AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Urban design and urban planning

Effects of socio-morphological dimensions on noise mitigation in public spaces

A Thesis submitted in partial fulfillment of the requirements of the degree of

Doctor of Philosophy in Architectural Engineering

(Urban design and urban planning)

by

Nardine Mansour Mohamed Mansour El-Bardisy

Master of Science in Integrated urbanism and sustainable design

Stuttgart university, Stuttgart, Germany , 2019

Ain shams university, Cairo, Egypt , 2021

Supervised By

Prof. Abeer Elshater

Dr. Samy Afifi

Dr. Abdulmoneim Alfiky

Cairo - (2024)

AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Urban Planning

Effects of socio-morphological dimensions on noise mitigation in public spaces

by

Nardine Mansour Mohamed Mansour El-Bardisy

Master of Science in Integrated urbanism and sustainable design

Stuttgart university, Stuttgart, Germany , 2019

Ain Shams university, Cairo, Egypt , 2021

Examiners' Committee

Name and Affiliation	**Signature**
Prof.Ayman Hassan Architecture , Cairo University	……………….
Prof . Ahmed Sami Urban Planning, Ainshams University	……………….
Prof.Abeer Elshater Urban Planning, Ainshams University	……………….
Dr.Samy Afifi Urban Planning, Ainshams University	……………….
Dr. Abdulmoneim Alfiky Urban Planning, Ainshams University	……………….

Date:

Statement

This thesis is submitted as a partial fulfillment of Doctor of Philosophy in Architectural Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

Student name

Signature

…………...……….

Date: 28 April 2024

Researcher Data

Name	**Nardine Mansour Mohamed Mansour El-Bardisy**
Date of birth	01 January 1994
Place of birth	Cairo
Last academic degree	Master of Science degree
Field of specialization	integrated urbanism and sustainable design
University issued the degree	Stuttgart university, Stuttgart, Germany and Ain shams university, Cairo ,Egypt
Date of issued degree	2019-2021
Current job	urban designer freelancer engineer

Abstract

This research focuses on the noise environmental awareness of individuals and environmental stress caused by noise pollution. Socio-morphological dimension impact on noise mitigation in public space, where socio-morphological dimension clarify the morphology of the city in respect to its physical pattern, culture and social aspects. From a global perspective, several research groups acknowledge the benefits of covid lockdown on the environment. Other researchers have documented the adverse impact of human use on nature, all over the years, studies show that we need 1.6 earth to cope with human demand. In addition to, the increase of ecological footprint and earth overshooting day change and environmental stress increased. All that reflects the relation between environmental awareness's powerful impact, environmental stressors, and environmental protection. As a result of Reviewing the global relevant literature which indicates that earth overuse challenge and lots of environmental stressors that impact human individual awareness, Additionally, Cairo, Egypt is the second noisiest city in the world. So, research deeply analyze noise in a specific case study in Egypt based on certain criteria and simulations, in parallel to the examination of environmental awareness about noise pollution in that context. Analyzing environmental awareness and noise using online questionnaires, observation, sound level meter, computer software and mapping tools. Our results confirmed the gap between the desired and current state of noise pollution in certain locations and the environmental awareness of individuals has drawbacks. The research ends up with an action plan for noise mitigation and environmental awareness dividing responsibilities into diverse levels. Action plans include noise mitigation strategies during the design process, toolkit for noise mitigation, guide for Egypt environmental affairs agency (EEAA). Moreover, enhancing environmental awareness about noise includes knowledge, skill, and motivation enhancement. Also, the recommended steps for the action plan implementation in case of any other environmental stressor and the future consequences of that action plan.

Keywords:

Earth overshooting day, Ecological footprint, Egyptian context, Environmental awareness, Environmental education, Environmental protection, Environmental psychology, Environmental stressors, individual awareness, Noise pollution

Acknowledgment

This work would not have seen light without God's blessings and the blessings of my dear family and friends. Throughout this research, I had the support of many people, and words won't be able to express my appreciation and gratitude towards them.

I hereby give credit to my family. I would like to deeply thank you for everything you have done for me. Thanks for always staying by my side during the whole process. Thanks for believing in me and supporting my choices. Thanks for your prayers. Thanks Mansour El Bardisy, Nadia El Dewany, Hadeel El Bardisy, Wesam El Bardisy, Juwana Mohammed, and Mohammed Lotfy

I would like to express my deepest appreciation to my supervisor, Prof. Abeer Elshater, for her continuous support, patience, immense knowledge, and constructive feedback that helped me during my PHD process. I would also like to express my deepest appreciation to Dr. Samy Afifi for his continuous enthusiasm, encouragement, patience, guidance, and useful comments that helped me in the research process. I gratefully thank Dr.Abdulmoneim Alfiky for his useful comments, advice, and support.

April 2024

Table of Content

List of Figures

List of Tables

List of Abbreviations

Abbreviations	Full description
dB	Decibels
EEAA	Environment Egyptian Affair Agency
EPI	Environmental Performance Index
SPL	Sound pressure level.
gha	Global hectares
GHG	Green House Gas
HDI	Human development index
IPCC	Intergovernmental Panel on Climate Change
NC	Noise criteria rating
RT	Reverberation time
SDGS	Sustainable Development Goals
STC	Sound Transmission Class
UNEP	United Nations Environmental Programs
WMO	World Meteorological Organization

List of Definitions

Name	Definition
Absorption coefficient	The fraction of sound energy that is absorbed at any surface. It has a value between zero and one and varies with the frequency and angle of incidence of the sound.
Architectural Acoustic	The technology of designing spaces, structures, and mechanical systems to meet hearing needs – "wanted" vs. "unwanted" sounds or "noise"
A Weighting	The most common weighting that is used in noise measurement is A-Weighting. Like the human ear, this effectively cuts off the lower and higher frequencies that the average person cannot hear. Defined in the sound level meter standards (IEC 60651, IEC 60804, IEC 61672, ANSI S1.4), a graph of the frequency response can be seen to the right.A-weighted measurements are expressed as dBA or dB(A). Source: https://www.noisemeters.com/help/faq/frequency-weighting/
Biocapacity	Biocapacity refers to the capacity of a given biologically productive area to generate an on-going supply of renewable resources and to absorb its spillover wastes. Source : https://www.greenfacts.org/glossary/abc/biocapacity.htm
C Weighting	The response of the human ear varies with the sound level. At higher levels, 100 dB and above, the ear's response is flatter, as shown in the C-Weighted Response to the right. Although the A-Weighted response is used for most applications, C-Weighting is also available on many sound levels meters. C Weighting is usually used for Peak measurements and in some entertainment noise measurement, where the transmission of bass noise can be a problem.

	C-weighted measurements are expressed as dBC or dB(C). Source: https://www.noisemeters.com/help/faq/frequency-weighting/
Cop21	The 2015 United Nations Climate Change Conference, COP 21 or CMP 11 was held in Paris, France, from 30 November to 12 December 2015. Source: https://www.cop21paris.org/
Decibels (dB)	unit for expressing the ratio between two physical quantities, usually amounts of acoustic or electric power, or for measuring the relative loudness of sounds. Source: https://www.britannica.com/science/decibel
dB(A)	A sound level meter reading with an A-weighting network simulating the human-ear response at a loudness level of 40 phones.
Earth shooting day	Earth Overshoot Day marks the date when humanity has exhausted nature's budget for the year. Source: https://www.footprintnetwork.org/our-work/earth-overshoot-day/
Ecological footprint	A method promoted by the Global Footprint Network to measure human demand on natural capital, Source: https://www.footprintnetwork.org/our-work/ecological-footprint/
Environmental Performance Index (EPI)	The 2020 Environmental Performance Index (EPI) provides a data-driven summary of the state of sustainability around the world. Using 32 performance indicators across 11 issue categories, the EPI ranks 180 countries on environmental health and ecosystem vitality.

	Source: https://epi.yale.edu/
Environmental protection	is the practice of protecting the natural environment by individuals, organizations, and governments. Its objectives are to conserve natural resources and the existing natural environment and, where possible, to repair damage and reverse trends.
Environmental protection agencies	the Intergovernmental Panel of Climate Change (IPCC) established by the United Nations Environment Program (UNEP) and the World Meteorological Organization (WMO), and the Global Environment Facility (GEF). Source: https://link.springer.com/referenceworkentry/10.1007%2F978-3-642-28036-8_385
Environmental psychology	Environmental psychology is the study of transactions between individuals and their physical settings. In these transactions, individuals change the environment, and their behaviour and experiences are changed by the environment. Environmental psychology includes theory, research, and practice aimed at improving our relationship with the natural environment and making buildings more humane. Source: https://www.psychology.org.au/About-Us/What-we-do/advocacy/Advocacy-social-issues/Environment-climate-change-psychology/Psychology%E2%80%99s-role-in-environmental-issues/What-is-environmental-psychology
Field Sound pressure level (SPL)	Field Sound pressure or acoustic pressure is the actual field pressure deviation from the ambient (average or equilibrium) atmospheric pressure, caused by a sound wave. In air, sound pressure can be measured using a microphone, and in water with a hydrophone. The SI unit of sound pressure is the pascal (Pa) source:

	https://www.engineeringtoolbox.com/sound-pressure-d_711.html
Global hectares (gha)	Global hectares are the accounting unit for the Ecological Footprint and Biocapacity accounts. These productivity weighted biologically productive hectares allow researchers to report both the biocapacity of the earth or a region and the demand on biocapacity (the Ecological Footprint). A global hectare is a biologically productive hectare with world average biological productivity for a given year. Global hectares are needed because different land types have different productivities. A global hectare of, for example, cropland, would occupy a smaller physical area than the much less biologically productive pasture land, as more pasture would be needed to provide the same biocapacity as one hectare of cropland. Because world productivity varies slightly from year to year, the value of a global hectare may change slightly from year to year. Source: https://www.footprintnetwork.org/resources/glossary/
Green House Gas (GHG)	Greenhouse gases, or GHGs, are compound gases that trap heat or longwave radiation in the atmosphere. Their presence in the atmosphere makes the Earth's surface warmer. Sunlight or shortwave radiation easily passes through these gases and the atmosphere. This radiation is absorbed by the surface of the earth and released as heat or longwave radiation. The molecular structure of GHGs allows them to absorb the heat released or trap them in the atmosphere and re-emit them back to the earth. This heat trapping phenomenon is known as the greenhouse effect. The accumulation of GHGs since the industrial revolution has accelerated this greenhouse effect, causing global warming and climate change. Source: https://www.esg.adec-innovations.com/about-us/faqs/what-is-ghg/

Human development index (HDI)	The Human Development Index (HDI) is a summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living. The HDI is the geometric mean of normalized indices for each of the three dimensions. Source: http://hdr.undp.org/en/content/human-development-index-hdi
Intergovernmental Panel on Climate Change (IPCC)	The Intergovernmental Panel on Climate Change (IPCC) is an intergovernmental body of the United Nations[1][2] that is dedicated to providing the world with objective, scientific information relevant to understanding the scientific basis of the risk of human-induced[3] climate change, its natural, political, and economic impacts and risks, and possible response options
LAeq	LAeq is a fundamental measurement parameter designed to represent a varying sound source over a given time as a single number. This number is a measure of the energy contained within the sound at the point of the receiver. This is useful in terms of the potential for sound to damage or disturb and is extensively used in environmental noise standards as well as many other regulations and documents. Source: https://www.castlegroup.co.uk/guidance/noise-at-work-assessments/what-is-leq/
L10	L10 is the noise level exceeded for 10% of the time of the measurement duration. This is often used to give an indication of the upper limit of fluctuating noise, such as that from road traffic. Source: https://www.castlegroup.co.uk/guidance/environmental-noise/percentile-levels/
L50	L50 is the noise level exceeded for 50% of the measurement duration. It is the middle point and has

	been incorporated in some American Community Noise Assessments. Source: https://www.castlegroup.co.uk/guidance/environmental-noise/percentile-levels/
L90	L90 is taken to be the ambient or background noise level as used, for example, in BS 4142 ‘Rating Industrial Noise Affecting Mixed Residential and Industrial Areas’. Source: https://www.castlegroup.co.uk/guidance/environmental-noise/percentile-levels/
1/1 Octave Band and 1/3 Octave Band	1/1 Octave Band measurements are used when the frequency composition of a sound field is needed to be determined. Octave analysis is often used in noise control, hearing protection and sometimes in environmental noise issues. The common octave frequency bands are: — 31Hz, 63Hz, 125Hz, 250Hz, 500Hz, 1kHz, 2kHz, 4kHz, 8kHz and 16kHz – and their composition is made up of the Lower Band Limit, Centre Frequency and Upper Band Limit. 1/3 Octave Band Noise Measurements Mainly used in environmental and noise control applications, 1/3 Octave Bands provide a further in-depth outlook on noise levels across the frequency composition. Each 1/1 (single) Octave is further split into three, providing a more detailed view of noise content. Source:https://www.castlegroup.co.uk/guidance/octave-bands/
Noise criteria	Standard spectrum curves by which a given measured noise may be described by a single NC number.
Pro-environmental behavior	Pro-environmental behavior are daily undertaken by individuals who voluntarily spend time and money to promote a sustainable environment. To effectively

	manage the environment, a clear understanding of such pro-environmental activities is necessary. Source: https://link.springer.com/article/10.1007/s10834-013-9354-3
PM2.5/ PM10	Particulate Matter (PM) is a mixture of solid and liquid particles that are suspended in the air. These are categorized into coarse, fine, and ultrafine. Coarse particles have a diameter of 2.5 micrometers to 10 micrometers (about 25 to 100 times thinner than a human hair), are relatively heavier and thus tend to settle. Dust, spores, and pollen are some examples. PM2.5 refers to particles that have diameter less than 2.5 micrometers (more than 100 times thinner than a human hair) and remain suspended for longer. These particles are formed because of burning fuel and chemical reactions that take place in the atmosphere. Natural processes such as forest fires also contribute to PM2.5 in the air. These particles are also the primary reason for occurrence of smog. PM10 refers to particles that have diameter less than 10 micrometers and remain suspended for longer. Source: https://www.airveda.com/blog/what-is-pm2-5-and-why-is-it-important
Reverberation time (RT)	The persistence of sound after the sound source has ceased, as a result of repeated reflections in an enclosed space. Most simply put it is the time required to drop 60 decibels below the original sound level.
Runway of Airport	according to the International Civil Aviation Organization (ICAO), a runway is a "defined rectangular area on a land aerodrome prepared for the landing and takeoff of aircraft". Runways may be a man-made surface (often asphalt, concrete, or a mixture of both) or a natural surface (grass, dirt, gravel, ice, sand or salt).

Sustainable Development Goals (SDGS)	The **Sustainable Development Goals (SDGs)** or **Global Goals** are a collection of seventeen interlinked objectives designed to serve as a "shared blueprint for peace and prosperity for people and the planet, now and into the future
Sound Transmission Class (STC)	Sound Transmission Class (or STC) is an integer rating of how well a building partition attenuates airborne sound. In the US, it is widely used to rate interior partitions, ceilings, floors, doors, windows and exterior wall configurations.
Sound pressure level (SPL)	Sound pressure or acoustic pressure is the pressure deviation from the ambient (average or equilibrium) atmospheric pressure, caused by a sound wave. In air, sound pressure can be measured using a microphone, and in water with a hydrophone. The SI unit of sound pressure is the pascal (Pa) source: https://www.engineeringtoolbox.com/sound-pressure-d_711.html
Sound level meter	A sound level meter (also called sound pressure level meter (SPL)) is used for acoustic measurements. It is commonly a hand-held instrument with a microphone. The best type of microphone for sound level meters is the condenser microphone, which combines precision with stability and reliability.[1] The diaphragm of the microphone responds to changes in air pressure caused by sound waves. That is why the instrument is sometimes referred to as a sound pressure level meter (SPL).
United Nations Environmental Programs (UNEP)	UNEP is the global champion for the environment with programmes focusing on sustainable development, climate, biodiversity and more. Source:

	https://www.unep.org/
World Meteorological Organization (WMO)	The World Meteorological Organization is a specialized agency of the United Nations responsible for promoting international cooperation on atmospheric science, climatology, hydrology and geophysics Source: https://public.wmo.int/en

(1) Introduction

1.1 General introduction

The urgence of saving the environment and improving environmental sustainability, in addition to my prior studies of urban design, sustainable development, environmental studies, and planning studies, gives me the motivation to conduct this research. Noise as part of the environment cause lots of environmental and health issues that impact human productivity, so it is important to have deep understanding of the root cause of problem from global perspective to local perspective reaching case study investigation.

Overusing earth resources has severe negative effects on both the global and local scales since it depletes supplies for future generations. Indeed, it is a thread for the 17 SDGs (sustainable development goals) and the general sustainability of cities (United nations environmental programme, 2022) Since everyone has a responsibility to protect the environment, both on a governmental and personal level, it is crucial to draw attention to this pressing matter.

People are the principal actors in the physical environment, which affects how psychologically responsive they are to their surroundings (Stokols & Altman, 1987) People respond to the environment differently depending on their environmental altitude, which they gauge through their judgement of the surroundings (Stokols & Altman, 1987; Bechtel & Churchman, 2002). They can be proactive people eager to improve their surroundings, or they can be passive people who simply accept and adapt to their surroundings. Because of its pollution, including "heat pollution," "visual pollution," "noise pollution," and "air pollution," the physical environment can be uncomfortable (Stokols & Altman, 1987). The study looks on the relationship between personal environmental awareness and environmental stressors.

Through case study analysis and individual responses to the current and desired condition, the research delivers a deeper knowledge of how people perceive their environments. The findings of the case study in-depth explain this. Following that, a variety of methods for improving personal environmental awareness may be found, which improves comprehension and acceptance of environmental protection rules.

In conclusion, People are actively behaving and influencing the environment, it is crucial to stimulate their direct and indirect environmental consciousness. In addition to the direct method through the global approaches and policies that cities try to apply, there is also an indirect method through enhancing affecting elements like environmental stressors. Mahatma Gandhi once said, "If you want to change the world, start with yourself," and he made this statement about the dire state of our planet.

1.2 Problem description

Global Footprint Network claims that human activity exceeds the ann ual budget for natural resources set by the planet. “Earth over shooting day” indicate that humanity use for earth is 1.6 times faster than our planet’s ecosystems can regenerate itself (Global footprint netwrok, 2023). The studies show that every year, "Earth Over Shooting Day" comes earlier, which causes lots of problems. If we look at the global footprint network's presentation of the earth o vershooting day from 1970 to 2020. in 1970, we used one earth by December, but this value changed over time to be August in 2020, as shown in Figure 1. 1 (Earth over shoot day , 2022). *"We have only got one Earth – this is the ultimately defining context for human existence. We can't use 1.6 without destructive consequences,"* said Mathis Wackernagel, co-inventor of Ecological Footprint accounting and founder of Global Footprint Network (Global footprint netwrok, 2023).

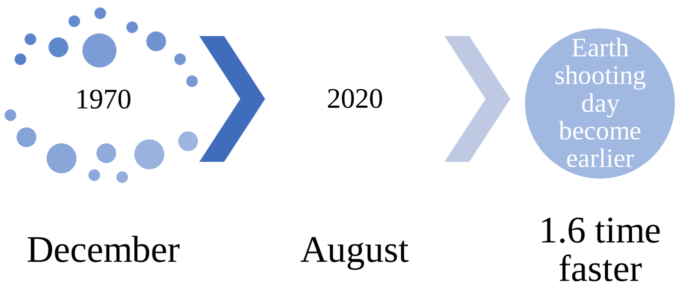


Figure 1. 1 Earth shooting day (1970-2020),source : author

Focusing on people as the smallest unit is crucial for improving the problem since doing so will have an impact on everyone and everything on the globe. The Global Footprint Network open platform provides a comprehensive "global footprint" analysis that quantifies the entire number of natural resources used by all people relative to the world's natural resources in global hectares (Global footprint network, 2023). It is evident that China, United states of America and India have highest value as industrial countries which impact other countries for instant Egypt.

Everyone does have a significant role in the whole system, as was sh own during the COVID 19 lock down, which reduced human influen ce on natural resources as evidenced by in Figure 1. 2. Moreover, earth shooting day in 2020 was august although in 2019 was July but after lock down regulation decreased it became in July again in 2021 (Earth over shoot day , 2022).

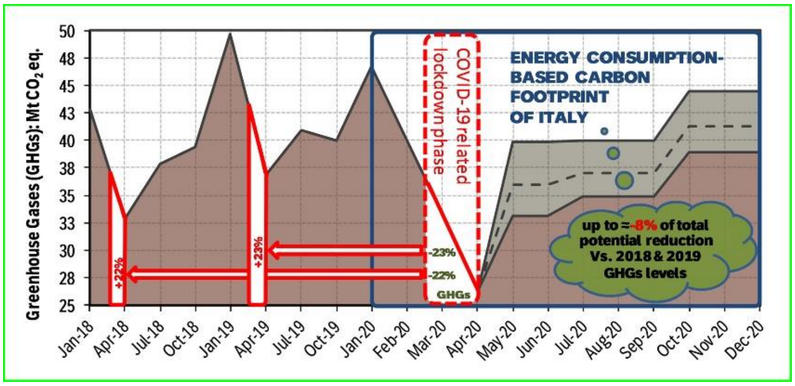


Figure 1. 2 Ecological footprint all over the world, source: (Benedetto & Dario , 2020)

An individual is affected by a wide range of components of daily life when viewed as a system. As an urban planner, I am aware of how the local population is impacted by the physical environment. Due to many factors as noise, air pollution, crowding, traffic, etc., the physical environment can be distressing for people. Problems with how people react to these stressors because of their nature can arise (Stokols & Altman, 1987).

In a nutshell, it is necessary to develop innovative strategies to raise a wareness of environmental issues on all levels. As the overuse of earth's nature became more and more critical nowadays as indicated by the ecological footprint statics and the rate of change of earth shooting day.

The research problem is noise pollution in Cairo as an environmental problem and a consequence of human use of nature. In addition to that, Cairo is the second noisiest city in the world. To preserve the environment, research aims to close the gap between desired and actual noise level and noise environmental awareness. A graphic illustrating the research challenge and its breadt h is shown in Figure 1. 3 .

Enhancing urban environmental stressors can lead to increased community environmental awareness, which could result in a reduction in human use of nature. Since the research attempts to improve the environmental awareness of the community in correlation with the environment, The research seeks long-term environmental sustainability, social sustainability, and ecological footprint reduction. It also reflected three SDGS goals, which are goal 8, goal 11, and goal 13. Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all, as research seeks a more productive community after achieving a comfortable environment. Also, make cities and human settlements inclusive, safe, resilient, and sustainable since research focuses on having more sustainable, healthier cities. Finally, take urgent action to combat climate change and its impacts because research will reduce environmental pollution impacts.

