor. Loud noise in hospitals often causes high levels of patient dissatisfaction, as patients do not get quality sleep and rest[12]. Hearing disabilities, interference with spoken communication, sleep disturbances, cardiovascular disturbances, as well as irritability are some of the ailments caused by noise exposure.[13].

2.3 Research Summary

An application system for reducing noise pollution that combines hardware and mobile technology. A comprehensive noise reduction solution for cities like Dhaka is provided by the design and implementation of noise pollution monitoring systems.

The process has three stages. In the first stage, the device (containing the sound sensor) detects the total sound at a particular location. Noise levels are measured by the device, and then displayed on digital displays standing on roadways with messages intended to raise public awareness.

The second stage consists of restricted areas where honking is strictly prohibited, referred to as silent zones. The majority of schools, colleges, hospitals, mosques, and other places of worship display warning signs. For these specific areas, we are trying to develop a customized system to automatically turn off vehicle horns in restricted areas. Devices will be attached to the vehicle, as well as a router at the perimeter of the restricted area. Thus, when any vehicle reaches the restricted area, its horn will automatically stop emitting a loud sound.

Stage 3 is essentially an extension of stage 2. In the Silent Zone, we cannot guarantee that there will never be a situation where we do not need horns. To avoid accidents in such situations, we plan to implement an emergency button/switch available in every vehicle. By pressing this button, the horn is again available for use in the aforementioned "silent zone" for emergencies.

However, to prevent overuse and exploitation of this emergency switch, a counter within our device (included in each vehicle), is activated even after the hydraulic horn is reactivated. It keeps track of how often the driver uses his horn within the silent zone. The device ID, along with its associated driver and vehicle information, is transmitted to a central server, ready for monitoring by authorities.

An individual's record will be deducted one demerit point each time his horn is used in a silent zone. Only if their combined demerit points exceed the threshold agreed upon will they be penalized. The server sends a message via SMS to both the driver and the relevant authorities when a driver honks for the 16th time within a silent zone. As an example, if the authorities decide that vehicles may honk only 15th times within a silent zone, a message will be sent to the driver after the 16th use. Warning both parties about violations of the rules. As a result of the incident, the authorities took appropriate measures to punish the driver.

CHAPTER 3

RESEARCH METHODOLOGY AND IMPLEMENTATION

3.1 Introduction

Noise pollution is tackled from several angles. The problem can also be treated by controlling and reducing it. In areas where noise pollution is most prevalent, preventing the problem entirely is a complex option to take as a solution. Increasing human activities due to rapid urbanization and industrialization contribute to an increase in the level of noise, as evident in Figure 4. Traffic is also a regular occurrence in this capital city with a population of around 12 million.

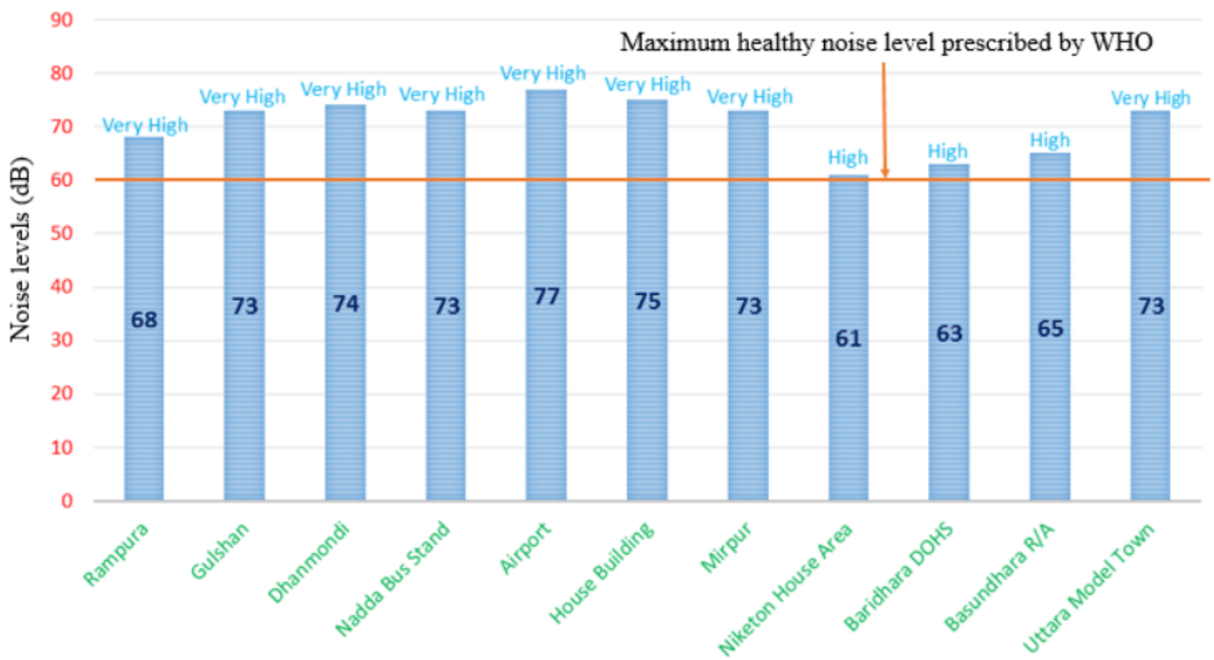

Figure 3.1: Noise level in different locations of Dhaka based on WHO healthy level[14]

Additionally, drivers are conditioned to continuously honk as an acceptable alternative to using their indicator lights. To prevent these causes, there would be a need for long-term regulation and monitoring via the government to affect behavioral change.