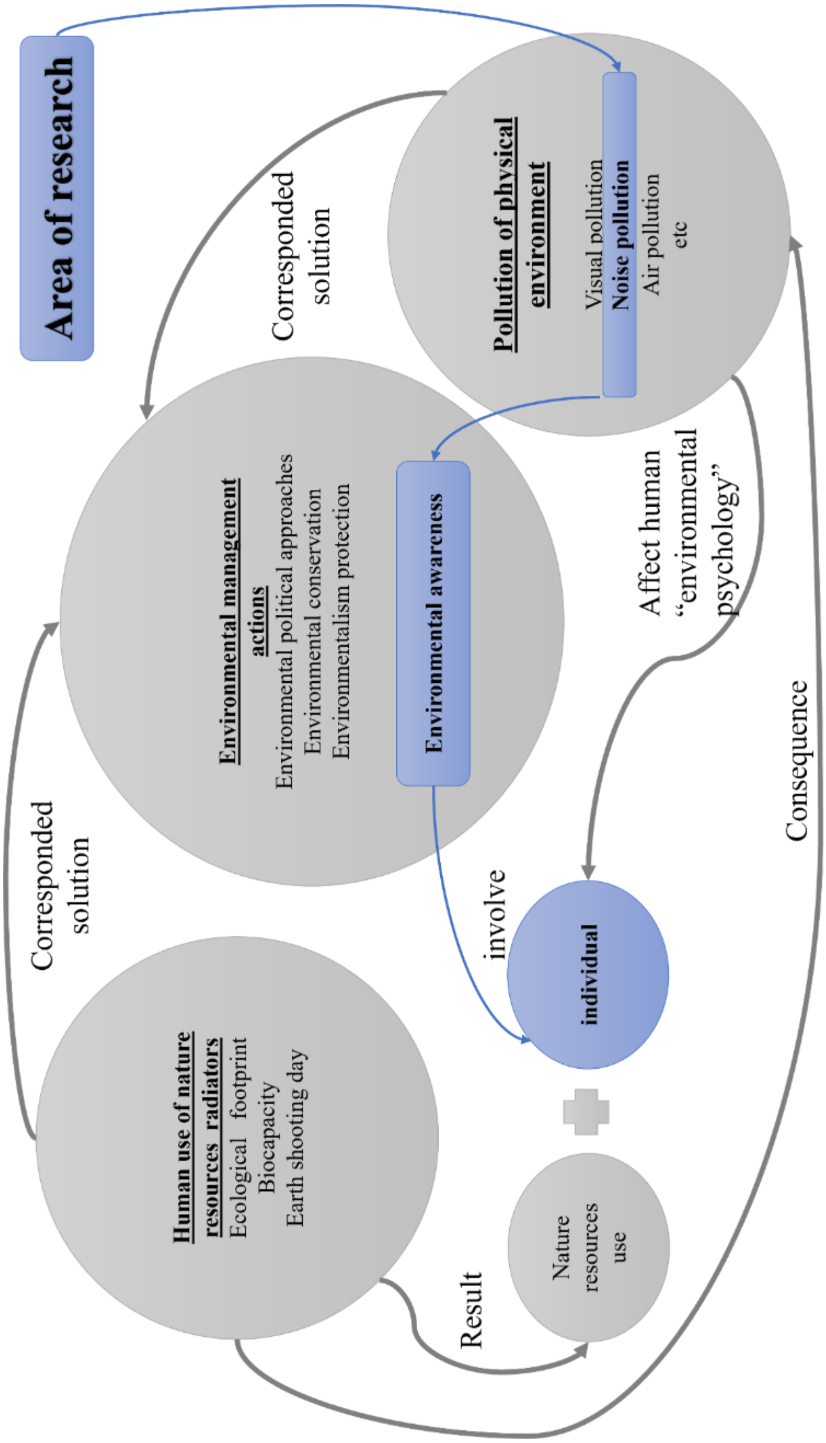


Figure 1. 3 Research problem diagram and research scope, source: Author

1.3 Research questions and research objectives

To accomplish the primary goal and its sub goals, the study focuses on providing answers to the collection of sub questions as well as the main question.

Main Question

How to reduce noise environmental stress and enhance noise environmental awareness in public spaces?

Sub Questions

1. How can environmental awareness play a role in individuals' perceptions of environmental protection strategies?
   1.1 why environmental natural resources became a critical challenge as indicated by earth shooting day and ecological footprint?
   1.2 What are the approaches taken to overcome it on various levels?
   1.3 What are environmental awareness and environmentalism political ideologies?
2. How does the urban physical environment impact individuals' environmental awareness?

2.1 How can the environment become stressful for individuals?

3. What is the current noise level and noise environmental awareness in Cairo, Egypt?

   3.1 What is the current level of noise pollution?

   3.2 What is the desired state of pollution based on regulations?

   3.3 What is the awareness level of the individual about the problem?

   3.4 What is the individual's response to that environmental problem?

4. What are the techniques (* ways, strategies, and policies) that can be used to mitigate noise?

Main objective

To improve noise stress and its environmental awareness in public spaces.

Sub objectives:

1. To recognize the dramatic changes in natural resources all over the years and strategies to overcome them, in addition to individual roles in that challenge.

2. To find the interlink between human responses to the environment and the physical environment.

3. To understand environmental awareness in relation to noise environmental problems.

4. To improve noise stress and environmental awareness indicators on various scales through certain strategies.

1.4 Methodology

To conduct this research and answer main and sub questions, the study relies on interrelated links between the theoretical and empirical frameworks explaining research design, as shown Figure 1. 4 .

1.4.1 Theoretical explanation

The main concept of the theoretical part is to give deep clarification about the problem and its related topics. The first section focuses on the problem of earth overshooting phenomena and ecological footprints, then the approaches that came up as responses, for instance: environment protection policies, environmental awareness strategies, etc.

The second section describes the individual as a complex system. The research identifies the concept of environmental psychology. In addition to the influence of environmental factors on individuals. Reviewing that literature gave a great interpretation of the roots of the problem and strongly enriched the empirical work in the case study.

1.4.2 Empirical explanation

The empirical part investigates the environmental awareness of individuals towards noise. The research examines the three indicators of awareness (motivation, skill, and knowledge) in parallel with simulating the current noise pollution level. The current situation analysis gives an indication of whether it meets the required guidelines or not. Individual awareness investigations highlight people's recognition and response to the difference between the current and desired state of noise.

The research focuses on noise pollution in the Egyptian context as vital pollution in Egypt because Cairo, Egypt, is the second noisiest city in the world. (Brüel &Kjær, 2022; Tawfeek, 2018). The research examines both noise pollution and environmental awareness with various tools. Accordingly, simulation programs, measuring devices, observation, and questionnaires were used to collect qualitative and quantitative data. Certainly, research and deep investigation help in noise mitigation on various scales.

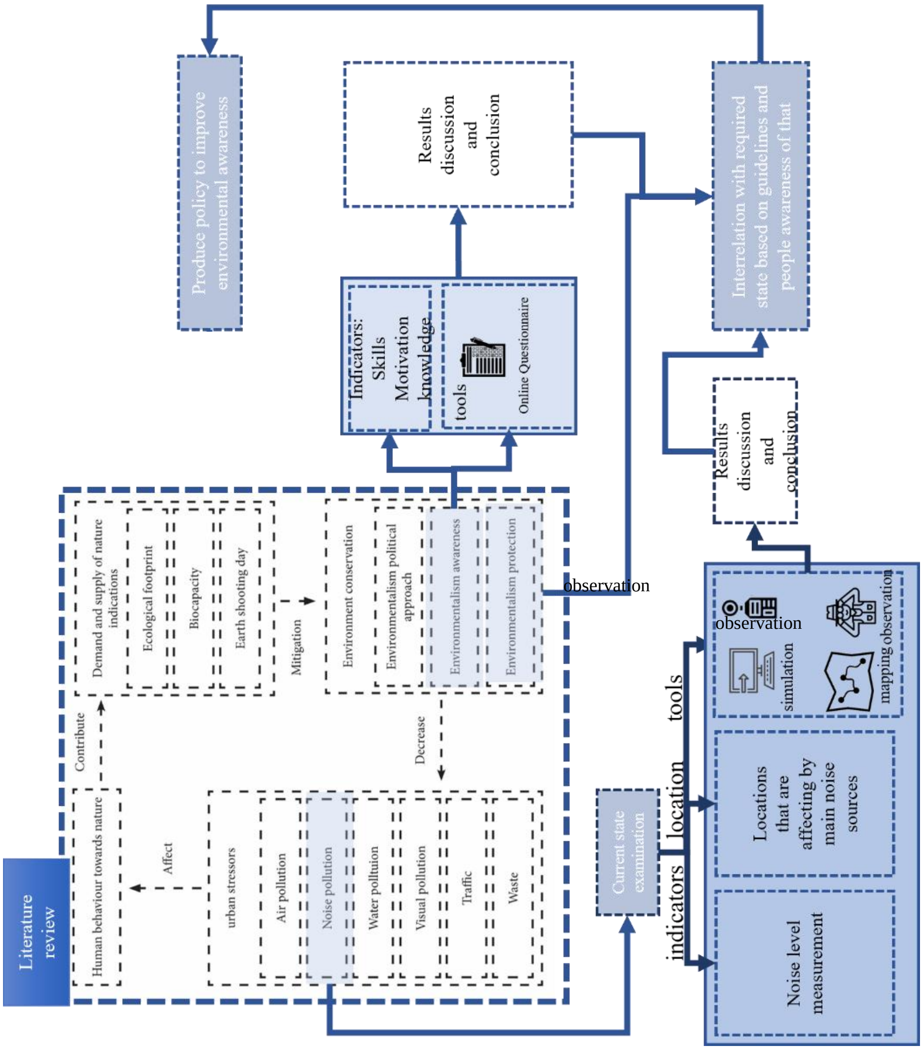


Figure 1. 4 research design diagram, source: Author

1.5 Structure

Initially, research clarifies the highlighted problem in chapter 1 , then builds knowledge about some interlinked topics in chapter 2 . the third step is reflection in context and clarifying method and tools used for case study as shown in chapter 3 and chapter 4. The fourth step is the interpretation of that literature in context by analyzing the current situation and mitigation as clarified in chapter 5, chapter 6 and chapter 7. The last step is recommending strategies or an adaptive model after analyzing the simulation with the expected results in chapter 8.

The research is divided into eight chapters. The first chapter is an introduction to the research, which includes the main elements: problem identification, hypotheses, research questions, research methodology, and expected findings.

The second chapter first topic clarifies the challenge of natural resource use, explaining the challenge itself and the ecological footprint of each city all over the world. Afterwards, the policies that governments took for environmental protection and the role of individuals through their environmental awareness.

The second chapter second topic expresses the correlation between the physical environment and humans, which is called environmental psychology. The chapter defines that concept, the environmental stressors and their impact on humans, and the consequences of that stress on the response to nature.

The third chapter explains the interpretation of the literature review in the Egyptian context. The fifth chapter includes case study selection, scale, indicators and measurement identification, and tools for analysis. The fourth chapter clarifies the tools and method used for case study in detail.

The fifth chapter shows the deep analysis of case study results and the simulation of existing models. Also, it offers a discussion of the findings and their significance considering both the theoretical review and the context of the case study.

The sixth and seventh chapter show the deep analysis mitigation techniques and their significance in the light of both theoretical review and the context of the case study. The eighth chapter set recommended strategies with comprehensive action plan, and future further research.

1.6 Expected findings.

It is expected that the study would highlight the issue of excessive use of natural resources and, in addition, provide workable solutions for environmental preservation to deal with this problem. Identifying the relationship between environmental stressors and environmental awareness Through specific case studies in Cairo, Egypt, the research provides a thorough understanding of noise environmental awareness, noise, and noise level. Additionally, the study examined several noise reduction strategies in the case study. An action plan that raises environmental awareness and reduces noise levels is anticipated as a result.

(2) literature review from a global perspective

Earth overuse challenge, policies, and environmental awareness

2.1 Inception

This part endorses the significance of environmental protection through clear explanation of the reason beyond environmental protection policies. Afterwards, explain environmental protection on various scales ending with environmental awareness as a motivator for responding to environmental protection techniques.

2.2 The challenges of nature demand and respond.

Due to the escalating use of technology, maintaining a balance between human demand for nature and natural regeneration is never easy. As a result, Figure 2. 1 illustrates, human demands on nature escalated to the point where they were 60% greater than the ability of the planet to regenerate. The demand for nature from people includes a variety of materials (fiber, timber, coal, and food). The ability of nature to absorb CO_2 and regenerate its materials is compared against demand (Global foot print network, 2020).

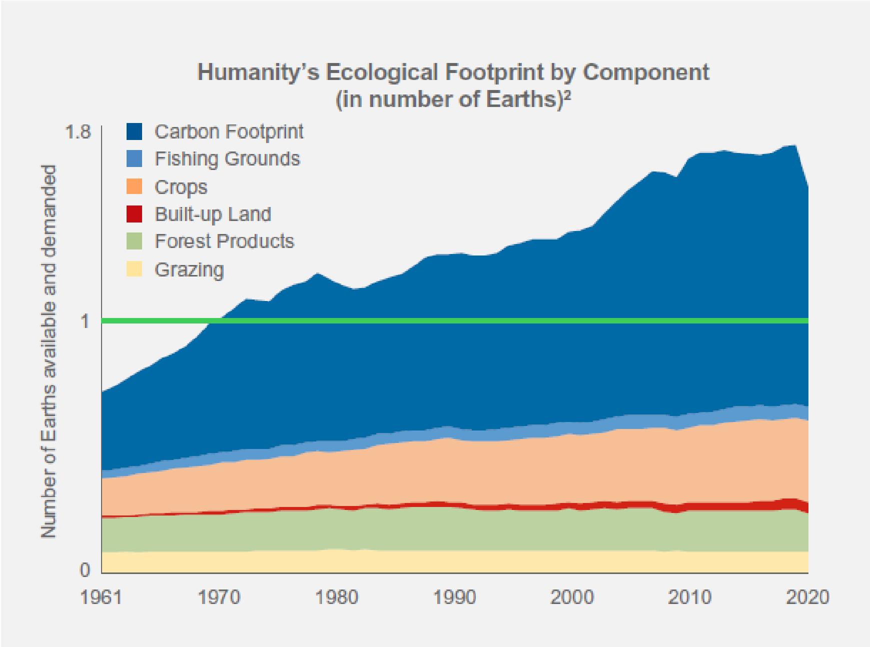


Figure 2. 1 human demand in relation with earth capacity, source : (Global footprint network, 2023)

Additionally, the relationship between the human development index (HDI) andecological footprint serves as a barometer for both metropo litan success and global demand. As demonstrated in Figure 2. 2, the HDI represents the three main dimensions of a healthy life: knowledge and a decent standard of living (Human development reports, 2022).

According to the Global Footprint Network (2022), ecological footpri nts indicate the actual demand and supply of nature, where demand in cludes all regions that might be exploited for production and supply i ncludes the productivity of municipal assets. (Global footprint network, 2023) .

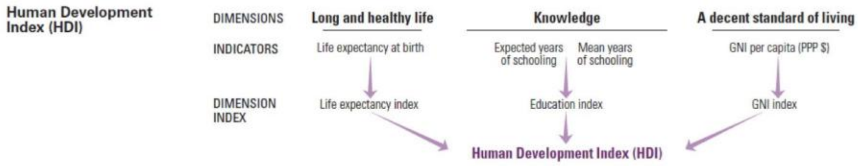


Figure 2. 2 Human development clarification , source: (Human development reports, 2022).

The HDI relation with ecological footprint study shows that most cities are not compatible with the desired state, as shown in Figure 2. 3. Most countries exceed the limit of earth use, and some countries still have low levels of prosperity.

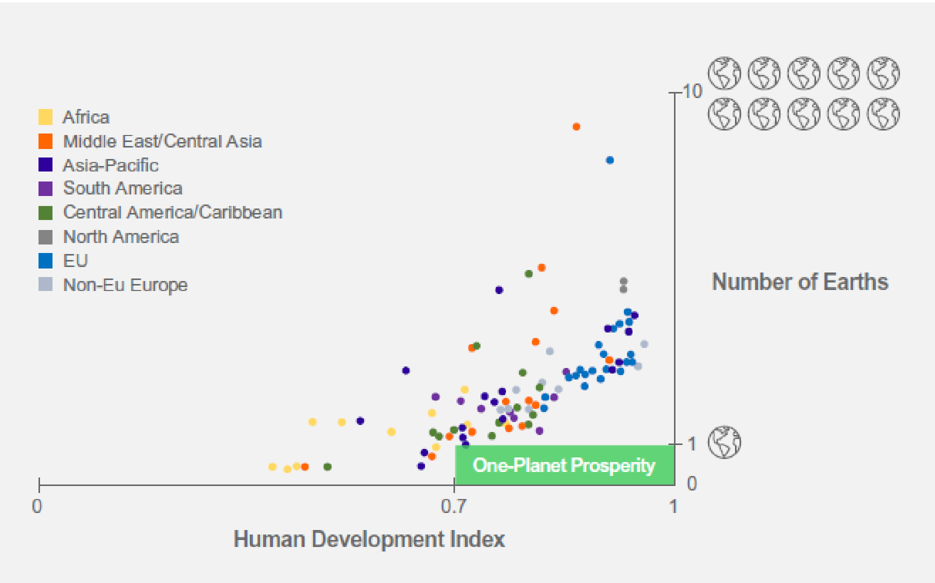


Figure 2. 3 ecological footprint relation with HDI, source: (Global foot print network, 2020)

The HDI relation with the Globel Knowledge Index (GKI) study shows that as GKI increases, HDI increases, as shown in Figure 2. 4 This reveals the importance of knowledge and awareness.

Figure 2. 4 HDI and GKI correlation , source : (UN's global development network, 2023)

In summary, ecological foot exceeds the limit, which reflects the reason why earth shooting day comes earlier each year. Figure 2. 5 shows the 2021 earth shooting day if the world population lived in a specific country; as indicated, all countries exceed the limit, with Qatar at the top and Vietnam at the bottom. Also, when relating ecological footprint to HDI, it is found that most cities are out of range. Accordingly, there must be strategies and policies that are implemented on various scales. These strategies are either offering suitable life within the available suitable resources or decreasing dependency of resources within human well-being enhancement.

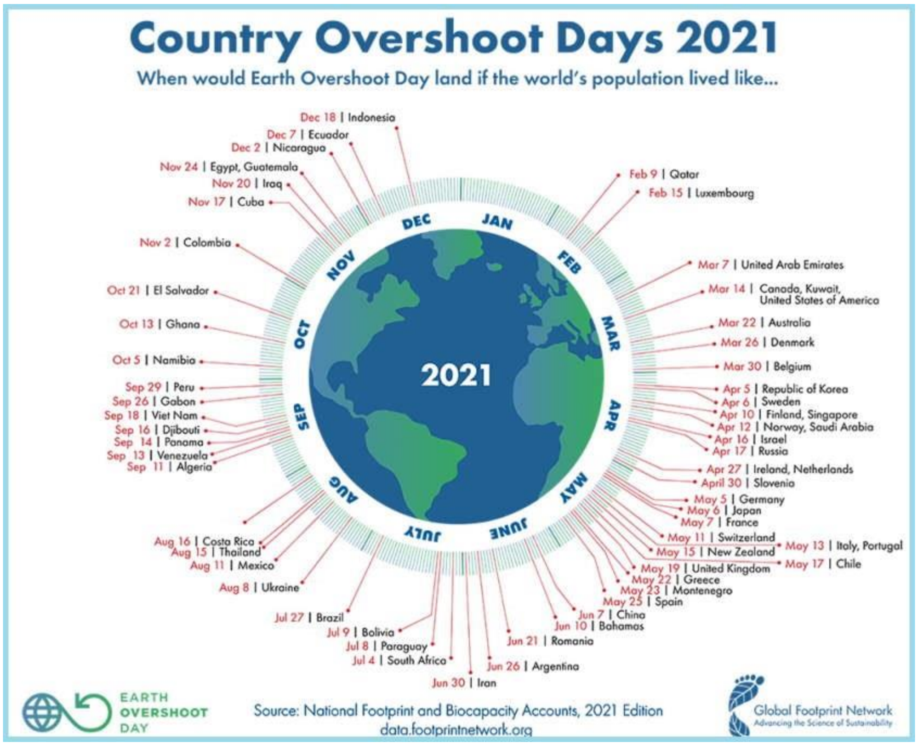


Figure 2. 5 earth shooting day of 2021, source: (Balkan green energy news, 2022)

2.3 The progression of environmental protection policies

Environmental protection is a relatively new concept that came up as a mix of nature alerts and human awareness. It is a new concept because fifty years ago there was not any discipline in universities that increased knowledge in that field. The reason beyond that delay is human perception towards nature; people thought of it as self-healing that was too big and basic to be damaged by them. Suddenly environmental awareness turned into a global problem with social value, so lots of scholars started to write, including Rachel Carson, whose book "Silent Spring" was published in 1962. In addition to that, nature itself sends awareness signs such as the Cuyahoga River Fire of 1969, Torrey Canyon in 1967, and many other incidents. So globally, it was understood that the environment cannot be its own rescuer; there is a need for human voice and action (Hill, 2017).

Obviously, the concept of environment protection was redefined over time because of more knowledge and interpretation. At first, policymakers understood it to reduce pollution; consequently, that was the aim on various scales (government, academics, individuals). Afterwards, the concept was widened to include sustainability, encompassing the whole ecosystem and its impact. This requires a deep evaluation of all affecting factors for environmental destruction in a specific location and how to eliminate their impact. Hence, environment protection involves pollution reduction, choosing sustainable approaches, looking for the best solution on a global, country, and city scale, and individual (Hill, 2017).

Consequently, environmental organizations formed on various scales on an international, local scale. These organizations form policies to serve environment, and goals to reach sustainability. Local agencies contextualize laws and policies based of its environmental current situation (Kaiser & Meyer, 2016; Environment, 2022; Lauesen, 2013). These policies and strategies implicate education in various disciplines to enhance knowledge and research. At the end, all organizations seek to advocate for the environment through various strategies, but the success of these strategies depends on various factors that need to be assessed.