However, while some research has been conducted on the matter, and many articles and papers have been written to highlight the issue to draw attention, there are nearly no existing solutions in place for the local context of Dhaka, or even the national context of Bangladesh.

One of the only methods used to deal with this issue has been ineffective "no honking signs" posted on the roads; although they are more effective within the Cantonment area due to a reputation for strict rules and regulations.

Aside from Bangladesh, in recent years, attention towards vibration and acoustic noise control in industrial applications, especially in the automotive industries, has been on the rise. The reduction of noise and vibration has proven to be essential in contributing both to the comfort of a car and to environmental and sound pollution within large urban areas. Two different approaches have been made to achieving noise and vibration attenuation: the passive approach and the active approach. These methods are generally suitable within a frequency range above 1kHz.

Alternative approaches offer control techniques to minimize unwanted structural vibrations and noise. Due to these methods being powerful and not increasing the structure's weight (considerably), this is an area of increasing interest for designers. An active structural acoustic control system is one of the most beneficial of these control techniques. It is imperative to note that these solutions work on the engines themselves, not the hydraulic horns. The overuse of honking is a problem more endemic to Bangladesh, as this habit would lead to major legal repercussions in other countries.

In America, there is a health and safety initiative known as “Buy Quiet", which encourages companies to purchase power tools and machinery that emit the lowest noise. They aim to both reduce occupational noise exposure, and the noise tolerated by the surrounding communities. While Buy Quiet serves a slightly different target audience, it still is an example of noise control strategies via prevention through design. Organizations complying with the Buy Quiet initiative aim to create workplaces and environments with no harmful noise. Many companies, for example, resort to automated equipment, or equipment that can be remotely operated by workers from a control room. These are free from the impact of noise, chemical agents, and heat, thus reducing workplace injuries. Buy Quiet also has a “Safe-in-Sound Excellence in Hearing Loss

Prevention Award” to recognise effective and innovative initiatives; this encourages companies to share information with the broader community.

Alternative approaches consecration control techniques to reduce undesirable structural vibrations and noise. Due to these methods being powerful and not increasing the structure's weight (considerably), this is an area of increasing interest for designers. An active structural acoustic control system is one of the most beneficial of these control techniques. It is imperative to note that these solutions work on the engines themselves, not the hydraulic horns. The overuse of honking is a problem more endemic to Bangladesh, as this habit would lead to major legal repercussions in other countries.

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These systems are a type of noise barrier. A sound barrier has additional factors to consider during implementation - such as material, structural integrity, compatibility with surroundings, and aesthetic appeal. Sound Fighter aims to create noise barriers as a solution. Likewise, Acoustical Solutions in America offers several solutions, but only for soundproofing static enclosed spaces, not while on the road.

3.2 Proposed System

There are three levels of noise pollution management in the proposed solution. Through the use of sensors, Wi-Fi, and microcontrollers, noise pollution reduction methods are implemented with the system's hardware and mobile applications. A large number of unhealthy levels of noise pollution exist in cities like Dhaka, which are being tackled and reduced by the implementation of this noise pollution control system. As a result, health benefits will increase. The system consists of three stages:

The first stage is to create public awareness through a measurement system.

It begins with the detection of overall noise at a specific location by a device. On the roadway, a sound sensor and a display board will be installed. Digital displays show the noise level along with a message designed to alert the public when the sound sensor detects a loud sound.

A second stage will be the establishment of a noise control system for areas where lower levels of noise are required. This will include schools, hospitals, and mosques, as well as reporting systems to control the level of noise.

A silent zone, such as a school, college, hospital, or religious place, is addressed in stage 2. Automobile horn honking is strictly prohibited in these places, as it disrupts focus and concentration and can also be harmful, particularly to patients. In restricted areas, an automatic system for turning off vehicle horns needs to be developed for these places. The silent zone must be equipped with devices inside the vehicle and with a router mounted on the wall. When vehicles approach the silent zone, they automatically cease emitting loud noises, eliminating any potential noise pollution.

In this particular system, a Wi-Fi module is utilized in conjunction with an Arduino microcontroller. Through the use of a centrally located Wi-Fi network, noise level control can be activated within the quiet zone. Once you exit these specific Wi-Fi areas, you cannot control the horn's activation or deactivation. It is now possible for the driver to use the horn as he wishes.

The third stage will involve automating the process of reporting and monitoring emergency situations in silent zones.

It is also pertinent, at this stage, to take into account the emergency situation because there is no guarantee that horns will not be needed. When such an emergency occurs, there is an emergency button on the dashboard. When the driver needs to warn another vehicle or a pedestrian, he or she may use this emergency button to activate the hydraulic horn.