COUNTRY	RANK	EPI SCORE	10-YEAR CHANGE
FILTER BY REGION: ALL REGIONS			
Denmark	1	82.5	7.3
Luxembourg	2	82.3	11.6
Switzerland	3	81.5	8.6
United Kingdom	4	81.3	9
France	5	80	5.8

Figure 2. 6 sample 1 of EPI Ranking, source: (Environmental Performance Index, 2022)

Environmental protection policies are evaluated to analyze implementation reliability; thus, The Environmental Performance Index (EPI) occurs. The EPI quantifies the implementation progress of their policies to protect nature through 20 separate indicators. The higher EPI score is, the better environmental protection policies is as shown in Figure 2. 6, for instance, Denmark has highest rank and EPI score in 2020. 10 years change indicate the progress through last 10 years, which is different from rank as illustrated in Figure 2. 7 Bahrain has highest although its rank is 56. Indeed, some international protocols occur as a respond to policies evaluation results (Environmental Performance Index, 2022; world ecnomic forum, 2022).

COUNTRY	RANK	EPI SCORE	10-YEAR CHANGE
FILTER BY REGION: ALL REGIONS			
Bahrain	56	51	17.3
Seychelles	38	58.2	14.8
Croatia	34	63.1	13.4
Morocco	100	42.3	13.3
Kuwait	47	53.6	12.8
Luxembourg	2	82.3	11.6

Figure 2. 7 sample 2 of EPI Ranking, source: (Global footprint network, 2023)

Kyoto protocol is one of the international protocols that started in 1997 with different approval processes. This agreement's aim is to commit industrial countries to limit and reduce Green House Gas (GHG) emission through specific target. 192 countries are involved in that protocol with various approval agreements as shown in Figure 2. 8 (United Nations Framework Convention on Climate Change, 2022).

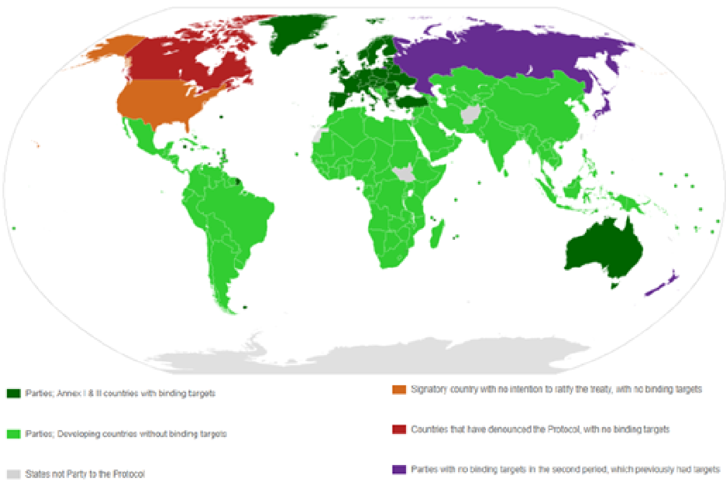


Figure 2. 8 Kyoto protocol countries map edited by author , source: (The Climate Change Guide, 2022)

Of course, there are lots of similar international agreements such as Paris agreement. It is a legal bind of international agreement on climate change, which has been adopted by 196 parties at COP21 in Paris since 2015.

At the end, environmental protection concept initiated and refined in last years because of environmental challenges that arise and knowledge increase. Some organizations have developed to adopt this concept through applied policies. Countries policies are evaluated EPI to give constant indicating about environmental situation. in addition to that, international protocols occur to serve global environmental benefits. Since individuals are the main complex factor of environmental problems and environmental protection implementation, it is important to understand individual environmental awareness.

2.4 The concept of environmental awareness

Despite the lack of standardised language or terminology, the idea of environmental awareness is clear. There are other words used to refer to the same idea, including environmental consciousness, environme ntal altitude, environmental behaviour, and environmental concern (Ham, Mrčela, & Horvat, 2016). Environmental awareness can be defined broadly as an interrelation between environment and awareness, where environment is the external condition and surroundings and awareness is the awakening of an individual towards a specific topic through knowledge and actions (Kokkinen, 2013). Environmental awareness can be defined as the recognition of individuals towards environmental issues based on knowledge, attitude, etc. (Kokkinen, 2013; Ham, Mrčela, & Horvat, 2016; Efut, Akpo, Okpashi, & Asuquo, 2017; Halmatov & Ata, 2017) . Obviously, environmental awareness perceptions vary from one individual to another, as it depends on their own beliefs and values. This issue raises a question among scholars, "How to understand environmental awareness in the same way." Accordingly, scholars attempt to find a classification that satisfies most of the concepts (Ham, Mrčela, & Horvat, 2016).

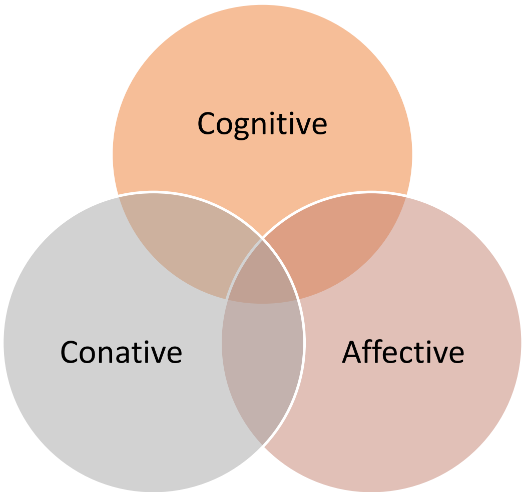


Figure 2. 9 components of environmental awareness as described in literature, source: (Ham, Mrčela, & Horvat, 2016) *edited by author.*

Researchers were encouraged to divide environmental awareness based on a three-altitude model to facilitate understanding and measuring with the same background. Environmental awareness is a multi-dimensional concept that involves cognitive, affective, and conative components, as shown in Figure 2. 9. The cognitive component is the mental process of knowledge, understanding, and analysis that impacts design and behavior. The affective component expresses the feeling and emotional reaction of an individual towards environmental issues; it also includes the individual judgement about their own behavior towards biophysical surroundings. The comparative component is the behavior intention of an individual that is reflected in the actual response to the environment (Ham, Mrčela, & Horvat, 2016) . Indeed, this classification is the outcome of a great deal of prior division, thus study sheds light on one of these ways and generates a variety of models.

An environmental awareness conceptual model was developed in 1999 during the project "Strategic Guidelines for Improving Public Awareness and Environmental Education in the Baltic Sea Area" by Partanen-Hertell et al. (1999). The concept expresses environmental awareness components such as knowledge, skill, and motivation. These components are developed among individuals through four stages, as shown in Figure 2. 10, where awareness increases in each stage, beginning with having concern about the environment in stage one, then becoming an actor after understanding policies and regulations in stage two, so increasing in three pillars in stage three. Lastly, in the holistic fourth stage, enormous exposure happens through various fields and disciplines (Efut, Akpo, Okpashi, & Asuquo, 2017).

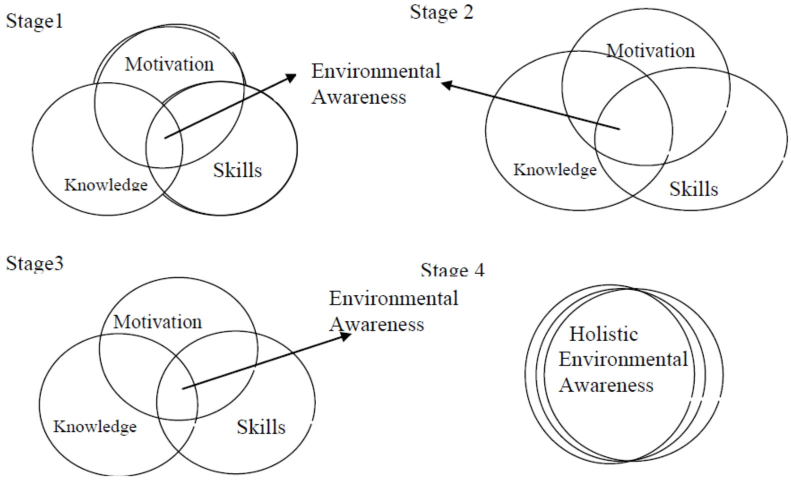


Figure 2. 10 environmental awareness conceptual model, source: (Efut, Akpo, Okpashi, & Asuquo, 2017)

The two-dimensional approach is an approach developed by Gagnon Thompson and Barton in 1994. They classified individual awareness altitudes into two groups: ecocentric and anthropocentric, as illustrated in Figure 2. 11.

Ecocentric people put their appreciation of nature and their commitm ent to environmental preservation ahead of their personal needs. Anth ropocentrics uphold the idea that nature benefits humanity, hence the y preserve it to improve the standard of living for people. Numerous r esearch has been conducted to clarify these ideas and explain how nat ure and the environment interact (Ham, Mrčela, & Horvat, 2016; Simsar, 2021).

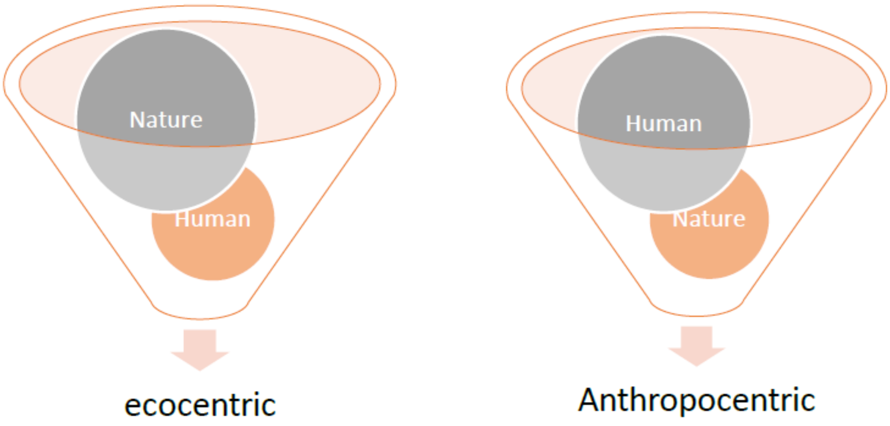


Figure 2. 11 Difference between ecocentric and anthropocentric perception for human and nature, source: Author

In conclusion environmental awareness can be defined through various perspectives but the main concept is unambiguous. Scholars formed the same background through environmental components identification (cognitive, affective, and conative components). Also, a conceptual model arises in 1999 which divides awareness into three similar components (Knowledge, skill, motivation) with its development stages among individuals. In addition, approaches occur that give better understanding of individual behavior toward environmental awareness, where they divide people into ecocentric and anthropocentric. All those models and approaches lead to enrichment of knowledge about that topic, which leads to a new broad field called environmental psychology.

2.5 Summary

Humans always explore nature for their own benefit to have a better life and adapt to population increases. Humans are in continuous search for materials and technologies to give the world population a comfortable life. Suddenly, nature speaks to give an alert that its capacity to regenerate itself is slower than people use. Accordingly, a movement was taken to consider environmental protection.

Environmental protection was developed based on knowledge gained at a certain time. Accordingly, organizations on global and local scales were initiated, and evaluation techniques were used to improve performance in reaching specific targets. Some international protocols occur as a type of cooperation and responsibility between countries. Indeed, the individual is the main contributor to nature protection, which depends on his or her environmental awareness.

Environmental awareness reflects human contribution towards nature because it considers the knowledge, motivation, and skill of individuals to save nature. For instance, ecocentric people give priority to nature over their own need to save it, while anthropocentric people believe in saving nature for their own benefit. As it became a comprehensive field, an innovative concept arose called environmental psychology, which will be explained in the next part.

Environmental psychology as an integrated system

2.6 Inception

This part emphasizes the relation between humans and nature as a complex interrelated system by explaining the concept of environmental psychology and its history. After that, understanding of environmental influences that affect human reactions towards nature ends with clarification of environmental stressors as an integrated element of environmental awareness.

2.7 The evolution of environmental psychology

A new idea called environmental psychology emerged as a result of in-depth environmental knowledge and the realization of the importance of protecting the environment. When examining the impact of environmental stimuli on human behavior in 1911, Hellpach was the first to coin the phrase. Additionally, he investigates some urban phenomena related to people's behavior. Brunswick and Lewin are referred to as the founding fathers of the discipline also. Environmental psychology was recognized as a subject in 1960 following additional investigation into that novel idea, as can be shown in Figure 2. 12 (Bechtel & Churchman, 2002; Stokols & Altman, 1987; S'teg, Van den Berg, & De Groot, 2018; Gifford, 2013; Valentín & Gamez, 2010).

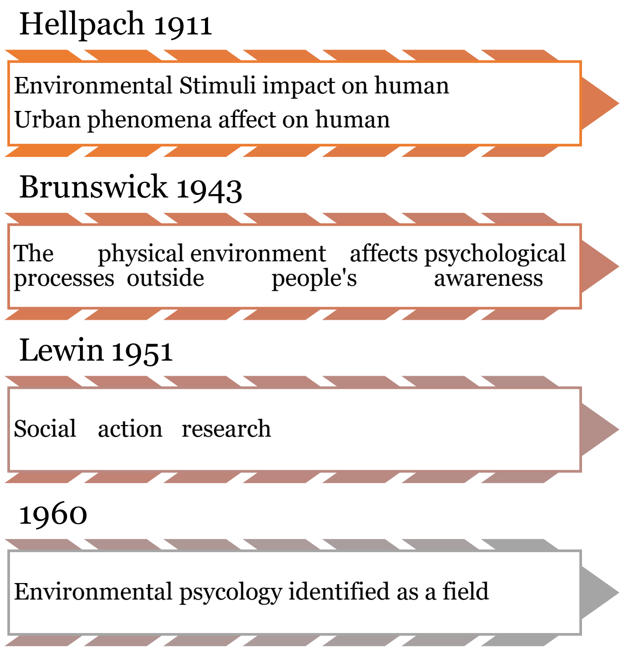


Figure 2. 12 Key founders of environmental psychology till it became a field, source: Author

2.8 The concept of environmental psychology

Environmental psychology is a comprehensive field that includes the study of all relationships between people and their constructed and na tural environments, as seen in Figure 2. 13 , making it a broad notion. Environmental psychology's primary goal is to examine how the envi ronment affects human behaviour as well as how human conduct affe cts the environment as illustrated in Figure 2. 14 (Bechtel & Churchman, 2002; S'teg, Van den Berg, & De Groot, 2018), this goal aids in understanding the variables that affect environ mental behaviour and strategies to promote pro-environmental behaviour. For better understanding, research briefly explains the main aim and benefits of environmental psychology.

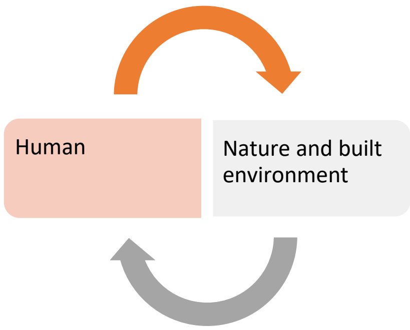


Figure 2. 13 the main scope of environmental psychology, source: Author

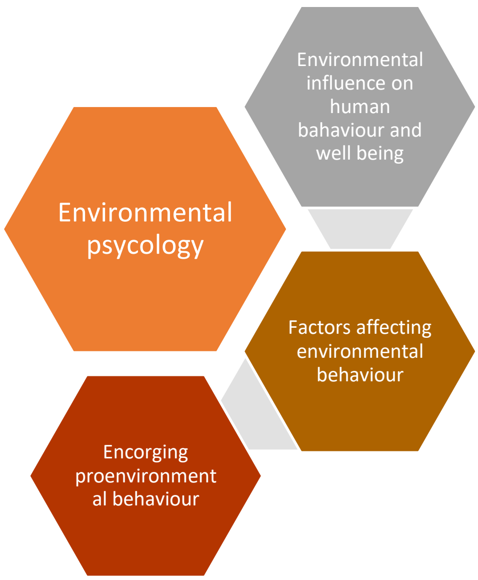


Figure 2. 14 the main aims of environmental psychology, source: Author

Firstly, environmental factors influence human behavior through various environmental conditions. These environmental influences include the perception of environmental risk, climate change, environmental stressors, scenic beauty, nature health benefits, built environment design as shown in Figure 2. 15. Secondly, environment and humans are considered interchangeable relations, arising from a relation called environmental behavior. Environmental behavior expresses the influence of humans on the environment, which should be measured. It is important to consider some affecting factors for pro-environmental behavior, such as social norms, emotions, motivation, etc. Finally, it is vital to encourage pro-environmental behavior to save nature in practice. So, strategies, encouraging techniques, and technology are essential to be placed with the consent of the community (Stokols & Altman, 1987; S'teg, Van den Berg, & De Groot, 2018). The research gives a glimpse of some environmental influence on human behavior since it is the result of human behavior and at the same time affects human behavior.

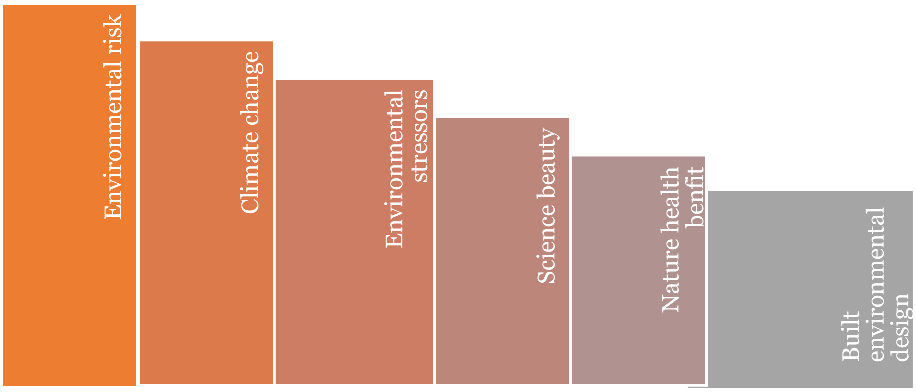


Figure 2. 15 environmental influence on human, source: Author

Understanding how to perceive environmental risks is essential since they are unanticipated crises that occasionally occur and need swift, competent action. Depending on how the issue is perceived, there are positive and negative actions that can be taken to mitigate the risk. The degree of understanding of the seriousness of the situation and the outcome of any unknown reaction are the two key components that make up risk perception. Our assessment of our ability to respond and manage the event, as well as our feelings toward the circumstance, affect how we estimate the risk (Bechtel & Churchman, 2002; S'teg, Van den Berg, & De Groot, 2018; Mrkva, Cole, & Boven, 2021).

Climate change is a consequence of human behavior all over the years because climate change changes gradually with population increases and human consumption increases. In 1970, research highlighted the risks of climate change. Climate change is an environmental problem that causes some environmental risk events such as forest fires, sea level increases, etc. The consequences of climate change increased which intensified public consciousness of the problem and knowledge about climate change. In 1980, people became more aware of the problem and started to act. Also, the perspective of climate change was no longer limited to weather, air pollution, and ozone depletion; nowadays, more relationships are examined, such as fossil fuels and climate change, etc. (S'teg, Van den Berg, & De Groot, 2018; Lee, 2021; Sen, et al., 2021; Baiardi & Morana, 2021)

Environmental stressors are the result of how the environment responds to human behavior because human influence on the environment causes some environmental problems that become stressful in an individual's daily life. Environmental stressors encompass noise, air pollution, visual pollution, crowding, etc., which affect individual health and respond to the environment. So environmental stressors are part of a closed system that considers the environment and humans as a cycle of actions and reactions as expressed in Figure 2. 16. for better understanding, next part explains environmental stressors deeply.

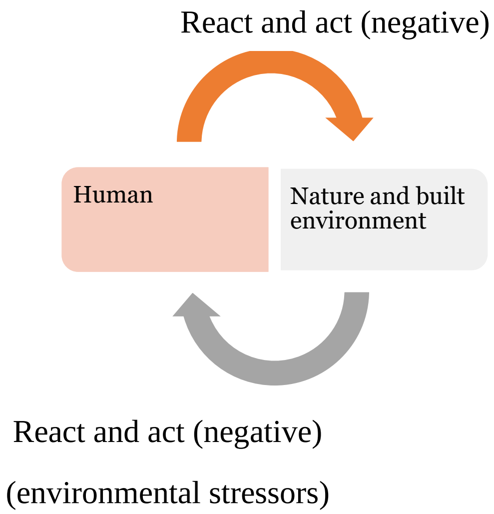


Figure 2. 16 the relation of human and environment as a series of actions and reactions, source: Author

Environmental stressors can be seen in various expressions because there are various types of stress. The imbalance between environmental demand and human response causes stress on humans, which is explained in the first part in this chapter. Stressors can be acute, such as crowding or pollution, where stress is something temporary. Also, chronic environmental stressors are more permanent and affect humans, such as noise, traffic, etc. It is important to identify these stressors to prevent their physical and mental health consequences accordingly. In the next part, give examples of stressors (Yuan & Wu, 2021).

First, noise is expressed as any undesired sound with high intensity, which is measured in decibels (S'teg, Van den Berg, & De Groot, 2018; Environmental pollution center , 2022). It has various typologies; it can be continuous or intermediate; and its duration defines if it is acute or chronic. Noise occurs when a source emits noise that passes through a path and reaches a receiver, as shown in Figure 2. 17.

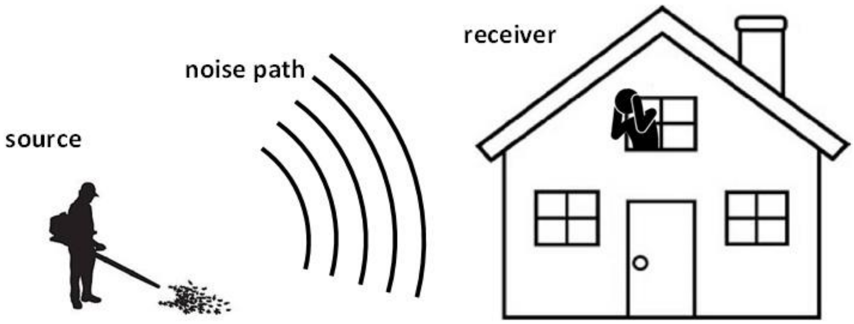


Figure 2. 17 Noise motion, source: (International Year of Sound, 2022)

There are five main sources of noise in cities, which are airports, traffic, industries, power plants, and residential areas (Ismail M. R., 2014; Abas & Tamura, 2003). For instance, people who live near airports may suffer from severe illness due to noise. Schools near noise sources tend to have lower student performance than other schools. Traffic noise can cause cardiovascular diseases (Münzel, Sørensen, & Dai, 2021; Klatte, et al., 2016). Accordingly, noise is an environmental issue that causes stress in human daily life.