In "silent no-horn zones", a push button activates an in-car device that measures how often the horn is used. This allows drivers to avoid using this emergency device. If the driver uses the horn in this Wi-Fi zone, he or she will receive one demerit point.

A Wi-Fi network also collects these demerit points, which can be accessed by regulatory authorities via a central database. Devices that reach the threshold of demerit points are registered with the vehicle and its owner/driver. The device is not allowed to be used within the silent zone more than 15 times. An alert message is sent to the driver's phone as a result. This information is communicated to the authorities so they can take the necessary actions and punish the driver appropriately.

3.3 Solution Assessment

There are no viable solutions in Bangladesh to mitigate sound pollution. Internationally, there are strategies and initiatives that deal with minimizing noise; some target different audiences such as employees in loud workplaces and the communities surrounding them, while others build structures to create a padding effect.

Noise pollution was identified as a pressing concern in the Master Plan for Delhi eleven years ago. As a result, the council directed the authorities to prepare an area-based "traffic calming scheme" as well as a plan for monitoring and controlling noise. Additionally, it requested the planting of thin-leaf trees along busy roads, as well as the creation of land formations, mounds, and embankments.

Delhi, however, lacks the wherewithal or even the administrative will to implement these measures. Considering that continuous honking is almost the norm in our city, it is useful to recall why horns were originally designed and integrated into vehicles - to warn other road users or animals of the presence of a vehicle. Generally, in all other situations, it is possible to never have to use the horn and thus drive without honking.

For changing lanes, using determinative switches and lights should suffice, but within metropolitan areas like Dhaka and Delhi, drivers continue to honk instead. The unfortunate thing is that no matter how many honks occur, traffic jams do not disappear. Instead, the collective population of the streets puts pressure on themselves and their fellow citizens in an already stressed city. Hence it is high time to have regulations in place for better monitoring of sound pollution, to begin with.

The use of technology is notably absent when resolving the issue of noise pollution, which is where our system comes in with a unique position. As a result of our solution, particularly in the second and third phases, sound and noise pollution can be monitored and regulated in a more effective and efficient manner.

3.4 Design Alternatives

For the second phase in silent zones, instead of having to incorporate a device into each car, we have also considered using the Wi-Fi-covered areas along with digital signal processing to cancel out the noise emitted from honking in real time or replacing the harsh sounds with a greener more environmentally friendly sound – such as a bird's call.

However, one problem here is that with our limited signal processing skills, we could not guarantee noise cancellation/replacement in real time without a noticeable delay. Furthermore, the volume of honking and vehicles is way too high within metropolitan areas like Dhaka; it would be nearly impossible to isolate vehicles on their own.

So, a mechanism in each car to cut off the power supply to the horn, thus eliminating honking, was implemented. This was chosen as the more effective solution for our second stage.

3.5 Technical Design: Module Level

Figure 5 illustrates the system design of stage-1, where we detect and display road noise levels and display awareness messages accordingly. Table 1 provides a definition of the terms used in awareness messages:

Table 3.1: Message to Display at Stage-1

Noise Levels Measured	Message Displayed
less than or equal 55dB	Quite
between 56dB to 67dB	High
Greater than or equal 68dB	Very High

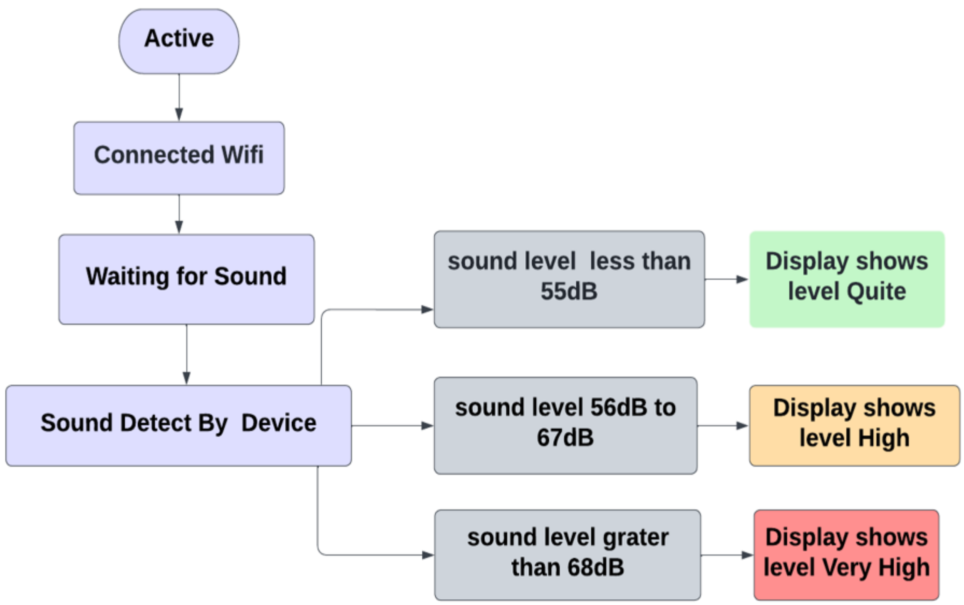

Figure 3.2: Flowchart of stage-1 [14]

A diagram of the system design for the third stage of control is shown in Figure 6, since it is essentially an extension of the second stage. Stage three is indicated by flowcharts that begin at the emergency point.