Second, crowding perception is different from one person to another because it happens when an individual recognizes that the number of people in space is higher than their desired preference. Crowding is influenced by culture, gender, age, personality, duration, space design, etc. Stress values increase gradually with time and the feeling of crowding. For instance, living in a crowded neighborhood causes more stress than being in a crowded service Centre for a few minutes. At the end, when individuals feel crowded, it becomes one of the environmental stressors that cause health issues. (S'teg, Van den Berg, & De Groot, 2018; Riva, et al., 2014; Andrew Baum, Tracey A. Revenson, & Jerome Singer, 2011)

Third Visual pollution is a consequence of rapid urbanization because amenities are needed but are usually not well planned. The visual fragmentation of urban fabric has many examples, for instance, billboard design, waste dumps, hanging wires, and bad road infrastructure. Visual pollution is a relatively new concept; the term "visual pollution" was defined in the mid-20th century. In 1960, some schools defined it as “a type of pollution that offends human vision, spatial orientation, physical, and mental health’. Other scholars, such as Nami et al. and Jana, describe visual pollution as “unbridled and uncoordinated diversity” of form, color, light, materials, and the accumulation of heterogeneous visual elements that make the manmade environment and urban landscape ugly and unattractive. Accordingly, the term "visual pollution objects" (VPOs) was identified to describe manmade features that have a visual effect in a physical space. Although there is enormous research about visual pollution and its stress effect, it is neglected in comparison to other types (Wakil, et al., 2019).

Fourth, poor neighborhood quality, the poor quality of retail services, recreational areas, visual surveillance, and traffic are some factors that represent the quality of the neighborhood. These factors cause a stressful environment when they are of poor quality. Also, the physical quality of education, healthcare facilities, noise, and traffic are contributors to a stressful environment when they are not of suitable quality. So, it is necessary to have a good quality of neighborhood for a less stressful environment (S'teg, Van den Berg, & De Groot, 2018).

Fifth, traffic congestion, Traffic congestion is one of the main sources of chronic stress in a city because it is a daily stress that individuals have to deal with. It is proven that people who face this kind of stress have three times higher health-related risks. (S'teg, Van den Berg, & De Groot, 2018).

In conclusion, a variety of effects occurred when the environment was no longer able to absorb human pollution. The idea of environmental risk perception is the result of certain surprising phenomena. Additionally, new environmental conditions emerged, such as the worldwide phenomenon of climate change. Environmental stressors are all those outside factors that lead to stress. It is any stress brought on by the environment as a result of the pollution that people's usage of nature creates. In fact, there are many good effects of the environment on humans as well, such as scenic beauty and health advantages from nature. Therefore, it is crucial to consider how humans interact with the built environment in a constructive way.

2.9 Summary

To establish a suitable, less stressful environment, a cycle of actions and reactions between humans and their surroundings must be maintained. Therefore, human conduct must be managed to have the least possible negative effects on the environment. Pro-environmental behavior strategies include encouragement tactics, technology, acceptance of environmental protection laws, and simulation to alter human knowledge, awareness, and altitude (environmental awareness). There is a linkage between environmental awareness, environmental preservation strategies, environmental pollution, and environmental stresses since humans and the environment are inextricably linked. The study tries to comprehend this relationship by examining the current state of a sample of environmental pollution in the setting of Egypt and contrasting it with the necessary environmental protection laws. additionally comprehending the state of environmental awareness in the Egyptian context. The goal of the research is to provide an action plan, methods, and approaches to enhance this reciprocal relationship.

(3) Reflection of a literature review in the Egyptian context

3.1 Inception

This section reflects the research problem and situation in an Egyptian context to help in understanding the case study context and selecting suitable methodologies for analysis. The section gives a glimpse of the ecological footprint, biocapacity, and earth shooting day specifically for Egypt, followed by the current pollution situation and environmental protection as a response to this pollution. lastly, environmental awareness strategies.

3.2 Ecological footprint in the Egyptian context

The ecological footprint in Egypt is higher than biocapacity because nature demand increases as population increases each year. Figure 3. 1 depicts an ever-growing ecological footprint. In 1975, the ecological footprint exceeded 1 global hectare per person; in 2000, it reached 1.5 global hectares per person; and nowadays, it is about to reach 2 global hectares per person. The graph shows that there has been a decrease in some years; for instance, from 1965 to 1973, due to the war at that time, there was an increase in other years due to the enormous reconstruction of the city and industrialization. So, it is essential to know that birth, death, and political situations affect ecological footprints (Global footprint network, 2023).

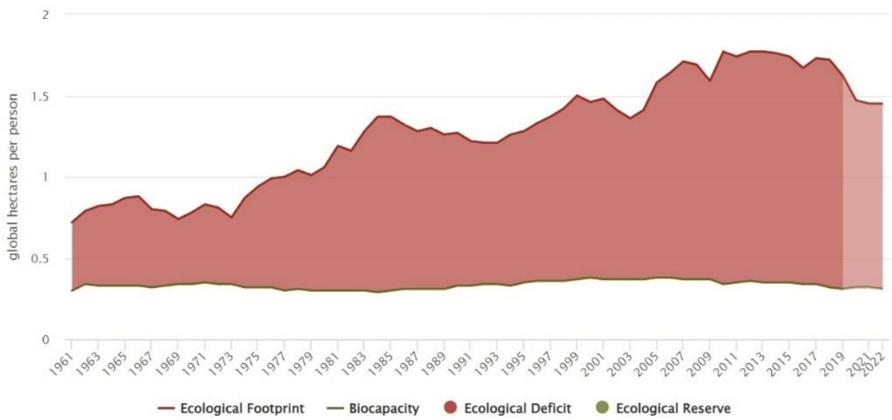


Figure 3. 1 Ecological Footprint vs Biocapacity (gha per person), source: (Global footprint network, 2023)

A huge increase in the ecological footprint is also shown in Figure 3. 2compared to the capacity of nature to restore itself. The graph demo nstrates that the rate of biocapacity growth is generally slower than th e rate of ecological footprint growth (Global footprint network, 2023).

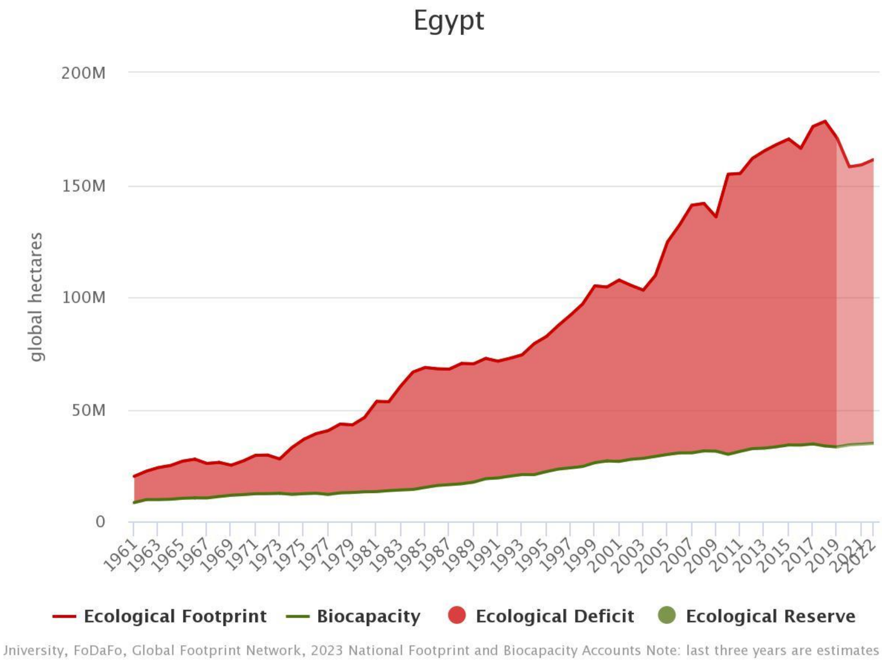


Figure 3. 2 Ecological Footprint vs Biocapacity (gha), source: (Global footprint network, 2023)

Moreover, Figure 3. 3 expresses the enormous increase in the number of earths required over the years because of the increase in ecological footprint. The graph shows a twist that happens in 2007, where we need more than one earth to bear the resources we need. Another twist happens in 2019 due to lockdown. Based on the global footprint network, Egypt has a biocapacity deficit of 410% , this twist is great potential for environmental pollution improvement (Global footprint netwrok, 2023).

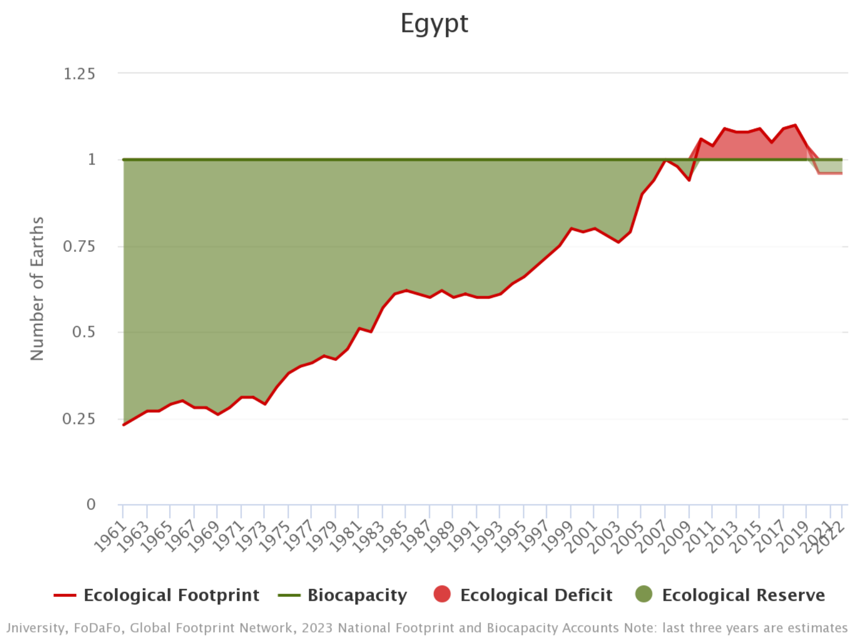


Figure 3. 3 Ecological Footprint (Number of Earths), source: (Global footprint network, 2022)

Environmental pollution is indeed exacerbated by the growing ecological footprint and the biocapacity deficit; as a result, organizations, regulations, and laws are created to lessen the severity of the current pollution issue. The research begins with an explanation of some pollutants to help readers better comprehend the effects of human behavior now in place and to identify pollutants that may put people under stress. Then, the research highlights environmental agencies and organizations in Egypt.

3.3 Environmental topics categories in Egypt

The Ministry of Environment (Egyptian Environmental Affairs Agency, EEAA) is the main authorized governmental environmental agency in Egypt. Based on the EEAA website, environmental topics are divided into categories including air, water, waste, nature, and management. Each topic has three to four subcategories, as shown in Figure 3. 4. The research focuses on air to give a clear explanation of the current air pollution situation in Egypt.

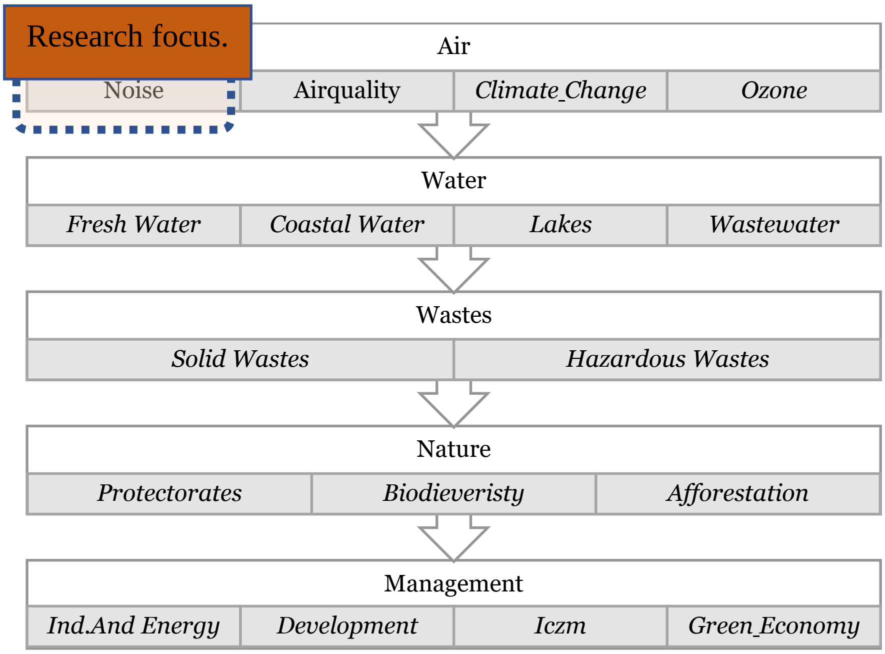


Figure 3. 4 diagram show environmental topics categorization based on EEAA and the focus of research, source: author

3.3.1 Air

Noise

Cairo, Egypt is the second noisiest city in the world (Tawfeek, 2018; Brüel &Kjær, 2022; Martinelli, 2022; world ecnomic forum, 2022). Based on the Brüel & Kjær Sound article, the average Egyptian noise level is 90 dB as measured by the Egyptian National Research Center, which is the same as staying in a factory all day. Moreover, EEAA monitors and assesses noise levels for the sake of reaching the required guidelines. The monitoring process is based on 29 fixed stations, as shown in Figure 3. 5,Figure 3. 6,Figure 3. 7. Since 2007, these stations have been fixed, and locations were selected based on specific criteria. The assessment reports are published quarterly and yearly (EEAA, 2022).

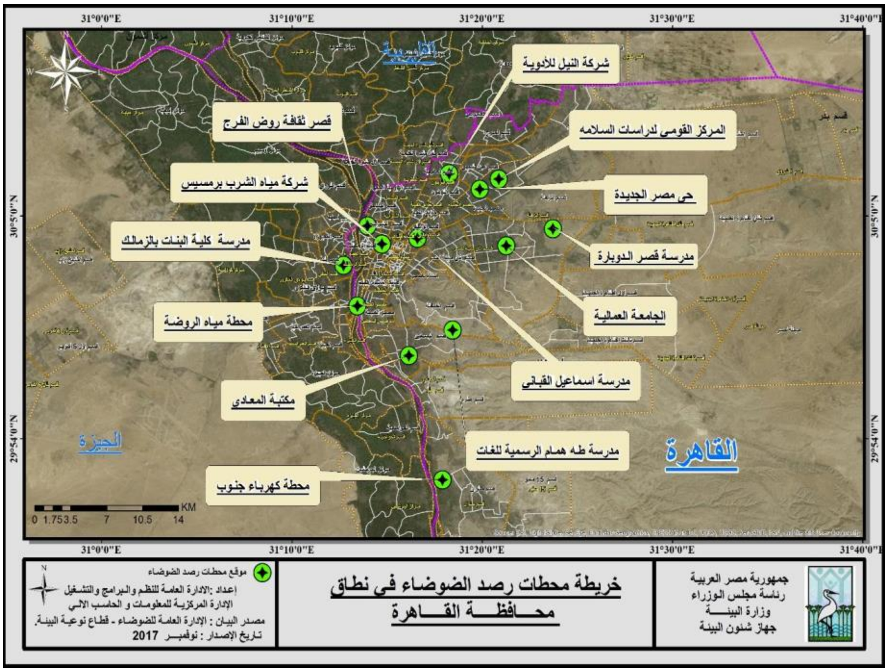


Figure 3. 5 Fixed stations all over Cairo, source: (EEAA, 2022)

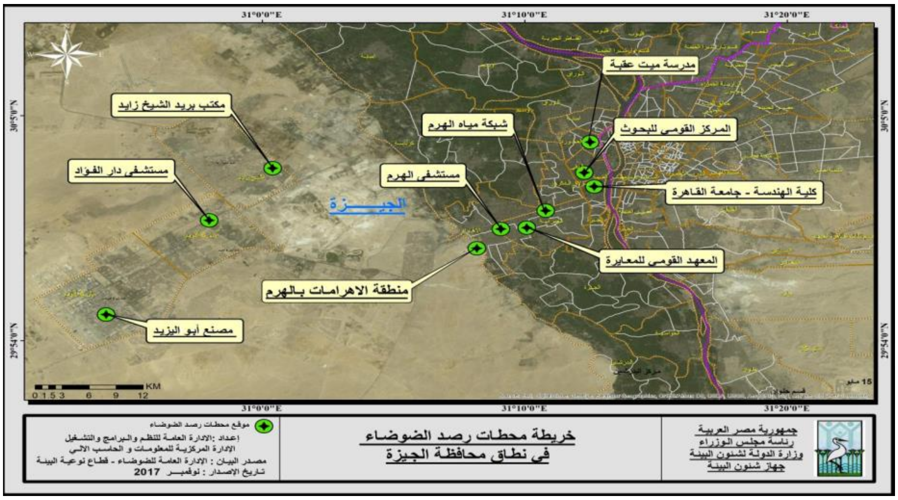


Figure 3. 6 Fixed stations all over Giza, source: (EEAA, 2022)

Figure 3. 7 Fixed stations all over Qalyobia, source: (EEAA, 2022)

The report confirms that there is still a high level of noise pollution at most stations. In the 2022 report, only three stations were within the morning limit based on guidelines; the rest of the stations exceeded the limit during the day and night. Guidelines are placed based on land use and function, as shown in Table 3. 1 (EEAA, 2022).

*Note:

1. All data are available in Arabic website version only.
2. For detailed report see website link: وزارة البيئة - جهاز شـئون البيئة > موضوعات بيئية > الهواء > الضوضاء > التقارير والدراسات

Table 3. 1 Noise level guidelines, source: (EEAA, 2022)

Zone type	Permissible limit	
	Day from (7 AM to 10 PM)	At night (from 10 pm to 7 am)
An area with sensitivity to noise (such as hospitals, schools, libraries and parks).	50 dB	40 dB
Residential suburbs with little traffic and limited service activities.	55 dB	45 dB
Residential areas in the city with commercial activities.	60 dB	50 dB
Residential areas located on roads of less than 12 meters, with some workshops, commercial activities, administrative activities, recreational activities, or amusement parks.	65 dB	55 dB
Areas located on roads 12 meters or more wide, or industrial areas with light industries and some other activities.	70 dB	60 dB
An industrial zone with heavy industries.	70 dB	70 dB

Of course, the ministry set a national plan to minimize noise pollution and eliminate its sources to achieve required guidelines. The comprehensive plan encompasses 11 governmental organizations such as ministry of interior, ministry of tourism, ministry of planning and local development, ministry of health and population, etc. (EEAA, 2022).

Air Quality

According to World Health Organization reports, Egypt has moderate air quality severity. Egypt suffers from a high level of PM2.5, as shown in Figure 3. 8 ,Whereas PM 10 is relatively moderate, as expressed in Figure 3. 9 . So, PM2.5 is considered the main cause of air pollution in Egypt; accordingly, EEAA took some actions to analyze and eliminate air pollution. (IQ AIR, 2022).

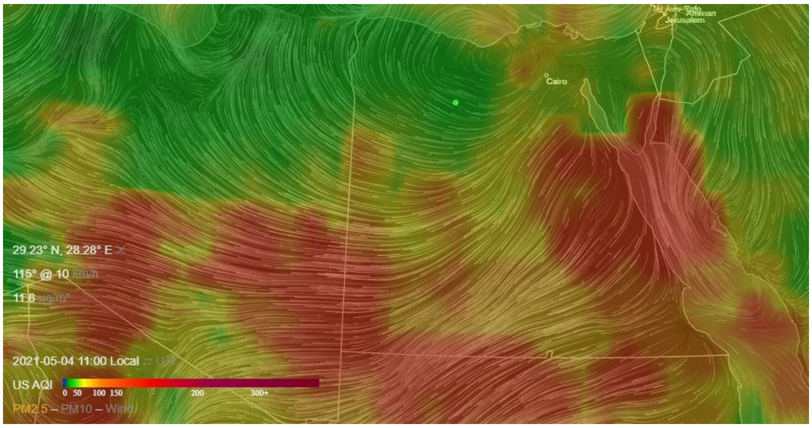


Figure 3. 8 PM2.5 analysis of Egypt, source: *(IQ AIR, 2022)*

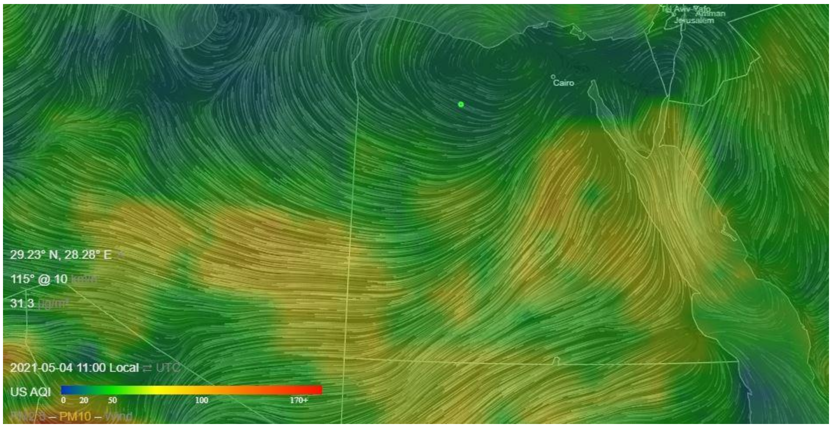


Figure 3. 9 PM110 analysis of Egypt, source: (IQ AIR, 2022)

EEAA is committed to tackling air pollution through monitoring and strategic plans to apply environmental legislation, where air quality is considered an environmental issue in Environmental Law No. 4 of 1994. The government makes a monitoring plan for various air pollutants, for instance, SO_2, NO_2, $PM_{2.5}$, and PM_{10}, and forecasts the air quality index. Moreover, the extreme situation was identified, along with the reasons for it and how to deal with it to prevent the enormous health issues. Monitoring reports are done quarter-yearly and published on the website. These reports help in forming a management plan for all pollution sources, including industries, vehicles, etc. (EEAA, 2022).

Climate Change and ozone

As global problems that transcend national borders and affect the entire planet, climate change and ozone depletion are special causes of environmental problems. Additionally, it has negative effects on the entire world (EEAA, 2022). Of course, a global response to climate change occurs when an entity called the Intergovernmental Panel on Climate Change (IPCC) develops in the United Nations. The World Meteorological Organization (WMO) and the United Nations Environmental Programs (UNEP) initiated the Intergovernmental Panel on Climate Change (IPCC) in 1988. The focus of the IPCC is to access knowledge related to climate change to help governments build effective climate policies (IPCC, 2022). As it is a global issue, some agreements between countries were reached to improve cooperation. When concentrating on Egypt, it follows the Kyoto Protocol, the Paris Agreement, and the United Nations Framework Convention on

Climate Change. In addition to that, EEAA forms a collection of data for improving knowledge about climate change and providing explanations for projects, laws, and risk management plans for Egypt. The government also responds to ozone depletion through commitment to global protocols, including the Montreal Protocol and relevant programs, in addition to policies and regulations to limit the situation locally (EEAA, 2022).