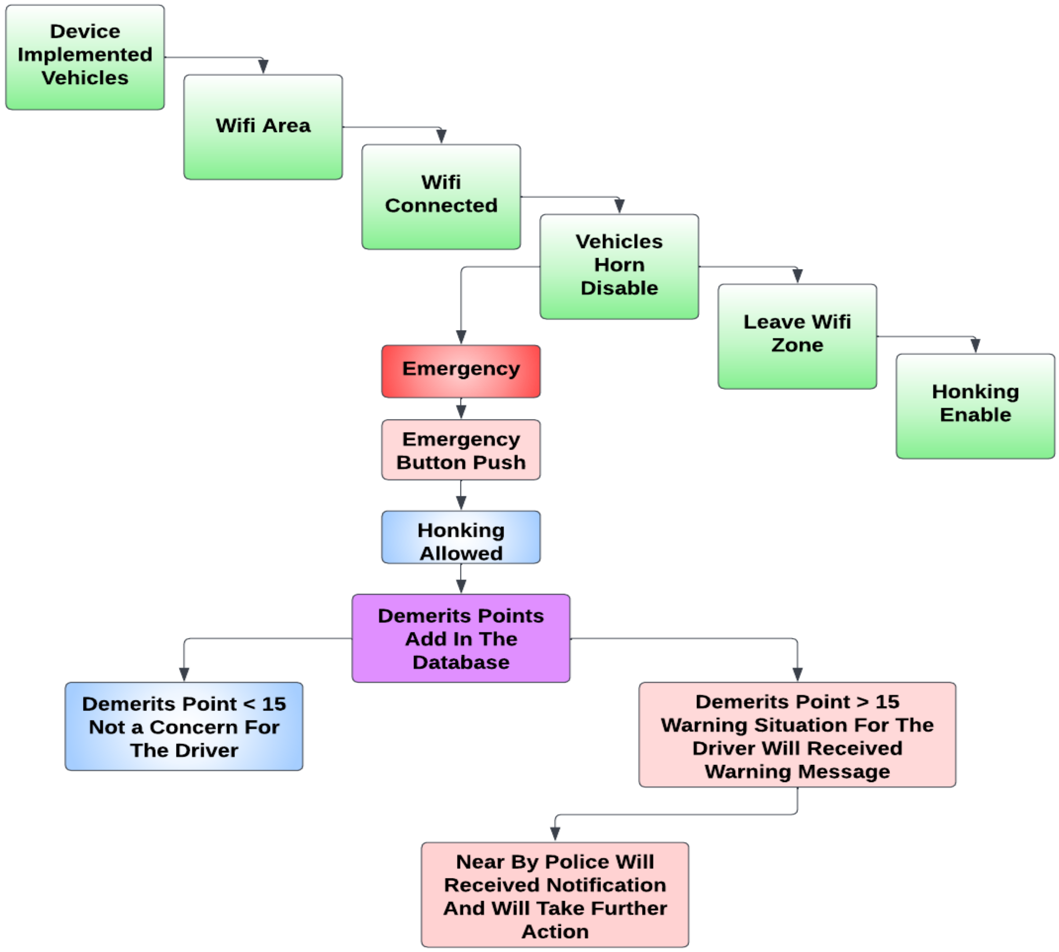

Figure 3.3: Architecture of stage 2 & stage 3 [14]

3.6 Measurement the noise parameter

Noise is characterized by the level of sound, the spectrum of its frequency, and its variation over time. Despite the fact that a person's subjective perception of loudness is crucial to determining the level of noise, the term sound level refers to a physical measurement based on variations in sound pressure. As a measure of acoustic level, sound pressure and intensity are typically used. This is also known as sound power density. It is the average rate of sound energy transmitted through a unit area perpendicular to the direction of sound propagation, typically measured in pW/m^2. Sound pressure is used as a measure of power levels since no instrument is available to directly measure power levels. There is a direct relationship between sound pressure and sound power.

In order to describe sound level, a logarithmic measure known as decibel (dB) is used due to the large range of numbers involved. As a measure of sound level, decibels are calculated as follows:

Sound level, $L(dB) = 10\ log_{10}\,(P/P_0)^2 = 20\ log_{10}\,(P/P_0)$ ………………………….(1)[18]

In this equation, P represents the root mean square sound pressure (N/m^2) and P_0 represents the standard reference pressure (20 μN/m^2). A decibel scale is used to measure sound levels from zero, which is the threshold for hearing, to 140 dB, which is the threshold for pain. The apparent loudness of a noise doubles for every three decibels increases in sound level. During sound level measurement, weighing filters are used to account for the ear's response to varying levels of noise.

In order to provide an accurate representation of a person's subjective response to variations in sound, the A-weighted sound level has been developed. Although originally intended for low-level sounds, A-weighting is now frequently used to measure environmental noise and industrial noise, as well as to assess the impact of noise on hearing and other health issues.

3.7 Requirements Skills

While the typical soft skills of communication and patience were required to complete this project, in terms of technical skills, we needed two major ones:

The ability to program in the language C/C++ using the ESP-32 platform. In addition, you will need an understanding of circuits and their components to be able to continuously debug and resolve hardware issues.