3.4 Environmental organizations and agencies in Egypt

Lots of various typologies of governmental organization formed as a respond to environmental challenges. figure 3. 10 show summarize categorization of environmental activities map in Egypt. * see deep details of organizations in Appendix 1 environmental protection organization in Egypt details

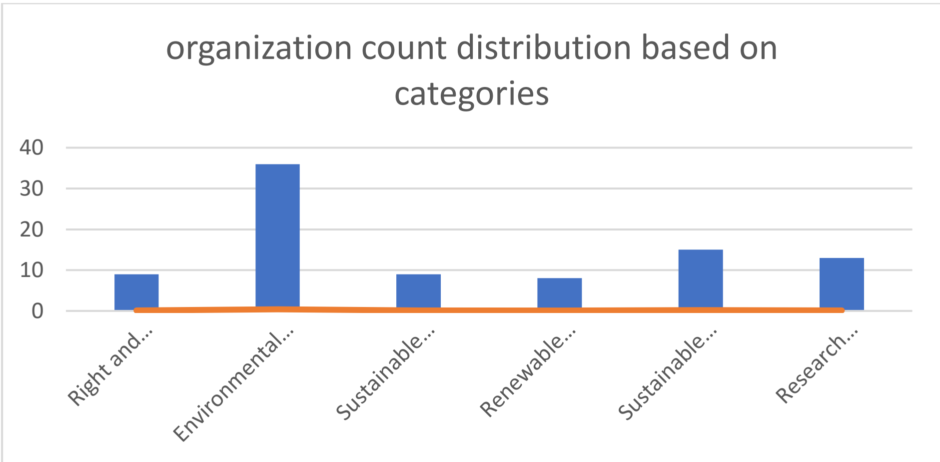


figure 3. 10 organizations categorization based on topic, source: Author.

In Egypt, there are a huge variety of environmental incentives. There are 90 entities with various philosophies and political contexts. figure 3. 10 shows the exact categorization, which indicates environmental protection has the highest count. Since there are 9 of 90 focusing on rights and justice, 36 of 90 concentrating on environmental protection, and 9 of 90 working in sustainable agriculture, Also, 8 of 90 are directed towards renewable energy use, 15 of 90 are working on sustainable urban development, and 13 of 90 are for research and academia. Moreover, they can be categorized into non-governmental organizations with various perspectives; environmental and social enterprises; and academic and research organizations, as identified in Figure 3. 11.

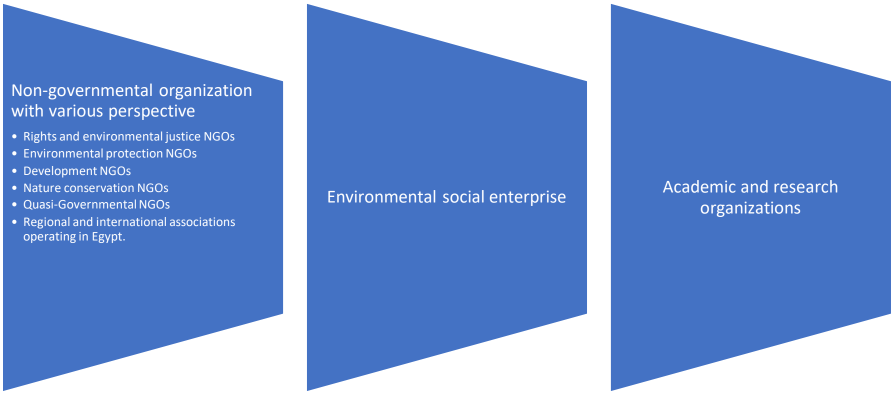


Figure 3. 11 categorization of environmental organizations, source : author based on (national justice social and economic justice authority, 2019).

In order to provide more accurate indicators of quality, research conducts a deeper investigation of academic and research advancement. The study examines how many scholarly articles have been written about environmental protection in Egypt, how it compares to other nations, and how things have changed over time.

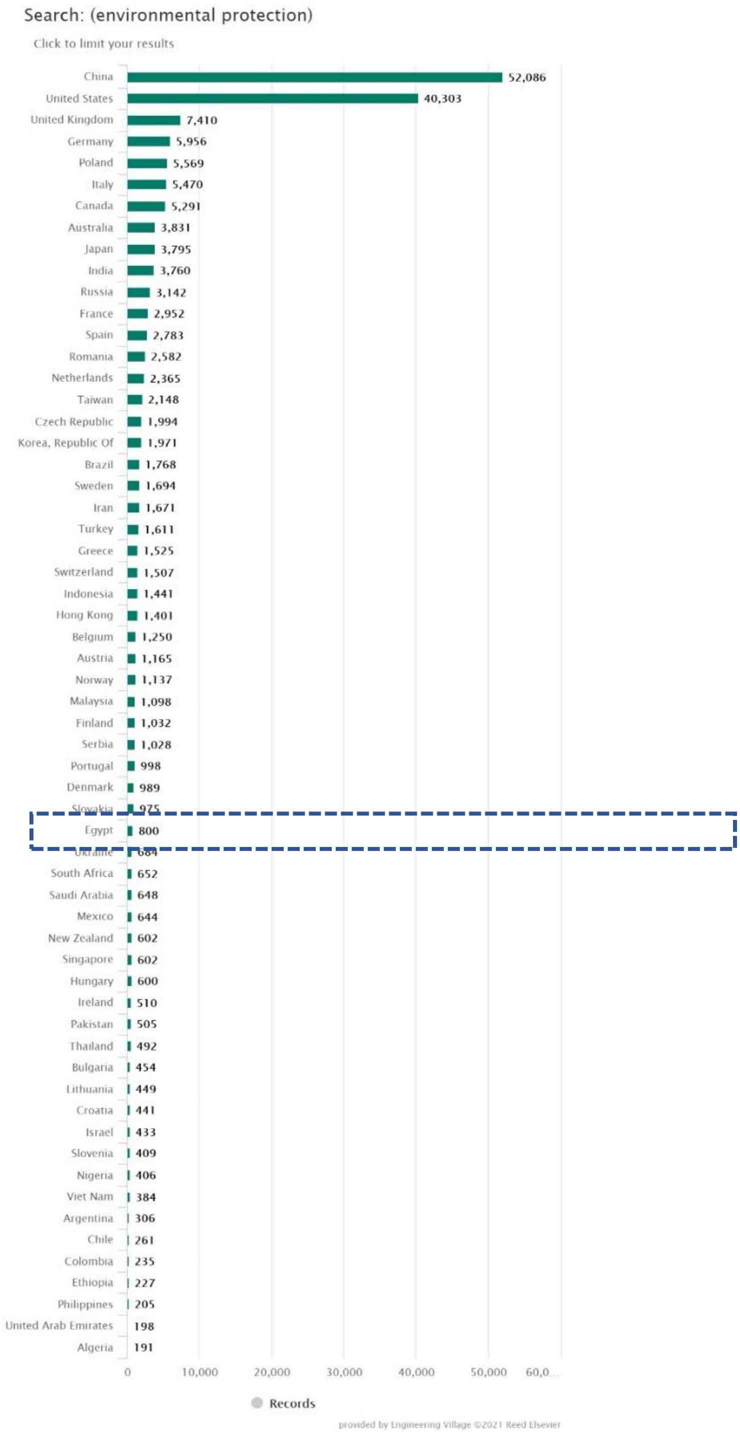


Figure 3. 12 Graph for the count of academic papers about environmental awareness all over the world, source: (El sevier, 2022)

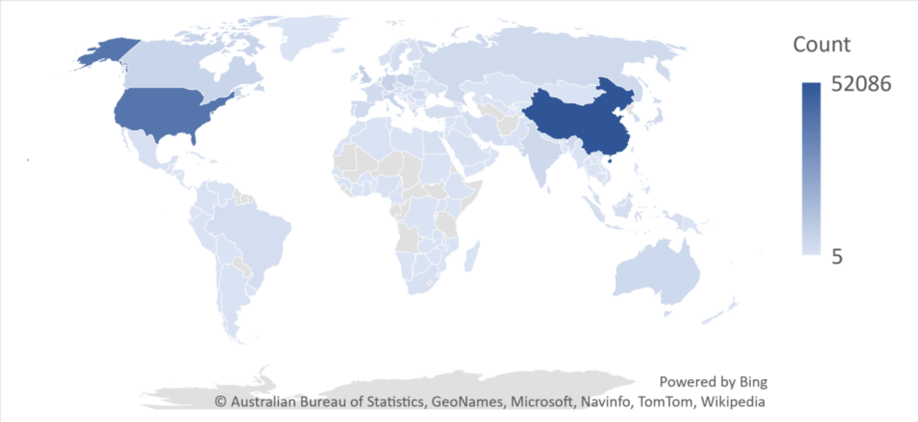


Figure 3. 13 Map of the count of academic papers about environmental awareness all over the world, source: (El Sevier, 2022)

Egypt has a comparatively low number of papers published when compared to other nations because it ranks 45, as shown in Figure 3. 12, Figure 3. 13. Figure 3. 14 shows that there has been a change in the number of publications in Egypt over the years, which is indication a potential for increase.

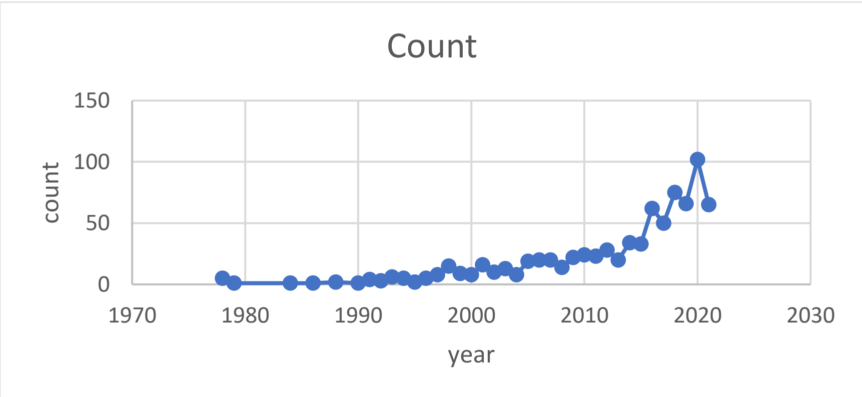


Figure 3. 14 the counts of environmental protection paper all over the years in Egypt , source: : (El sevier, 2022)

3.5 Summary

Concisely, Egypt has an ecological footprint higher than its biocapacity, which causes lots of environmental pollution. After analyzing some of these environmental pollutants (stressors), it was found that there are lots of organizations working on environmental protection. These organizations have policies and regulations in addition to governmental environmental monitoring and guidelines to enhance the environmental situation and reach specific requirements. Despite all that, there is still a gap in the implementation of environmental protection techniques. So, the next part has a deeper research analysis of noise pollution, and it is environmental awareness of the community about noise. The environmental awareness indicators used are knowledge, skill, and motivation. In addition to mitigation techniques used are inspired from noise motion (source, path, receiver). The next part of the research explains the methodology of empirical work.

(4) Materials and Methods

4.1 Inception

This section explains the detailed identification of empirical analysis. The description of variables, indicators of these variables, tools, case study location selection simulation, and measurements

4.2 Variables selection

The research tests noise pollution as a sample of environmental stressors, in addition to noise environmental awareness analysis.

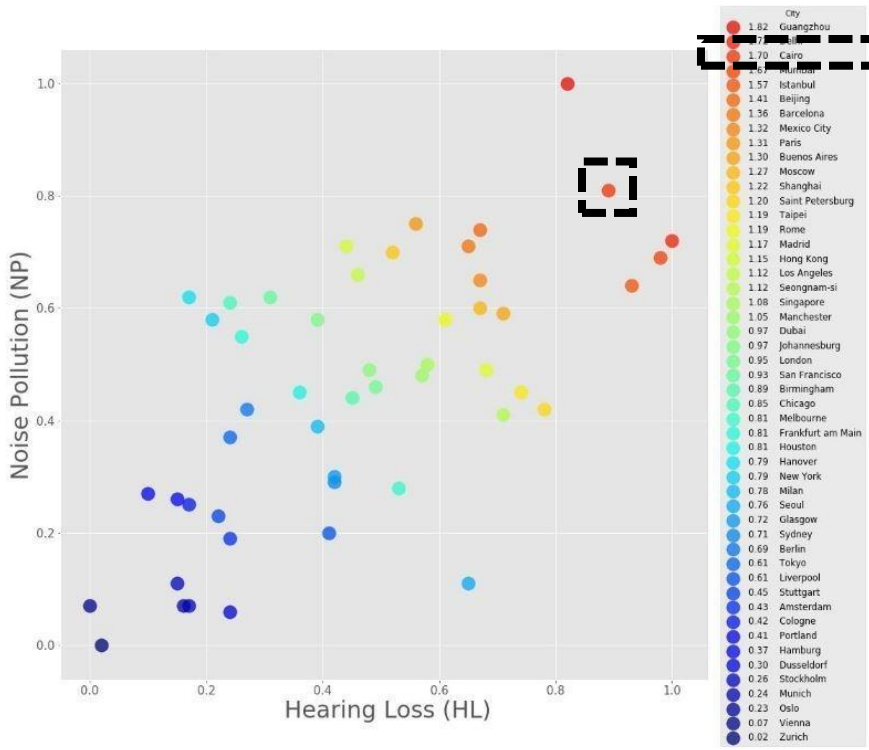


Figure 4. 1 noise pollution around the world and hearing loss effect, source: (world ecnomic forum, 2022)

Noise pollution was selected as a variable because Egypt is one of the noisiest cities in the world (Tawfeek, 2018; Brüel &Kjær, 2022; Martinelli, 2022). As shown in Figure 4. 1 which cause various mental and physical health problems (Okokon, et al., 2018; Beutel, et al., 2016; Hahad, et al., 2020; Bressane, Mochizuki, Caram, & Roveda, 2016).

4.3 Variables, indicators, and tools

Noise is measured by sound pressure level (SPL) in decibels, and it is identified as any unwanted sound (Environmental pollution center , 2022). The author measured the sound pressure level by measuring devices (2245 sound level meter B&K). Moreover, computer software (AEDT, Predictor-lima software, and Insul sound insulation prediction software) was used as a verified tool for simulation and prediction, in addition to the Pearson correlation coefficient (Brüel & Kjær, 2022; Brüel & Kjær, 2022; Federal aviation adminstration , 2022). Devices, software, Tools used are summarized in Figure 4. 2,Figure 4. 3. * see Appendix 2 devices and software data

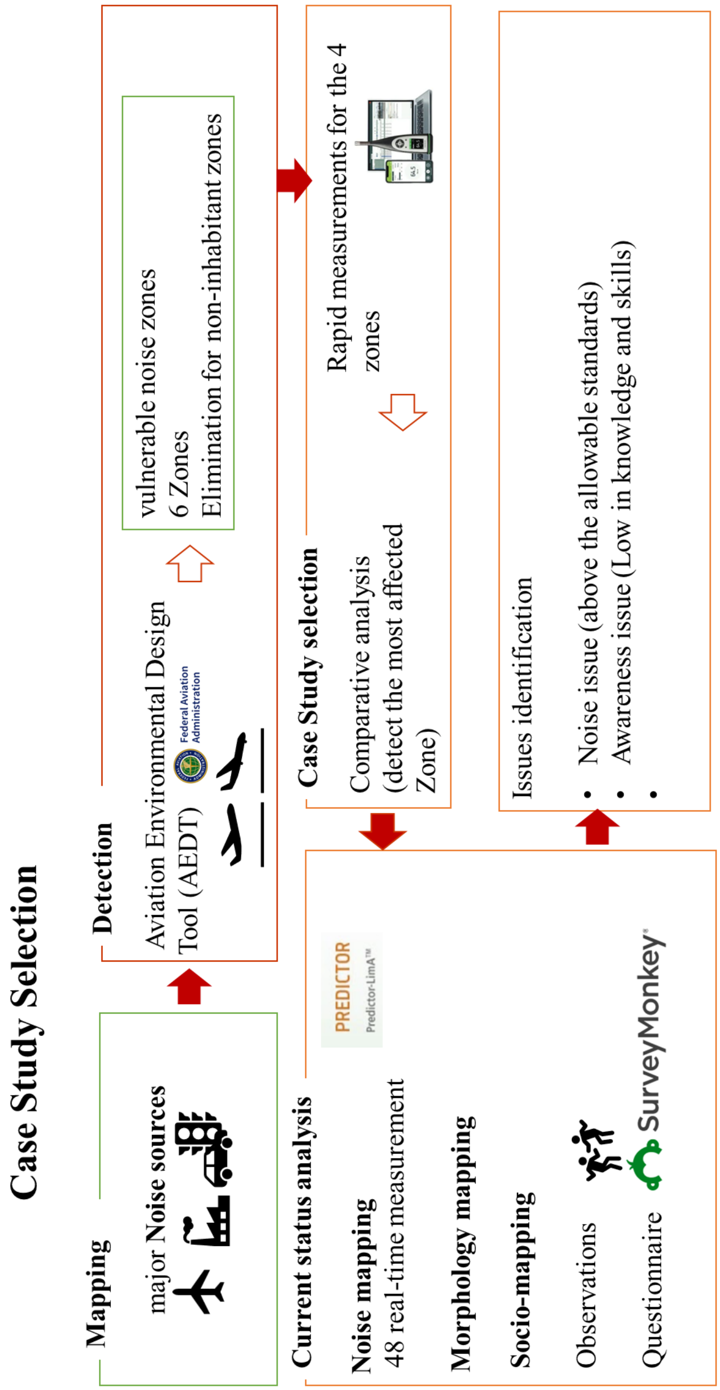


Figure 4. 2 case study selection and analysis methodology diagram ,source :author

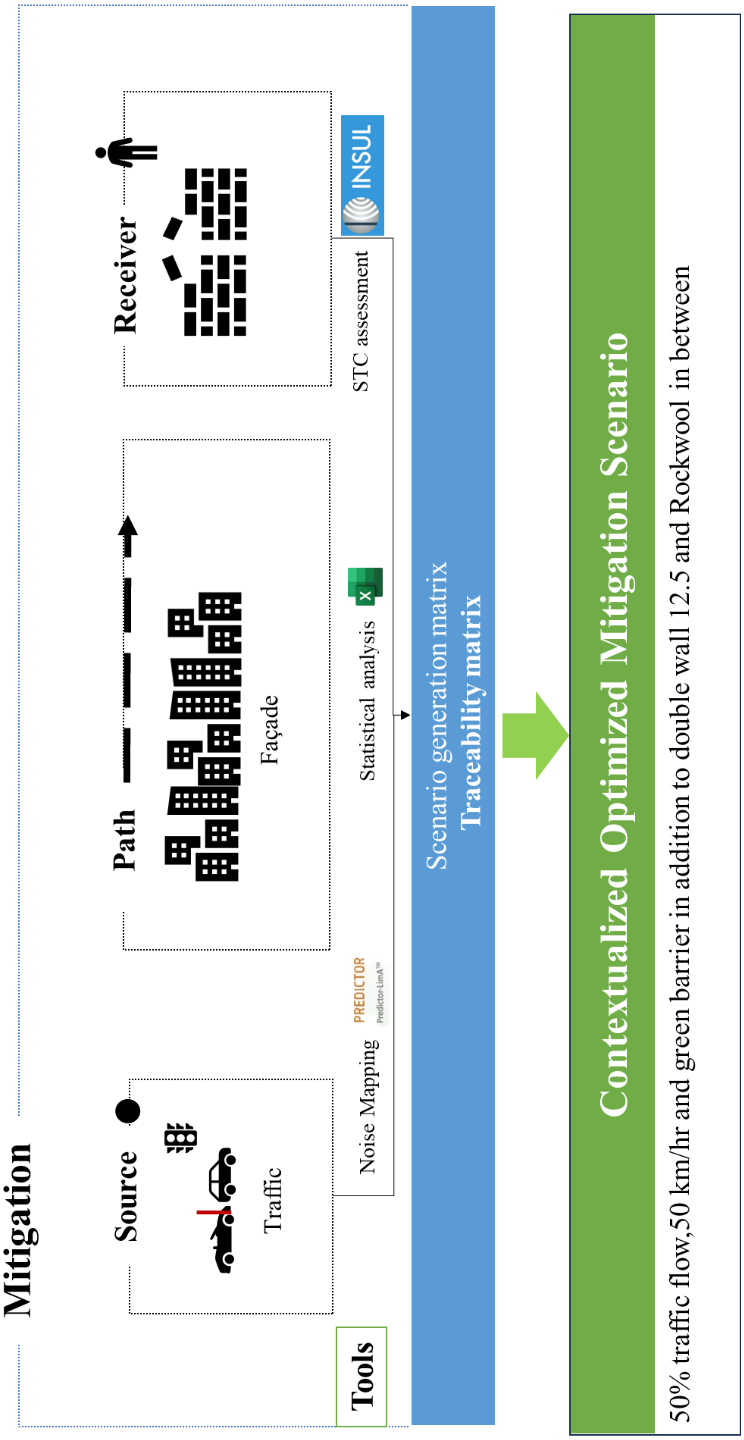


Figure 4. 3 case study mitigation methodology diagram ,source :author

In our first method, AEDT was used as software for mapping the noise surrounding airports according to international standards. The main aim of using AEDT in this research was to utilise the affected zones of the airport as a noise source. The research tool was designed to model studies ranging in scope from a single flight at an airport to regional, national, and global scales. The device was used by aviation professionals, researchers, manufacturers, airlines, airports, and other federal aviation authorities to address various environmental questions associated with aircraft operations. Additionally, AEDT supported our analysis needs for the International Civil Aviation Organization's (ICAO) Committee on Aviation Environmental Protection (CAEP) (Federal Aviation Adminstration, 2022). In this study, AEDT was preferred for airports because it contains more aviation-specific information.

The second method used B&K 2245 to measure sound levels that might be affected based on the building height in metres. In this regard, we use noise parameters such as LEAQ, LA max, LA min., LA 10, and LA0.LA90 (Brüel & Kjær, 2022b). The noise level was used initially to measure the selected zones for 5 minutes at each point, day and night. Measurements took place on May 29, 2021, at day and 1/6/2021, at night, where day was defined from 7 a.m. to 10 p.m. and night was defined from 10 p.m. to 7 a.m. After selecting a specific case study, a long measurement was taken on the selected street for nearly two days. The measurement period began on September 3, 2022, at 10:14:50 am and ended on September 5, 2022, at 8:41:56 pm. The effects were used as input data for the predictor lima model.