CHAPTER 4

EXPERIMENTAL RESULTS AND DISCUSSION

4.1 Introduction

Noise pollution and car horns are a nightmare. Nowadays, sounding a hydraulic horn is something of an achievement. Time is getting dark. Even though hydraulic horns are illegal, drivers forget about them. But city dwellers are fed up with the indiscriminate use of hydraulic horns, ubiquitous loudspeakers, and construction noise. Exposure to noise pollution increases the risk of heart disease and hearing loss among the elderly and children. Prolonged exposure to high levels of noise can cause hearing loss. Various complications can develop in the body. For example, excessive noise can increase the heart rate. It also increases the risk of heart disease.

Figure 4.1: Noise Pollution is harmful.[17]

4.2 Description of the Components

The components used in constructing the overall system of the prototype are

- ESP 32 Microcontroller
- LCD 16*2 Display
- I2C Module
- MP 1584 Step-down Converter
- Buzzer
- Jumper
- Sound Sensor

- SIM800L Module
- Breadboard
- Breadboard Power Supply

4.3 Test Requirements

In the first phase, we tested with the actual equipment involved in making the device, i.e. all the components listed. To test the second phase though, we added an LED for initial testing before connecting the circuit to the horn. A light off will indicate that the horn will not operate and vice versa. Hence the equipment for testing is as follows in table 3

Table 4.1: Components needed to prototype

Component	Quantity
ESP 32 Microcontroller	1
LCD 16*2 Display	1
I2C Module	1
MP1584 Step-down Converter	1
Buzzer	1
Jump wire	10
Sound Sensor	1
SIM800L GSM Module	1
Breadboard	1
Breadboard Power Supply	1

4.4 Technical Design: System Level

Compared to other systems, Nibir relies very little on equations, theories, or calculations. Amore application-based hardware system would be implemented through C/C++ programming language on ESP 32 Microcontroller software, implemented through conditions set via C/C++ programming.

Our prototype began with an ESP 32 Microcontroller connected to a sound sensor and LCD display, which was then programmed using ESP 32 Microcontroller Software. Figure 7 shows a circuit diagram, while figure 8 shows a photo of the prototype for stage 1.

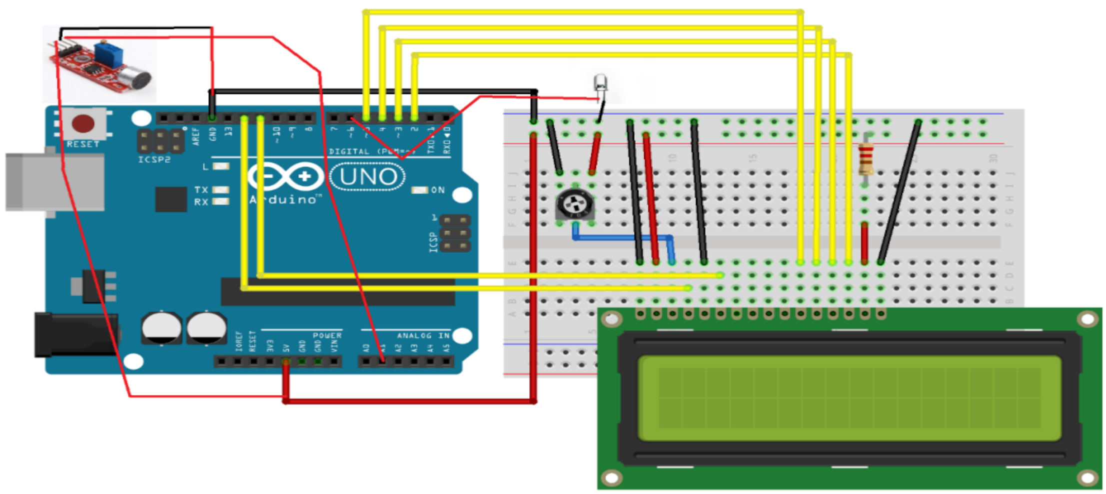

Figure 4.2: Stage-1 Circuit diagram [14]