In the third method, Predictor-LimA was our noise mapping software, which was used to predict the noise of traffic on the selected street. The mapping analysis consisted of a vertical grid, a horizontal grid, and receivers at different building heights. The research tool was initially used to assess the current situation in relation to Egyptian law and also to predict the results of mitigation scenarios for traffic parameters and façade. Usually, this software was used in various projects, including industry, road traffic, rail traffic, and wind turbines. Many acoustic consultants, environmental authorities, heavy industries, and educational institutes in many countries operate the Predictor-LimA software. The acoustic determinator of software for sound power levels was based on several measurement methods, including ISO 3744, ISO 3746, and ISO 8297 (Brüel & Kjær, 2022a). On June 1, 2021, a site visit was conducted to collect data for developing a prediction model. Building heights, construction materials, and facade types are considered in this category. Also, the measurements of the sound-level metres were used in the model's creation.

The fourth method, Pearson correlation, was used to analyse the results of sound pressure level predictor lima with height, traffic flow , and traffic speed. Pearson correlation gives a profound indication of the correlation depth between two variables. The values used in the following step should be absolute, then the t-statical value with the following Equation 1:

$t = r\sqrt{n-2} \,/\, \sqrt{1-r^2}$ ………………………….....….. (1)

Where r is the Pearson correlation coefficient, and n is the number of values. Afterward, P-Value was calculated as the following Equation 2:

$P = TDIST(t, Df, Tails)$ ………………………….. (2)

TDIST is a continuous probability distribution, and DF is the degree of freedom with values equal to n-2. Tails are the number of variables used.

The last research tool used is INSUL software, which is used to assess different scenarios for wall partitions to reduce noise inside buildings. INSUL calculates the sound reduction values of walls, floors, ceilings, and windows. It can predict transmission loss (TL) along the 1/3 octave band and the overall weighting value of sound transmission class (STC).

Environmental awareness has three indicators (skills, motivation, and knowledge) (Kokkinen, 2013), so research examines these indicators through an online questionnaire. questionnaire measures awareness of noise pollution, in addition to other environmental pollution.

4.4 Identification of measurement locations

Zones that are impacted by noise sources determine the selection criteria for the noise pollution measurement site. Noise sources in a city are airports, traffic, industries, power plants, and residential areas, which are identified in Figure 4. 4 (Ismail M. R., 2014; Abas & Tamura, 2003). To determine which areas are most affected and need further investigation, research provides a brief study of the five main sources of noise in Cairo, Egypt. The main airport in Cairo and the one with the most flight traffic is Cairo International Airport. According to research, the airport's noise influence disappears after 5 kilometers (Faiyetole & Ibrahim, 2019). Given that Cairo is the nation's capital, traffic is the biggest cause of noise pollution in the city (World Bank, 2013; Transport Planning Authority, 2012). Activities in residential areas do not have a significant noise impact, but they do produce background noise.

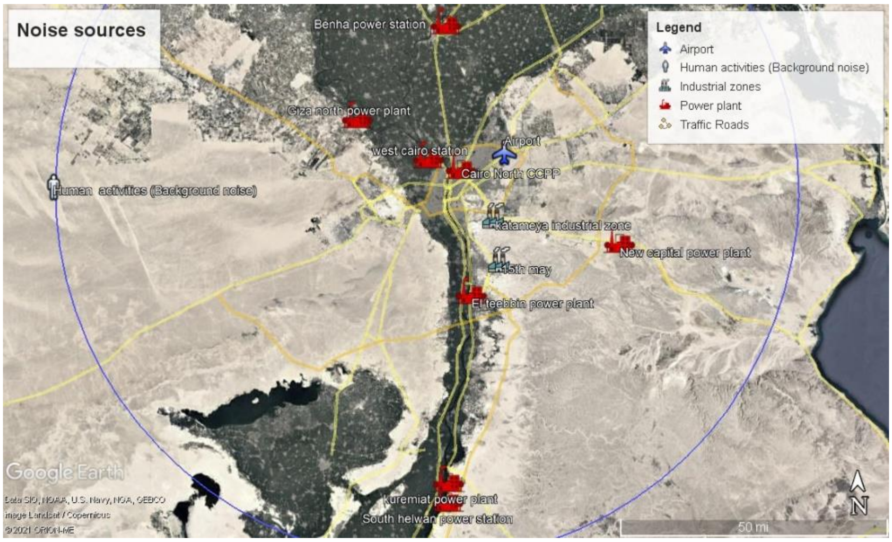


Figure 4. 4 the five noise sources in Egypt, source: Author

Industries are neglected because they are located in 15th May and Katmeya, which are far away from residential areas (Attia, 1999). Power plants are out of scope since reports from the Ministry of Environment mention that all power plants follow guidelines (New and Renewable Energy Authority, 2006). To conclude, the noise impact of airports, traffic noise, and residential activities are the focus of research, as highlighted in Figure 4. 5

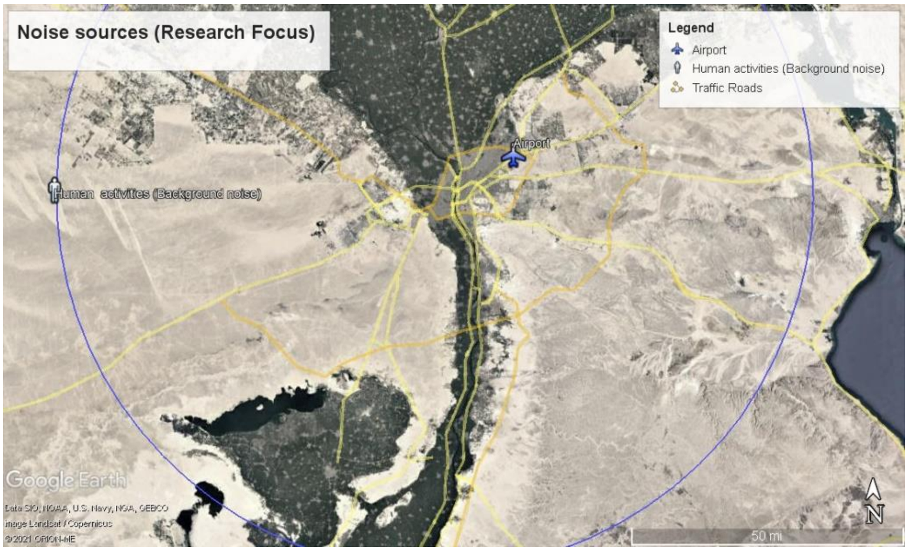


Figure 4. 5 Noise sources that research focus on, source : Author

The research conducted an analysis of the operation of Cairo Airport to identify the zones that are affected by aircraft noise. The airport's operational analysis is based on domestic and international flights through various runways. The next part explains the deep noise exposure of Cairo International Airport in various scenarios that end up with zone selection.

Figure 4. 6 Cairo airport Runways location, Source: Author through AEDT software

Cairo International Airport consists of three main runways, as shown in Figure 4. 6. Accordingly, the six scenarios for the runway are identified as shown in Table 4. 1. Three simulations for each scenario were conducted for domestic flights, international flights, and both together, as shown in Table 4. 2 (*see Appendix 3 domestic flights, Appendix 4 International flights, for aircraft types in detail)

Table 4. 1 Scenarios number with runways name, source: Author

No.	Runways end name
scenario 1	05R
scenario 2	05C

scenario 3	05L
scenario 4	23R
scenario 5	23C
scenario 6	23L

Table 4. 2 runways scenarios in relation to flights type, source: Author

	scenario 1	scenario 2	scenario 3	scenario 4	scenario 5	scenario 6
Domestic	05R	05C	05L	23R	23C	23L
International	05R	05C	05L	23R	23C	23L
Both	05R	05C	05L	23R	23C	23L

The simulation results explain the noise exposure-equivalent sound level (LAEQ) because of aircraft with a color scheme of grey, purple, blue, and red. Grey represents a very low sound pressure level, and red represents a very high sound pressure level. Figure 4. 7 shows a simulation of the six runway scenarios for domestic flights. Figure 4. 8 shows a simulation of the six runway scenarios for international flights. Figure 4. 9 shows a simulation of the six runway scenarios for international and domestic flights. Noise exposure is highest when both domestic and international flights are on the same runway, which is called the worst scenario.

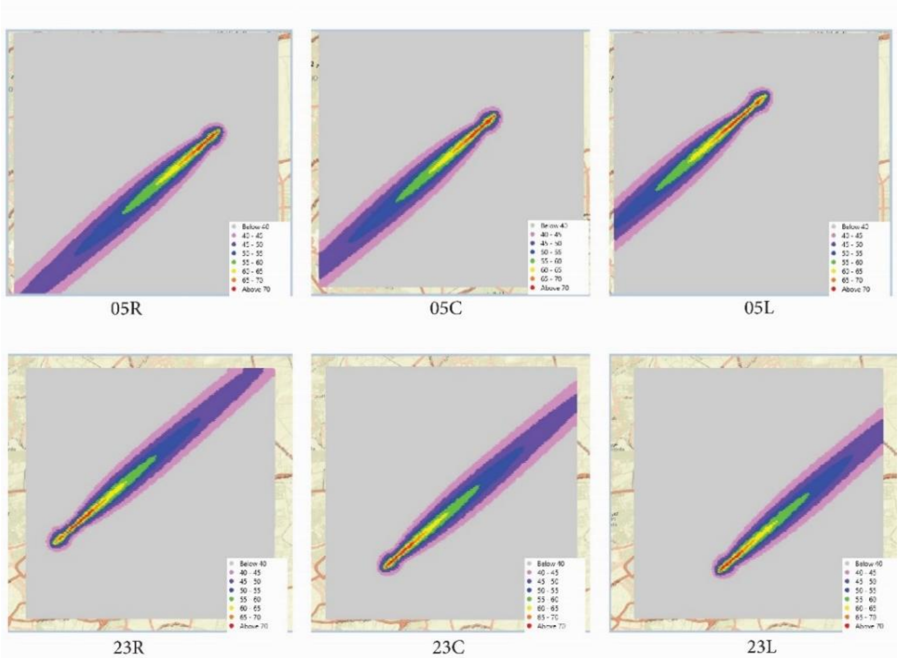


Figure 4. 7 Domestic flights simulation, Source: Author

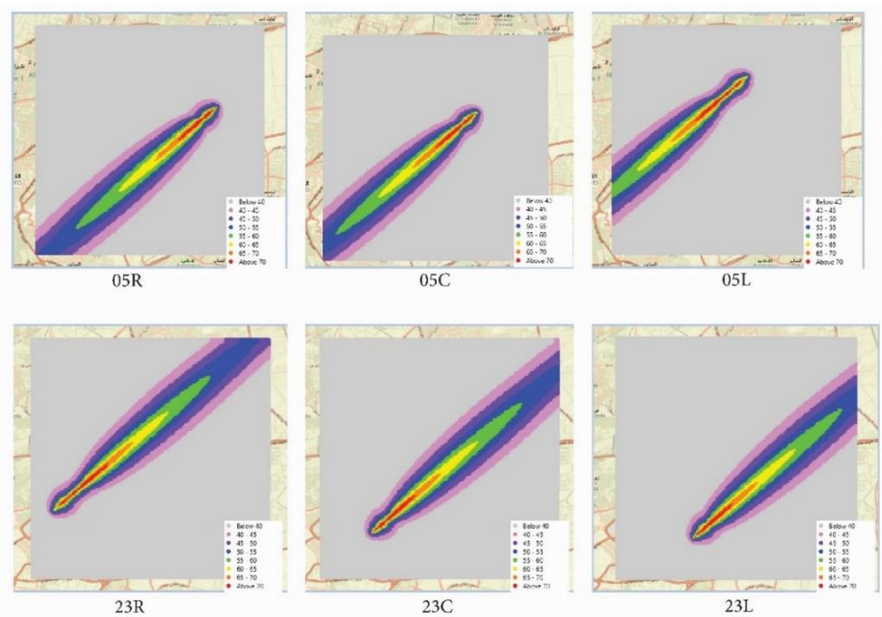


Figure 4. 8 International flights simulation, Source: Author

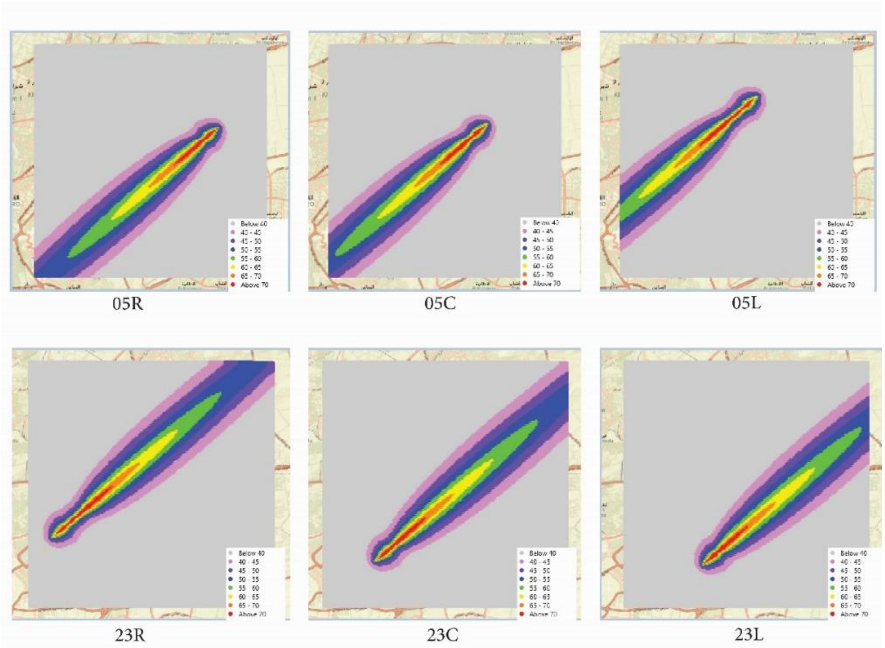


Figure 4. 9 Domestic and international flights simulation, Source: Author

When summing up the six scenarios for runways with both international and domestic flights, it is found that there are six affected zones, as shown Figure 4. 10. To pinpoint each zone's position and context, an analysis of how it relates to its surroundings is performed.

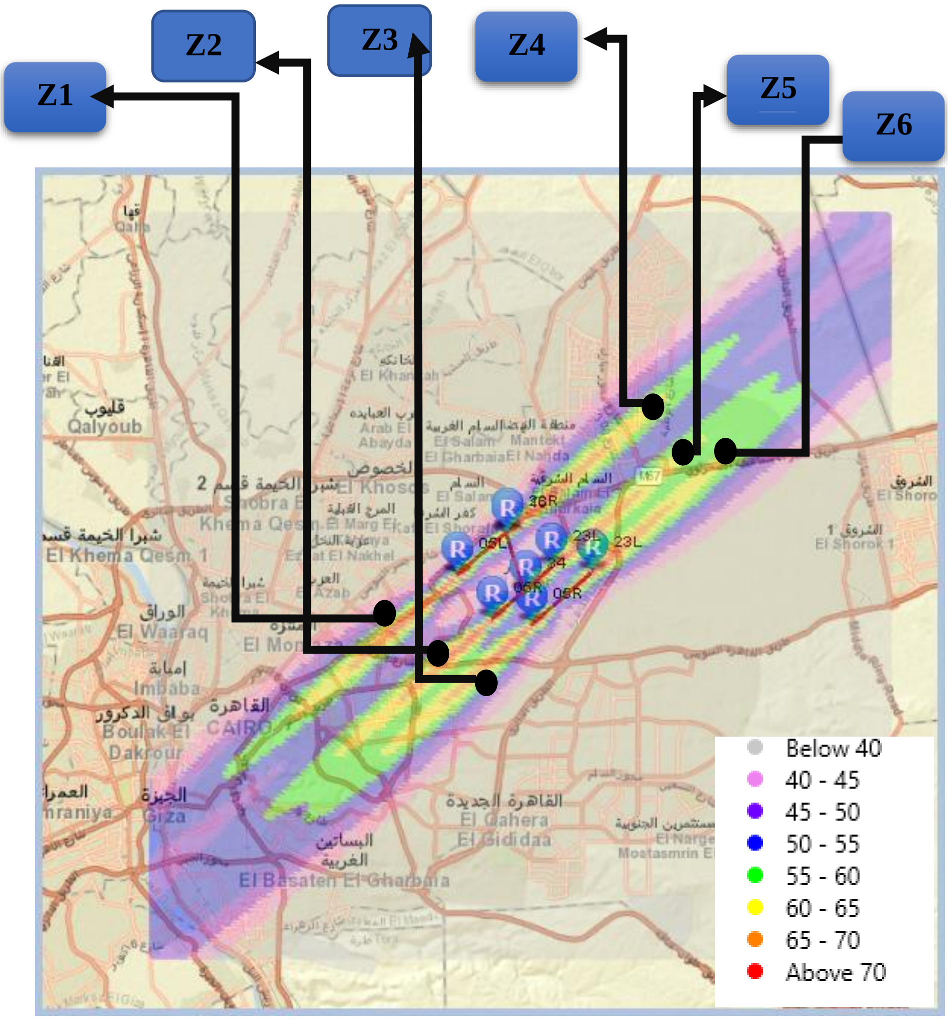


Figure 4. 10 Domestic and international flights simulation on all runways, Source: Author

<u>Zone 1,2,3:</u>

Figure 4. 11 shows that Zone 1 encompasses Salah Salem Street, and part of Masr El Gdeida Zone 2 includes Al Ahly Club and part of Nasr City. Zone 3 is located at the airport, passing through Suez Road and Ezbet Hgana.

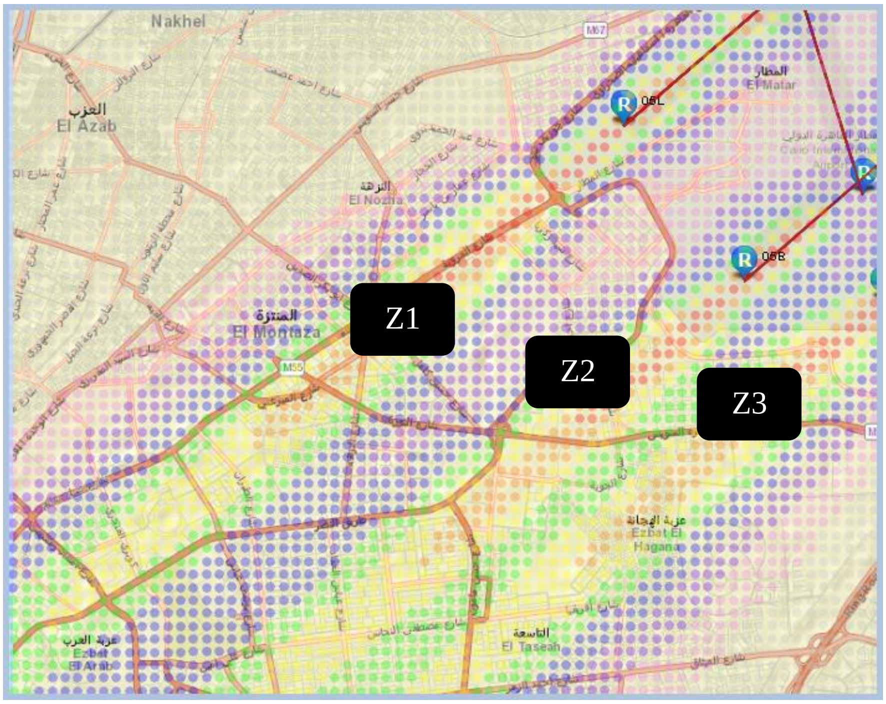


Figure 4. 11 Zone 1 , 2 and 3 detail , source: Author

<u>Zone 4,5 and 6:</u>

Zone 4 is near El-Obour industrial zone; Zones 5 and 6 are located on empty land, as shown in Figure 4. 12, so Zones 5 and 6 are excluded since they have no significance to be analyzed.

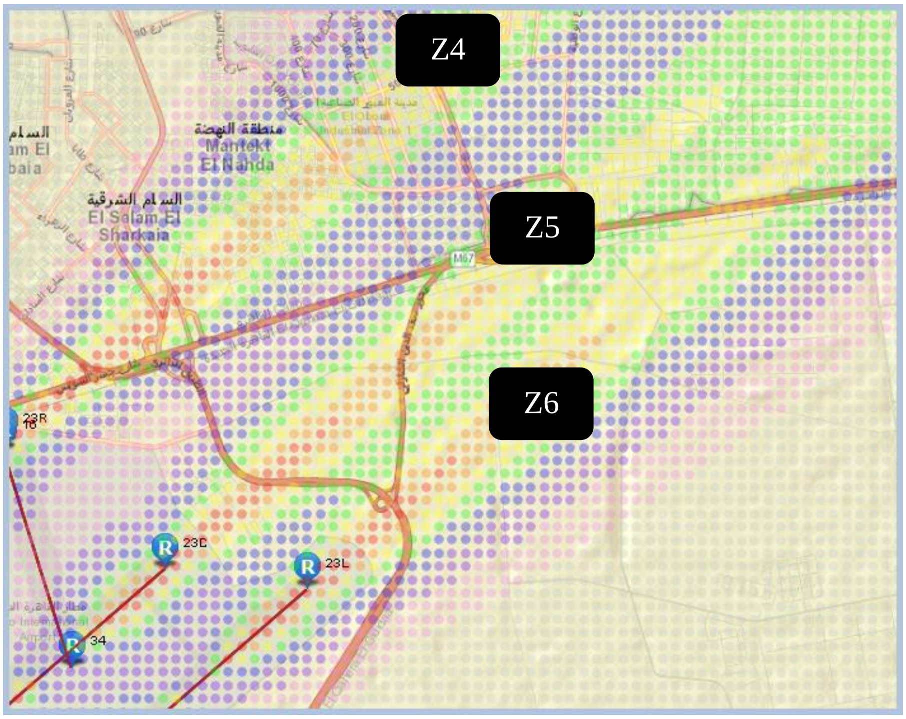


Figure 4. 12 zone 4, 5 and 6 , source: Author

The field sound pressure level in Zones 1, 2, 3, and 4 will then be measured using a Type 1 sound level meter 2245 in the direction of down wind . Understanding the entire sound level, including air traffic, traffic noise, and residential activity, if any, is aided by measurements taken in Zones 1, 2, 3, and 4. To provide a complete picture of the current state of concerns in these zones, the measurement period will span both day and night. The measurements will be based on suitable field locations that fall within the range of the maximum noise levels. Figure 4. 13,Figure 4. 14,Figure 4. 15,Table 4. 3,Table 4. 4 illustrate measurements location during day and night .

* (see detailed device setting in **Appendix 5 device setting**)

Figure 4. 13 Measurements point 1,5 and 6 location, source: author

Figure 4. 14 Day measurements points location, source: author

Table 4. 3 day measurements GPS location, Source: Author

Measurement	Latitude	Longitude	Zone
M01	30° 4' 45.012" N	31° 22' 24.168" E	Zone 3
M02	30° 4' 3.324" N	31° 21' 37.692" E	Zone 2
M03	30° 8' 21.192" N	31° 23' 50.856" E	Zone 4
M04	30° 6' 17.028" N	31° 22' 12.864" E	Zone 1
M05	30° 4' 43.032" N	31° 22' 21.972" E	Zone 3
M06	30° 4' 42.924" N	31° 22' 21.864" E	Zone 3

Note: M05 and M06 are same location as M01 with aircraft passing

*(see Flight 1)

Figure 4. 15 Night measurement locations, source: Author

Table 4. 4 Night measurements GPS location, Source: Author

Measurement	Latitude	Longitude	Zone
M01	30° 8' 17.5266" N	31° 23' 42.9612"E	Zone 4
M02	30° 6' 16.9596"N	31° 22' 12.7158"E	Zone 1
M03	30° 4' 0.876" N	31° 21' 37.227"E	Zone 2
M04	30° 4' 44.7384"N	31° 22' 23.7642"E	Zone 3

Aircraft pass while measuring Mo4 (see Flight 2)

Zone 2 excluded from deep analysis as it contain a mix of entertainment, commercial activities, zone 3,4 is excluded because they are on highways which not affect residential . zone 1 is selected as commercial residential area where there is an urger for low noise level as indicated in EEAA allowable limits.

4.5 the detailed case study brief description

The street is called Shahed Said Zakareya, it located in Sheraton Heliopolis. Shahied Said Zakariya analyzed as a sample as shown in Figure 4. 16, There is a middle island on this street, and the overall width is approximately 80 meters. There was a reduction in the width of the green islands in the centre, and the asphalt on both sides was more comprehensive. Recently, many urban transformations have been carried out to facilitate road mobility. Speed radars and speed limit signs have not yet been installed. Due to a pedestrian collision that occurred in the middle of 2023, a traffic light post was erected to make crossing the road easier.

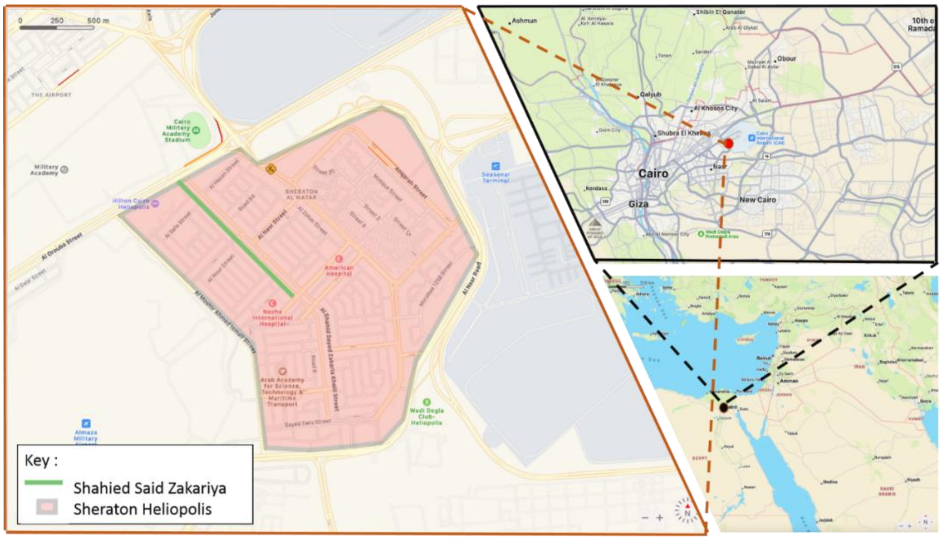


Figure 4. 16 show Sheraton Heliopolis and selected street within the affected noise zone range , source : Author

A site visit and extra measurements were done to support predictor model creation. site visit to collect some data, for instance, building heights as shown in Appendix 6 Detailed height map, materials, and typology. In addition, the noise level was measured by using the B&K 2245 sound level metre device on the selected street for nearly 2 days. Measurements started from 9/3/2022 at 10:14:50 AM until 9/5/2022 at 8:41:56 PM.

This study created a base model with a fixed receiver point to precisely monitor the values of in sound pressure values. Figure 4. 17 shows the allocation of the eight receivers, and the layout was divided into two street segments. The first segment contain receivers (A,B,C) as shown in Figure 4. 18 and the second segment include receivers (1,2,3,4,5) as illustrated in Figure 4. 19. Receivers are selected in direction of main street were there is more traffic and higher noise level as indication of worst case scenario . The selected street segments for interstation were classified into four sub-typologies (Table 4. 5). This research also selected six measurements ranging from 1.5 to 18 meters, representing the following heights: 1.5, 4, 8, 12, 15, and 18 metres.

Table 4. 5 Types of classification, source: Author

No.	shape	façade block length	Height ranges
Type 1	rectangle form	25-meter	24 and 33 meters
Type 2	rectangle form	30-meter	18 meters
Type3	rectangle form	15-meter	various
Type 4	Rectangular with inner courts	_	18 meters

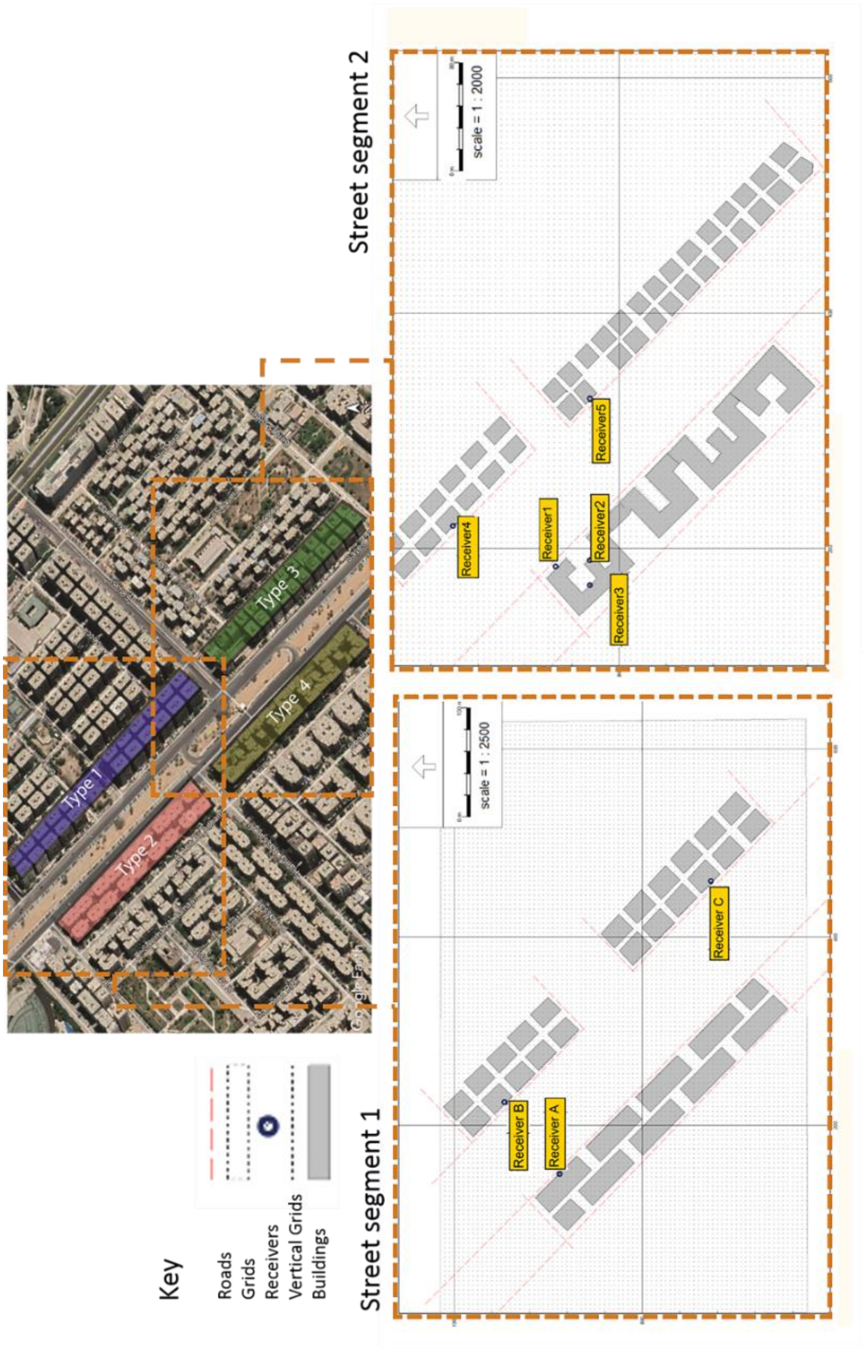


Figure 4. 17 selected street and housing typologies, source author

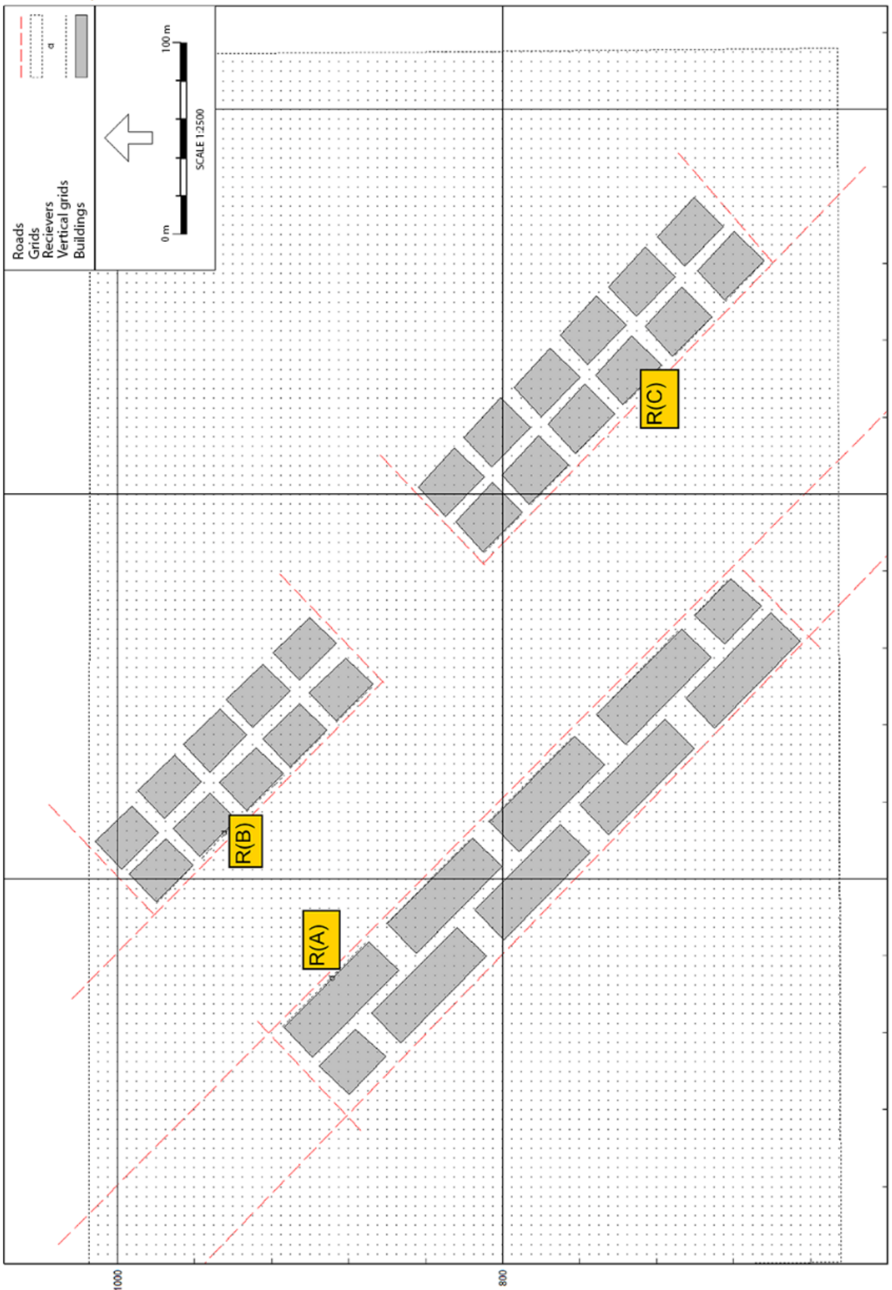


Figure 4. 18 type 1 and 2 items key plan, source: Author

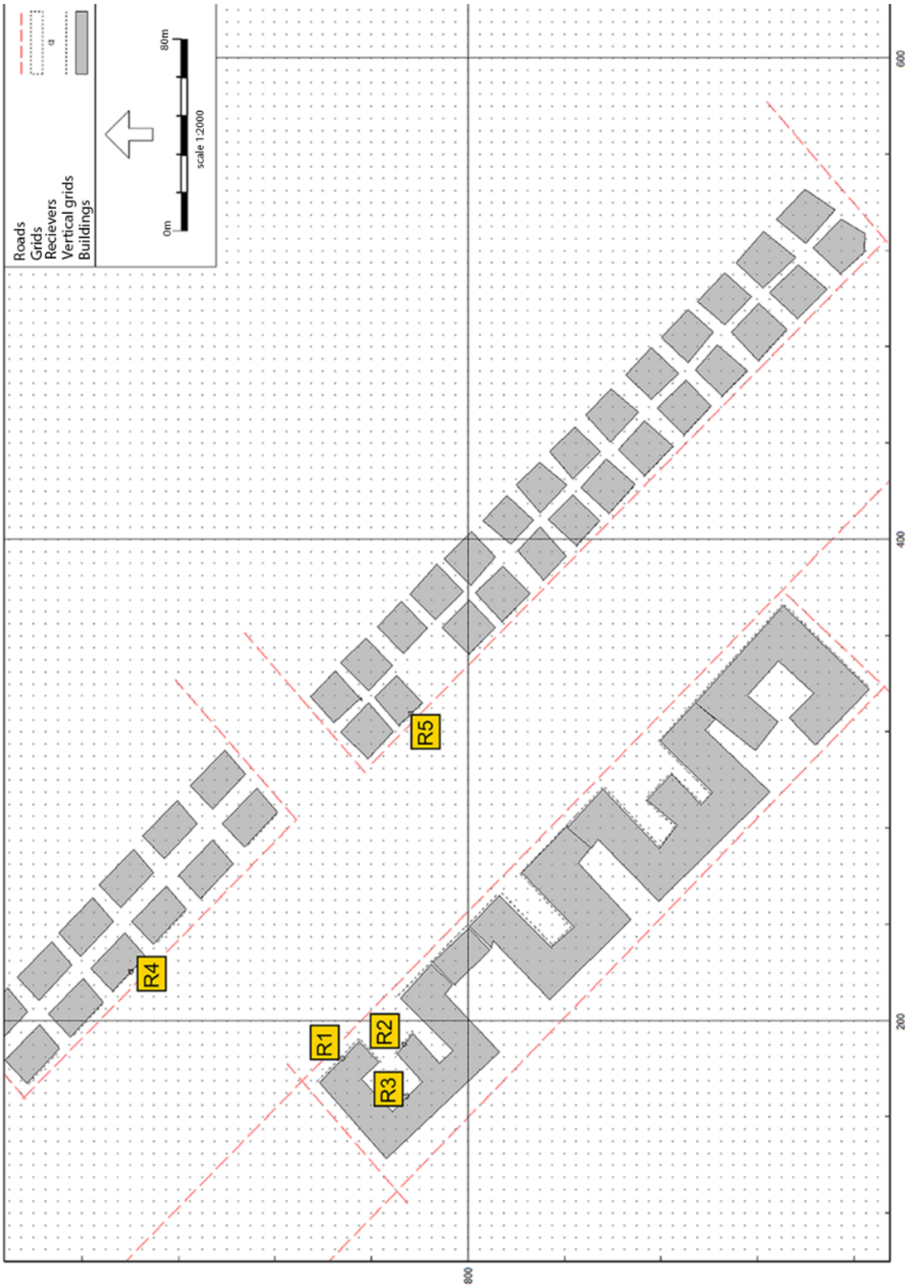


Figure 4. 19 key items plan, Source: Author

4.6 Environmental noise awareness scope

Using an online questionnaire, environmental awareness was examined broadly to provide a picture of the level of awareness in the city. In fact, a realistic estimate of the sample size revealed that 107 responders were necessary as explained below

$$\text{Sample size} = \frac{\dfrac{z^2 \times p\,(1-p)}{e^2}}{1 + \left(\dfrac{z^2 \times p\,(1-p)}{e^2 N}\right)}$$

N = population size • e = Margin of error (percentage in decimal form) • z = z-score

Desired confidence level	z-score
80%	1.28
85%	1.44
90%	1.65
95%	1.96
99%	2.58

Assuming:

Population size= 21,323,000

*source: https://www.macrotrends.net/cities/22812/cairo/population

Confidence level=90%

z-score =1.65 (survey mokey, 2022)

Margin of error =8%

Required sample size =107

*source: https://www.surveymonkey.com/mp/sample-size-calculator

Observation of noise mitigation strategies implemented in the street deeply analyzed.

4.7 Evaluation criteria

Noise pollution is evaluated based on the regulations of the Ministry of Environment Egyptian Affair Agency (EEAA), which has been the official local environmental agency since 1982.

4.8 Summary

Noise pollution and environmental awareness are selected as main variables. Sound pressure level is the main indicator for noise level which is analyzed by sound level meter, noise mapping through AEDT and predictor lima software in addition to Insul software. Moreover, morphological mapping and statical analysis. For case study selection, major noise sources in the city were mapped then investigation of airport as noise source. Measurements by sound level meter to detect affected zones and select specific case study then results are compared to allowable limits specified by EEAA. deep analysis and mitigation for case study are done. knowledge, skill and motivation are indicators of environmental awareness which is tested by observation and online questionnaire.

(5) Noise pollution assessment of a case study in the Egyptian context

5.1 Inception

This section explains the detailed analysis of the current noise situation and the desired state, correlating that with the literature. In addition to the overall environmental awareness of noise pollution.

5.2 Actual noise level vs. desired noise limit

There is a gap between the actual and desired state for the noise limit because the current state shows a higher noise level than expected. The measurements of the 29 stations placed by EEAA show that the results exceed the allowed noise level guidelines, as clarified in the reflection of literature in the Egyptian context chapter 3 (*see Appendix 7 noise guidelines required by EEAA). Moreover, the measurements of the four selected zones show that the noise level is higher than the required limit during the day and night, as shown in table 5. 1,table 5. 2.Indeed, the research deeply investigates measurements to have a better analysis of noise sources to fill the gap between the desired and actual states.

table 5. 1Day measurement summary, source: Author

Day Measurement	Start Time	Elapsed Time	LAeq	LAF10.0	LAF50.0	LAF90.0	Required LEAQ Limit	Zone
M01	5/29/2021 7:28:25 PM	0:05:00	77.42	79.21	76.93	74.8	50	Zone 3
M02	5/29/2021 7:54:28 PM	0:05:00	73.81	75.51	70.56	66.22	60	Zone 2
M03	5/29/2021 8:18:55 PM	0:05:00	77.55	78.67	75.69	73.17	70	Zone 4
M04	5/29/2021 8:34:08 PM	0:05:00	69.06	71.63	65.6	58.94	55	Zone 1
M05	5/29/2021 9:02:32 PM	0:02:00	80.01	81.65	77.59	75.33	70	Zone 3
M06	5/29/2021 9:04:50 PM	0:02:00	79.43	81.18	77.97	76.04	70	Zone 3

*See Appendix 8 Day measurement

table 5. 2 night measurement summary, source: Author

Night Measurement	Start Time	Elapsed Time	LAeq	LAF10.0	LAF50.0	LAF90.0	Required LEAQ limit	Zone
M01	6/1/2021 10:00:51 PM	0:05:00	80.44	82.15	78.04	74.14	60	Zone 4
M02	6/1/2021 10:19:27 PM	0:05:00	68.82	70.85	64.73	60.15	45	Zone 1
M03	6/1/2021 10:41:08 PM	0:05:00	75.45	78.39	72.2	65.12	50	Zone 2
M04	6/1/2021 10:53:54 PM	0:05:00	78.22	80.62	76.72	74.17	40	Zone 3

*see Appendix 9 Night measurement

After measurements analysis, it is found that traffic noise has major impact on noise level increase since average noise level during flight motion does not show significant different, the difference is only 1 to 3 decibels.   (*for flight details see Appendix 10 Flight details of aircraft pass while measurements). Additionally, traffic has a greater impact on the bottom half of the building than on the top part, which is more affected by flight. Therefore, it is crucial to comprehend traffic noise in greater detail. The research used Predictor Lima software to better understand traffic noise in a specific case study. A street in zone 1 was selected as a sample because zones 3 and 4 are located near highways apart from residential areas, and zone 2 is located near a sports club, which leads to a higher traffic flow than normal residential flow with few commercial activities. Furthermore, zone 1 has historically been mitigated due to noise complaints; in 2010, the runways at Cairo Airport were modified.

5.3 Noise level results for the case study (Sheraton Heliopolis)

5.3.1 measurements results

Sheraton Heliopolis has residential areas in the city that are also commercially active, so the required sound level is 55 dB during the day and 45 dB at night. The measurement received from Equivalent Continuous Sound Pressure Level (LAeq) measured 56.9 decibels during the day and 54.24 decibels during the night. The values exceeded the allowable limits of 55 decibels during the day and 45 decibels during the night. Other than the maximum LAeq values during the day were 68.82 dB, and at night, they were 69.06 dB as shown in Table 5. 3,Figure 5. 1. * see Appendix 11Detailed measurements.