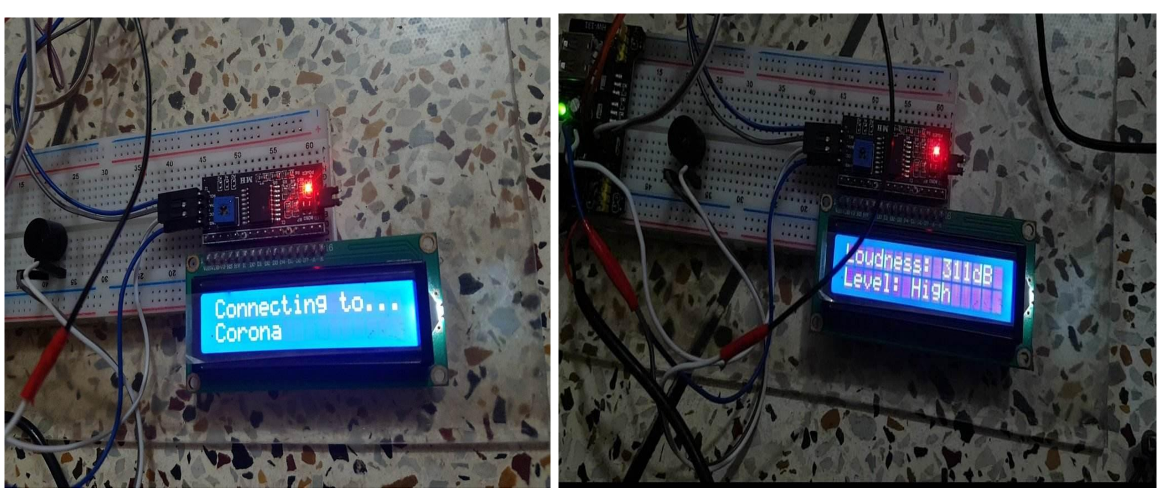

Figure 4.3: Stage-1 prototype

For phase 2, the prototype where our ESP 32 Microcontroller, in coalition with the SIM800L GSM Module, was connected to a switch that would turn on/off the horn. Again, the C/C++

program is run through the ESP 32 Microcontroller software to have connections to the SIM800L GSM and subsequently cut off the power supply to the horn.

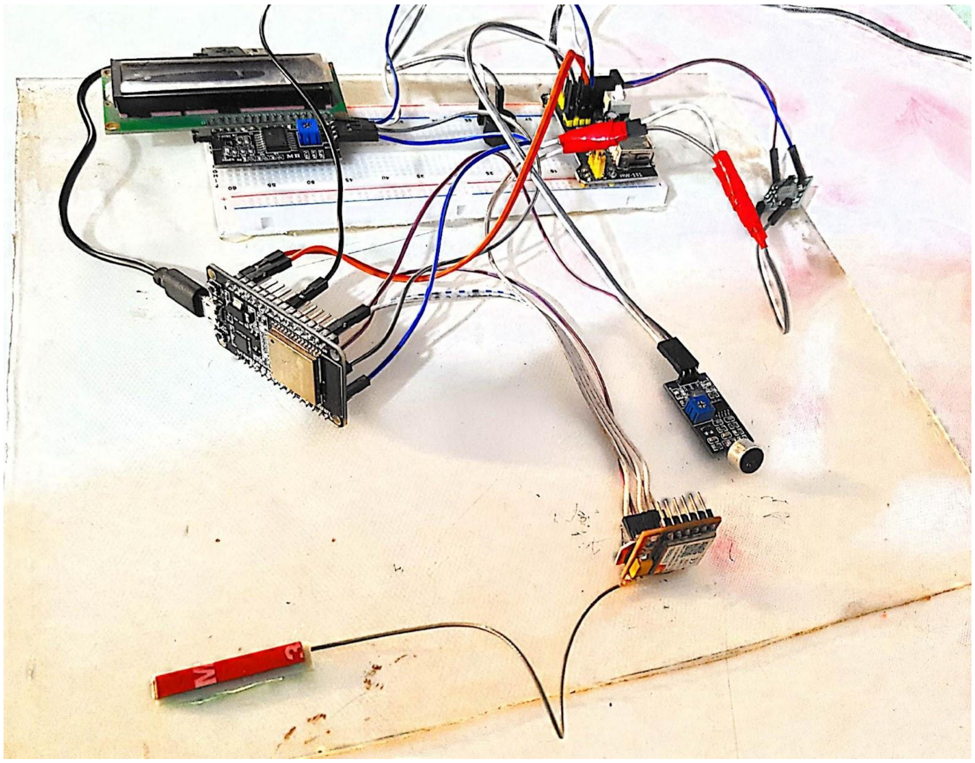

Figure 4.4: Stage-2 prototype

4.5 Hardware and Circuit Description

1) Creating stage 1 using sound sensor: We have connected the ESP32 microcontroller to this section using the sound sensor and LCD display. Our code has been written in the ESP32 IDE and burned into the ESP 32 Microcontroller in order to verify the hardware will work properly. Yes, it works in accordance with our expectations. An electronic display shows a noise level and message when a sound sensor detects sound.

2) Creating Stage 2 Using WiFi Module: The ESP-32 is connected here to an I2C module via a SIM800L GSM module. Since the car horn operates at 9V, the ESP-32 can supply 3.3/5V. A horn, a power and one connected to an ESP-32 which is converted to voltage using an I2C module. The ESP-32 was rated at 5V, but the supply was lacking and the SIM800L GSM Module rated at 3.3 V was unable to provide a stable power supply, causing it to perform erratically. Breadboard Power Supply stability was finally achieved by using it with a 3.3/5V I2C module. The code for the ESP-32 is written in the ESP-32 IDE so that it can be burned into the device to test its functionality. It works as expected according to our expectations. By connecting the Wi-Fi module to the router, the device is successfully connected to the Wi-Fi network; However, pressing the horn switch produces no sound.

3) Application Details: Our system includes an Android mobile platform. We divided the app into two sections, one for drivers and one for police. There's a requirement for the driver to register and put some information in such as their name, email address, password, vehicle number, and mobile number. The police are also required to register in order to check their database. All honking incidents were recorded in the database, which users could access via the application.

4.6 Financial Plan and Costs

It should be noted that when scaling up this prototype, further costs will be incurred. Software setup will incur a one-time cost. Each Arduino-based device will also cost the same.

However, considering that we would need to create multiple devices for a large volume of cars for the system to be effective. Also, LED displays cost thousands, so we would need to source funding from a significant source to pilot this prototype. Such sources we could turn to would include Government-based initiatives such as BASIS ICT Awards, or other competitions, such as the Urban Innovation Challenge, powered by BRAC.

4.7 Results and Discussion

In spite of compliance with a plan to build the systems, satisfactory results were obtained, with final outcomes conforming to expectations. Progress was significantly slowed by a number of issues, especially those related to voltage and power rating incompatibilities.

Stage 1: Measurement and awareness of the system

The Government enacted the Noise Pollution (Control) Rules, 2006 under the authority of the Bangladesh Environment Protection Act 1995 to control noise pollution. Noise levels are prescribed separately for peaceful residential areas, mixed areas, and commercial or industrial areas under the regulations. The Noise Pollution (Control) Rules, 2006 prescribe the noise level in the area

Table 4.2: Noise standards prescribed as per the Noise Pollution (Control) Rules, 2006

Zone Class	**Limits in dBa**	
	Daytime (6 a.m. – 9 p.m.)	**Nighttime (9 p.m.-6 a.m.)**
Silent zone	45	35
Residential zone	50	40
Mixed (residential/ commercial/industrial) zone	60	50
Commercial zone	70	60
Industrial zone	75	70

For stage 1, it was successfully detected that there was noise present. It distinguished between three different thresholds and displayed the appropriate messages as shown in the following example.

- It should be less than or equal to 50dB "Library QUIET"
- It is considered "Normal" for the sound level to be between 51 and 70dB
- 71dB or higher is considered "Noise Pollution"

Unfortunately, the final result shows that the sound sensors are not able to detect sound well. A hollow funnel around the sound sensor was later added to improve noise detection. A blurry message appears at first or the screen blinks continuously. With a potentiometer, the LCD can be powered more reliably and the voltage can be stabilized.

Stage 2: It involves a system for controlling and reducing noise pollution in silent no honking areas in addition to a reporting system that controls driver behavior.

When the device was connected to the Wi-Fi network, there was no sound coming from the horn after pressing the switch.

Moreover, users could log in and view their honking records through the app interface, while incident reports were stored in a database..

However, this episode also had power supply issues. Initially, when the ESP-32 microcontroller was rated at 5V, it seemed to lack supply and the SIM800L GSM Module rated at 3.3 V was not able to provide a stable power supply, causing it to operate erratically. SIM800L GSM Module stability is finally achieved by using a 3.3/5 power supply module.

Furthermore, the horn was rated to operate at 9V, while the circuit was operating at 3.3V. An MP1584 Step-down Converter was subsequently used to solve this inconsistency problem.

CHAPTER 5

IMPACT ON SOCIETY, ENVIRONMENT AND SUSTAINABILITY

5.1 Financial perspective

As stated within our financial breakdown, there is only a one-time set-up cost for the software. While due to hardware such as large LED displays, and a large number of devices to incorporate within individual vehicles, the cost would be too much to bear from the pockets of the four team members, in terms of the greater picture, this project would not be too expensive for potential investors to invest their capital in.

5.2 Resource Availability

In terms of resources for our project, they are easily available at low costs. From ESP 32 Microcontroller, to SIM800L GSM Module, to basic circuit components, to scaling up to larger LED displays for the road, the equipment is easily accessible with appropriate capital.

5.3 Safety Issues

The system is reasonably safe to use. There is no risk of accidents here. Using the system, condensation will be prevented. The only concern arises when there is a genuine need within the "silent zone" to sound a horn to warn someone of impending danger - in that case, it would be detrimental to abolish the use of the horn altogether. The horn can be heard in quiet areas in some emergency situations. For which there will be a separate button. It can be used only in an emergency. However, our entire third phase is designed to address this issue.

5.4 Impact on Society

This system is of high social importance. It is expected that the ultimate goal will significantly improve the quality of life in urban areas. This is because there would be fewer risks of hearing damage. Furthermore, less usage of honking may encourage drivers to follow driving rules better, leading to less chaotic and safer roads.

For the sake of building a civilized society, and creating intelligent, elegant, and developed future generations, the issue of noise pollution control is considered to be a social and state responsibility that is taken very seriously today.

Loud honking of vehicles, sounds of engines and construction work, and noise of building demolition are the main causes of noise pollution in the capital and other populous cities of the country. More noise pollution is caused mainly by hydraulic horns used in vehicles or by microphones or audio players (cassette pairs). Men and women who play on busy city roads are seriously injured by the sound of hydraulic horns used by buses, trucks, and scooters.

Mohammad Solaiman Haider, director of the Department of Environment, said there is no option for people to be "aware and controlled" to prevent noise pollution.

The noise pollutants of Dhaka metropolis are consequently destroying the hearing ability of heaps of children each moment. Professionals say that if an infant under the age of three hears a legitimate sound level of 100 dB from close range, he can lose his hearing. Different elements were harmful to the physical development of children, including loud noises from radios, televisions, cassette players, and microphones and high levels of shouting, commotion, and noise. People commonly listen to sounds in the 15 to 20 kilohertz (kHz) frequency range.

Noise pollution should be brought to a controlled level not only through legislation but also through its proper implementation. Make the country truly livable for future generations by ensuring people's complete connection with melodious sounds, eliminating unvoiced sounds, and bringing them to a regulated level in some areas.

5.5 Impact on Environment

Environmental pollution has reached an intolerably high level. Our environment is polluted in various ways. One of the major contributors to environmental pollution is noise pollution.

As previously reported, the Economist Intelligence Unit (EIU), a well-known United Kingdom policy institute, released (in September 2019) a list of unlivable cities across the globe. According to that listing, Dhaka ranks 0.33 from the bottom of the list of the most inhospitable towns in the world. In other words, only two cities after Dhaka are among the most unlivable cities on the list of the lowest 10 countries. Culture and the environment are among the characteristics that were determined in determining the livability of cities. So naturally, noise pollution is also covered.

It is true that there are a number of discussions and criticisms about this report. It is my hope that many will agree with me that noise pollution in Dhaka can be controlled in a variety of ways. If we consider Dhaka in terms of its potential, there is no way to deny that it is possible to move forward in many other areas. This includes noise pollution, as well as livability.

In this context, it is necessary to mention that if awareness can be created from childhood to prevent any environmental pollution including noise pollution, then these children can grow up to become not only responsible citizens but also environmentally conscious citizens.

The crux of our project is designed to provide environmental benefits, by minimizing a specific form of pollution – sound or noise pollution. By offering environmentally friendly solutions, it aims to contribute to a "greener earth technology."

5.6 Ethical Aspects

Noise pollution is constantly increasing in the city. There are no ethical conflicts created by our project. This pollution has worsened day by day. Currently, about 43 million people in the world suffer from hearing problems. And rickshaw drivers suffer the most from this problem in Bangladesh. They are followed by traffic police and Laguna drivers. The picture above is the result of a study conducted by the Bangladesh University of Health Sciences. The institute conducted research on Bangladesh Road noise pollution in Bangladesh and hearing problems of road workers due to noise pollution.

If anything it encourages drivers to act more ethically by properly following traffic rules. By implementing it, motorists will be discouraged from excessive honking and reckless driving. As many as 65% of site visitors and policemen manning roads in the Bangladeshi capital Dhaka are experiencing sleep disturbances as a result of excessive noise pollution within the city. This is in accordance with a study carried out by Bangabandhu Sheikh Mujib clinical college.

CHAPTER 6

CONCLUSION & FUTURE WORK

6.1 Conclusion

Noise pollution is a major health concern. It is obvious that technology-based systems can contribute significantly to the environment, given all the possibilities. The government's support could make its use widespread across capital cities like Dhaka.

The system received a lot of approval from the audience during its screening; they could relate to the issue and praised us for our efforts because they believed that it would have a significant impact. The residents of our metropolitan area of Dhaka appreciated the solutions provided and wished us well. With such recommendations and feedback, we are encouraged to refine our project even further.

6.2 Limitation & Future Work

As a result of some limitations, we are unable to make the system completely functional. WiFi connections between microcontrollers and routers are extremely slow. Records are not saved every second in the Thingspeak database; they are saved every 15 seconds. Occasionally, the sound sensor provides the same output.

It is possible to improve the technological system to make it even more effective in the case of an emergency in stage 3. In the future, it is possible that devices within vehicles can be programmed to continuously monitor the horn usage of cars on the road at all times. This will facilitate future work.

Each vehicle's registration number can be associated with the device installed on it. In this way, the driver's hydraulic horn is monitored by this device, which serves as a counter. The microcontroller within the device is also capable of recording the duration of long incessant honking in addition to counting the number of times a driver honks. As soon as the device connects to Wi-Fi networks in designated areas within the city, it can return this information to the central database at regular intervals. The most traveled streets within the city can be considered potential candidates for these Wi-Fi networks.

In order to determine the maximum acceptable number of times (or duration) for honking, a threshold can be established. The database will include information about drivers who exceed this threshold. SMS notification will be sent to the owner or driver of the vehicle as soon as the violation has been detected. In this case, appropriate action may be taken. In addition, the appropriate authorities receive notification of the offense so that they can identify the offender and punish them appropriately.

Finally, to take this project to any further exhibitions or showcases we must test it thoroughly using Human Centered Design (HCD). Problem-solving can be creative when HCD keeps the target group of the problem and the solution in mind. While we have thoroughly thought through the technical aspects of our project, we have not carried out sufficient surveying to verify our assumptions and validate our solutions.

Our HCD process is divided into three phases. The Inspiration Phase enables us to gain a deep understanding of our target audience by immersing ourselves in their lives; the Ideation Phase enables us to identify opportunities for design and prototype possible solutions using our learning; the Implementation Phase enables us to bring our solution into existence, and ultimately to market. Keeping the target group at the center of the process greatly increases the chances of solutions becoming a success. Thus, we can improve our project further so that it is acceptable to all relevant stakeholders - the government, drivers, pedestrians, and residents of major cities.

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