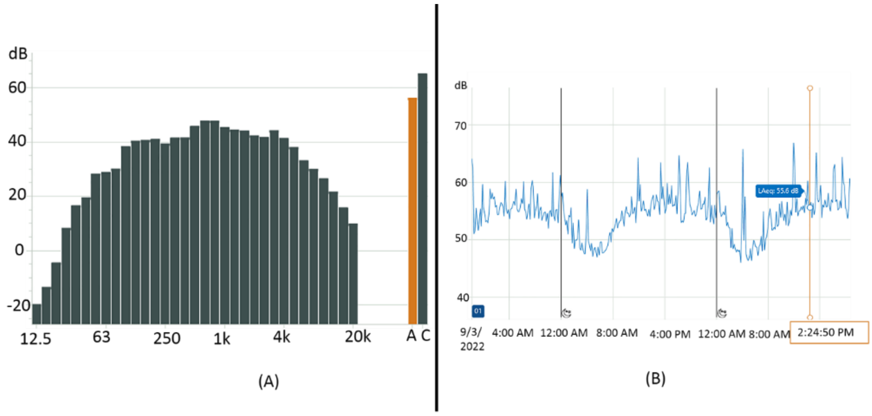


Figure 5. 1 (A) spectrum 1/3 octave bands, where the x-axis is Leaq in dB and the y-axis is the frequency in HZ, (B) time history of LAeq(dB), showing the change of dB in the x-axis all over the time in Y-axis

Table 5. 3 LAeq (A) measured versus the allowable limit of sound levels

	LAeq (dB (A))	Limit (dB (A))
Day 1	56.49	55
Day 2	56.80	55
Day 3	57.38	55
The average day	56.91	55
max day	69.06	55
Night 1	53.62	45
Night 2	54.79	45
The average night	54.24	45
max night	68.82	45

5.3.2 current noise contour map results

The results were figured out from the two spatial street segments in our case study. The first street segment showed the values of receivers A, B, and C, while the second street segment represented receivers (1, 2, 3, 4, and 5). Each receiver's values were calculated at different heights. The Predictor-LimA software simulated these values. The following subsections of this study showed the receiver's sound pressure level (SPL) LAeq (dB) value, resulting in the statical analysis.

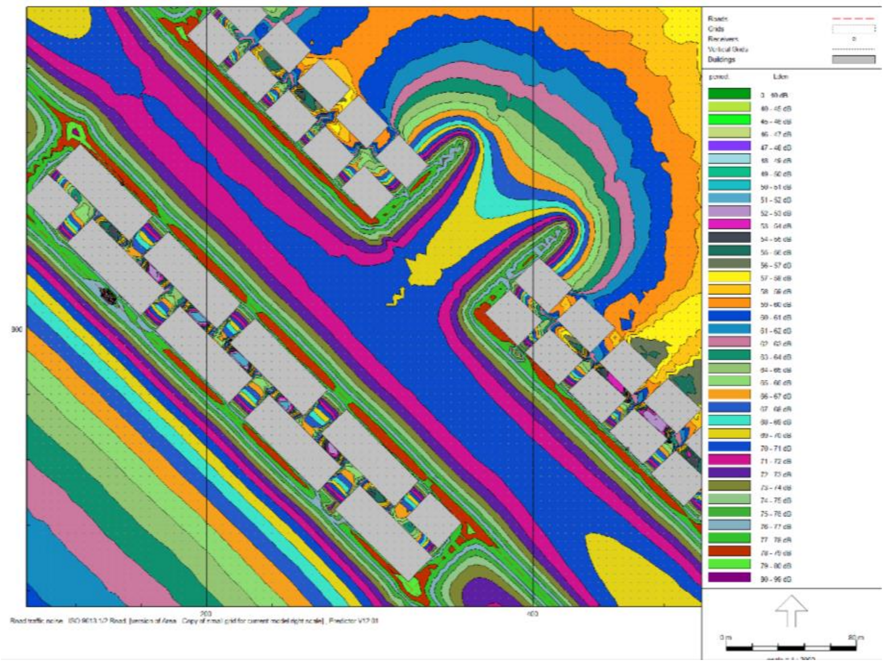


figure 5. 2 type 1 and 2 contour plans, source: Author

figure 5. 2 indicate that flat facades have the same performance regardless of the length of the façade because the only difference is that more surface area is exposed to noise inside the building.

Table 5. 4 Receiver noise levels at various height ,Source: Author

Name	Height	Day	Night
Receiver A	18	65.1	64.5
Receiver A	15	65.8	65.2
Receiver A	12	66.7	66.1
Receiver A	8	68.3	67.7
Receiver A	4	70.5	70
Receiver A	1.5	71.9	71.3
Receiver B	18	65.1	64.5
Receiver B	15	65.8	65.2
Receiver B	12	66.7	66.1
Receiver B	8	68.2	67.6
Receiver B	4	70.4	69.8
Receiver B	1.5	71.5	71
Receiver C	18	64.8	64.2
Receiver C	15	65.5	64.9
Receiver C	12	66.4	65.8

Receiver C	8	67.8	67.2
Receiver C	4	69.6	69
Receiver C	1.5	70.4	69.8

The results show that three receivers (A, B, and C) reach 65–72 dB near the building façade during the day and 65–72 dB near the building façade at night, as shown in figure 5. 4,Table 5. 4

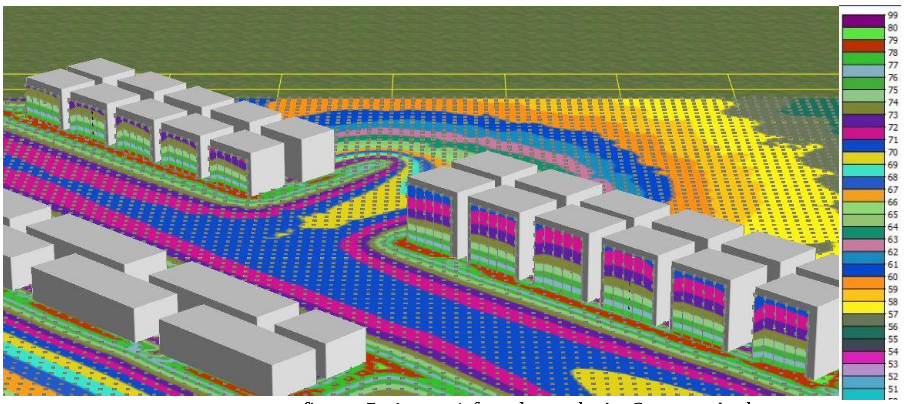


figure 5. 4 type 1 facade analysis, Source: Author

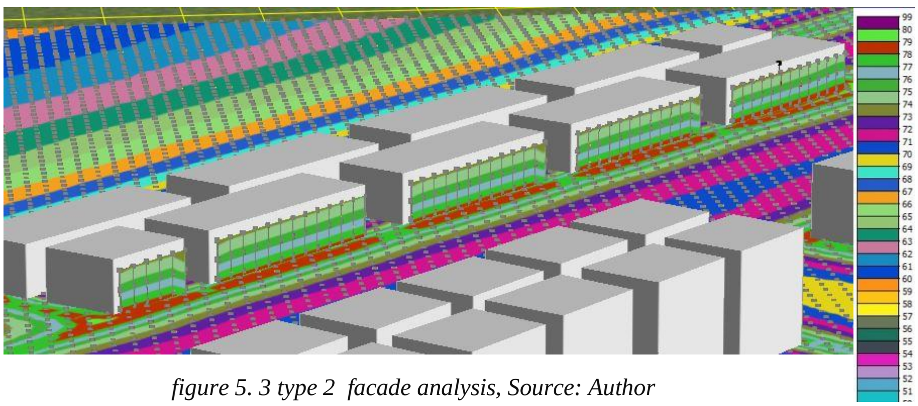


figure 5. 3 type 2 facade analysis, Source: Author

figure 5. 4, figure 5. 3 represents the façade analysis of types 1 and 2, so it's clear that the higher the building, the lower the impact of noise on the upper floors. Table 5. 5 shows a decrease of nearly 2 decibels within each of the 2 or 3 floors.

Table 5. 5 the difference of noise level between 1.5m and all other heights

Name	Height	Day	Night	difference from first floor at day	Difference from first floor at night
Receiver A	1.5	71.9	71.3	0	0
Receiver B	1.5	71.5	71	0	0
Receiver C	1.5	70.4	69.8	0	0
Receiver A	4	70.5	70	-1.4	-1.3
Receiver B	4	70.4	69.8	-1.1	-1.2
Receiver C	4	69.6	69	-0.8	-0.8
Receiver A	8	68.3	67.7	-3.6	-3.6
Receiver B	8	68.2	67.6	-3.3	-3.4
Receiver C	8	67.8	67.2	-2.6	-2.6
Receiver A	12	66.7	66.1	-5.2	-5.2
Receiver B	12	66.7	66.1	-4.8	-4.9
Receiver C	12	66.4	65.8	-4	-4
Receiver A	15	65.8	65.2	-6.1	-6.1
Receiver B	15	65.8	65.2	-5.7	-5.8
Receiver C	15	65.5	64.9	-4.9	-4.9
Receiver A	18	65.1	64.5	-6.8	-6.8
Receiver B	18	65.1	64.5	-6.4	-6.5
Receiver C	18	64.8	64.2	-5.6	-5.6

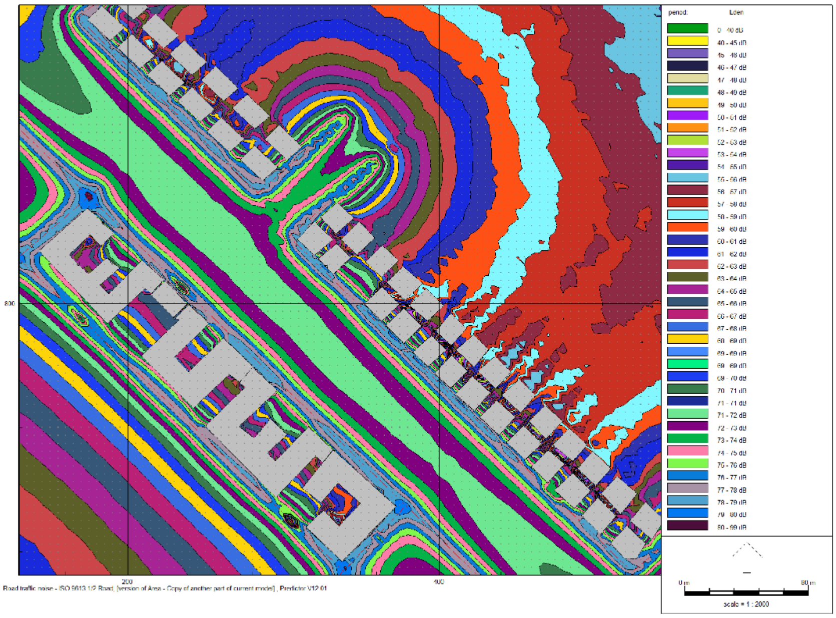


Figure 5. 5 type 1, 3 and 4 contour plan, Source: Author

Because just the exposed area of the façade causes noise, Figure 5. 5 explains that flat facades perform the same no matter how long they are. According to the receiver data, during the daytime, the noise level of vehicles will be between 62 and 73 dB close to the building façade. Since receiver three is a little further away from the source, it exhibits a noise level of 55–57 dB during the day. As indicated in Table 5. 6 receivers' average noise levels near building facades vary from 62 to 73 dB at night, while receivers' three values are between 55 and 57 dB. 6. noise exposure on facades because the distance between the noise source and receiver rises. Therefore, since some facades are further away from the source, courts aid in noise reduction.

Table 5. 6 Receiver noise levels at various height ,Source: Author

Name	Height	Day	Night
Receiver 1	18	65.5	65
Receiver 1	15	66.1	65.6
Receiver 1	12	66.9	66.4
Receiver 1	8	68.2	67.6
Receiver 1	4	69.6	69
Receiver 1	1.5	70.3	69.7
Receiver 2	18	62.6	62
Receiver 2	15	62.7	62.2
Receiver 2	12	63.1	62.5
Receiver 2	8	63.4	62.8
Receiver 2	4	63.7	63.1
Receiver 2	1.5	64.1	63.5
Receiver 3	18	57	56.4
Receiver 3	15	55.9	55.4
Receiver 3	12	56	55.4
Receiver 3	8	56.1	55.5
Receiver 3	4	56.2	55.7
Receiver 3	1.5	56.7	56.1
Receiver 4	18	65.1	64.5
Receiver 4	15	65.8	65.2
Receiver 4	12	66.6	66
Receiver 4	8	68	67.4
Receiver 4	4	69.7	69.2
Receiver 4	1.5	70.6	70
Receiver 5	18	65.2	64.6

Receiver 5	15	65.8	65.2
Receiver 5	12	66.6	66
Receiver 5	8	68.3	67.7
Receiver 5	4	70.8	70.2
Receiver 5	1.5	72.4	71.9

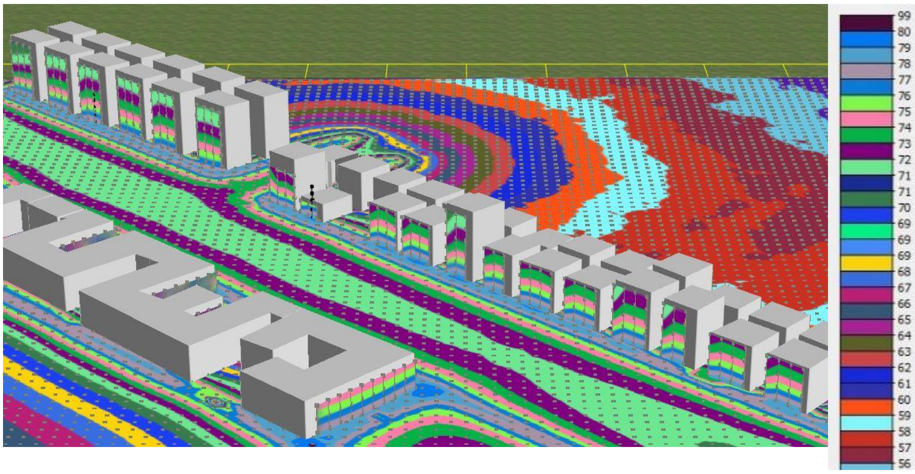


figure 5. 7 type 1and 3 facade analysis, Source: Author

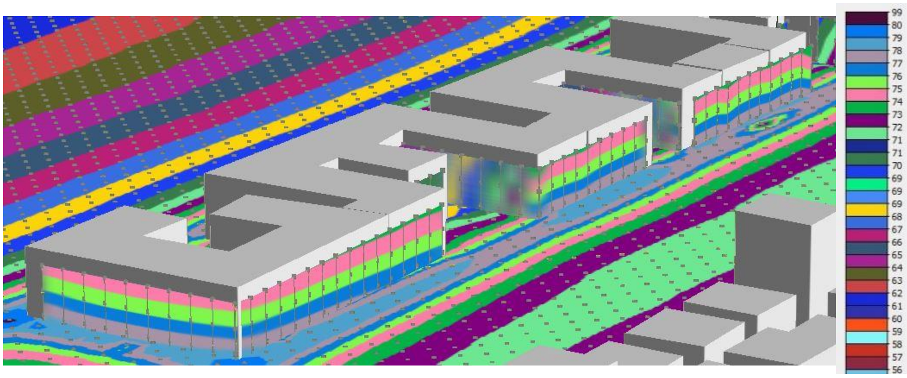


figure 5. 6 type 4 facade analysis, Source: Author

figure 5. 7 , figure 5. 6 Show façade analysis for types 1, 3, and 4. The results show a reduction in noise level on the upper floor of the building. design of courts (u-shaped buildings) minimizes noise levels on recessed facades, as shown Table 5. 7.

Table 5. 7the difference of noise level between 1.5m and all other heights, Source: Author

Name	Height	Day	Night	difference from first floor at day	Difference from first floor at night
Receiver 1	1.5	70.3	69.7	0	0
Receiver 2	1.5	64.1	63.5	0	0
Receiver 3	1.5	56.7	56.1	0	0
Receiver 4	1.5	70.6	70	0	0
Receiver 5	1.5	72.4	71.9	0	0
Receiver 1	4	69.6	69	-0.7	-0.7
Receiver 2	4	63.7	63.1	-0.4	-0.4
Receiver 3	4	56.2	55.7	-0.5	-0.4
Receiver 4	4	69.7	69.2	-0.9	-0.8
Receiver 5	4	70.8	70.2	-1.6	-1.7
Receiver 1	8	68.2	67.6	-2.1	-2.1
Receiver 2	8	63.4	62.8	-0.7	-0.7
Receiver 3	8	56.1	55.5	-0.6	-0.6
Receiver 4	8	68	67.4	-2.6	-2.6
Receiver 5	8	68.3	67.7	-2	-4.2
Receiver 1	12	66.9	66.4	-3.4	-3.3
Receiver 2	12	63.1	62.5	-1	-1
Receiver 3	12	56	55.4	-0.7	-0.7
Receiver 4	12	66.6	66	-4	-4
Receiver 5	12	66.6	66	-5.8	-5.9
Receiver 1	15	66.1	65.6	-4.2	-4.1
Receiver 2	15	62.7	62.2	-1.4	-1.3
Receiver 3	15	55.9	55.4	-0.8	-0.7
Receiver 4	15	65.8	65.2	-4.8	-4.8
Receiver 5	15	65.8	65.2	-6.6	-6.7
Receiver 1	18	65.5	65	-4.8	-4.7

Receiver 2	18	62.6	62	-1.5	-1.5
Receiver 3	18	57	56.4	0.3	0.3
Receiver 4	18	65.1	64.5	-5.5	-5.5
Receiver 5	18	65.2	64.6	-7.2	-7.3

At the end, traffic noise levels are relatively high, which increases the noise level of building facades more than required guidelines. In addition, noise levels on lower floors increase due to residential activities; also, some zones in the city have high noise levels on the upper level due to aircraft. These zones are identified in the methodology chapter. There was no incentives for noise mitigation only few greens exists This situation requires mitigation for the noise source, path, or receiver.

To have a reliable action plan, a deep investigation of community perceptions towards noise problems through an online questionnaire is needed, and the results are discussed in the next part. ***See** Appendix 12 Questionnaire

5.4 The awareness of individuals about noise pollution

5.4.1 First general info about questionnaire respondents.

The number of respondents is 109, and most of the respondents are female. 11.93% (13 of 109) respondents are males, and 88.07% (96 of 109) respondents are females as shown in Figure 5. 8 .That does show that women are more willing than men to engage in community activities. Understanding the respondents' ages will help identify their demographic types.

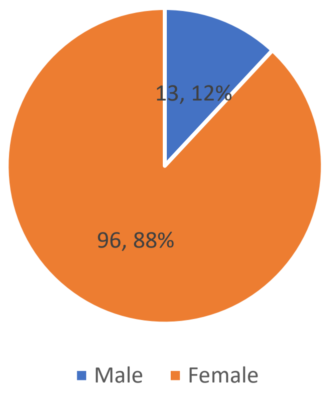


Figure 5. 8 number of female and male respondents pie chart, Source: Author

1.83% (2 of 109) of respondents are under 18; 36.70% (40 of 109) are between 18 and 24; the majority are in the age range 25–34; the percent is 57.80% (63 of 109); and only 3.67% (4 of 109) are between 35 and 44, as shown in Figure 5. 9,Figure 5. 10. In fact, analyzing educational level gives an impression of knowledge level.

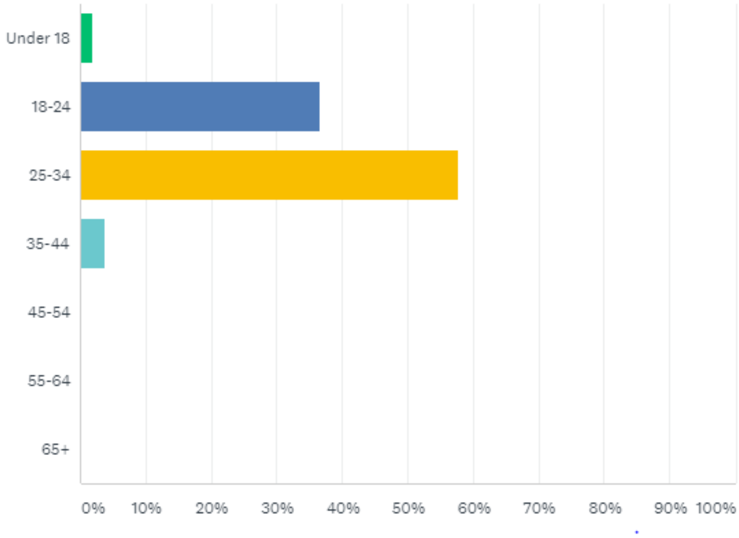


Figure 5. 9 ages distribution bar, source: Author

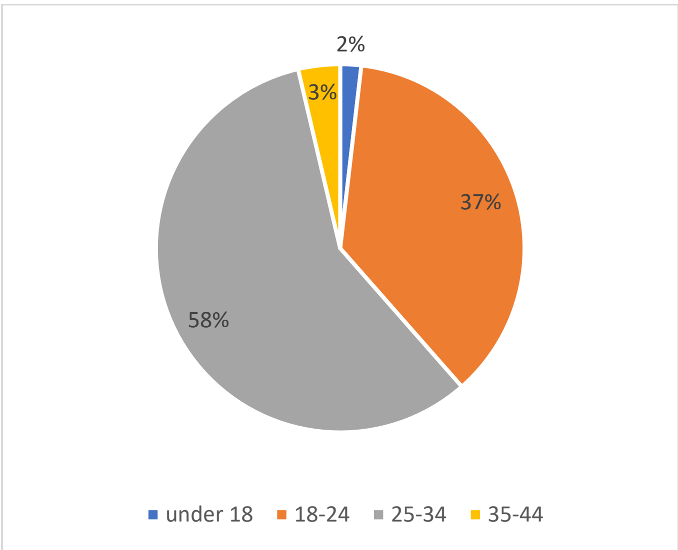


Figure 5. 10 pie chart of ages distribution pie chart , Source: Author

For educational level, 11.93% (13/109) graduated from high school. 11.93% (13/109) are master's degree holders, and the majority are bachelor's degree holders (76.15%) (83/109), as shown in Figure 5. 11,while Figure 5. 12 show their profession distribution.

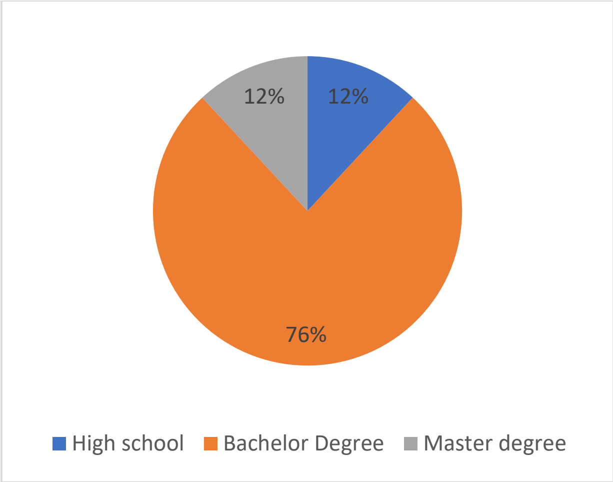


Figure 5. 11 educational level distribution pie chart, Source: Author

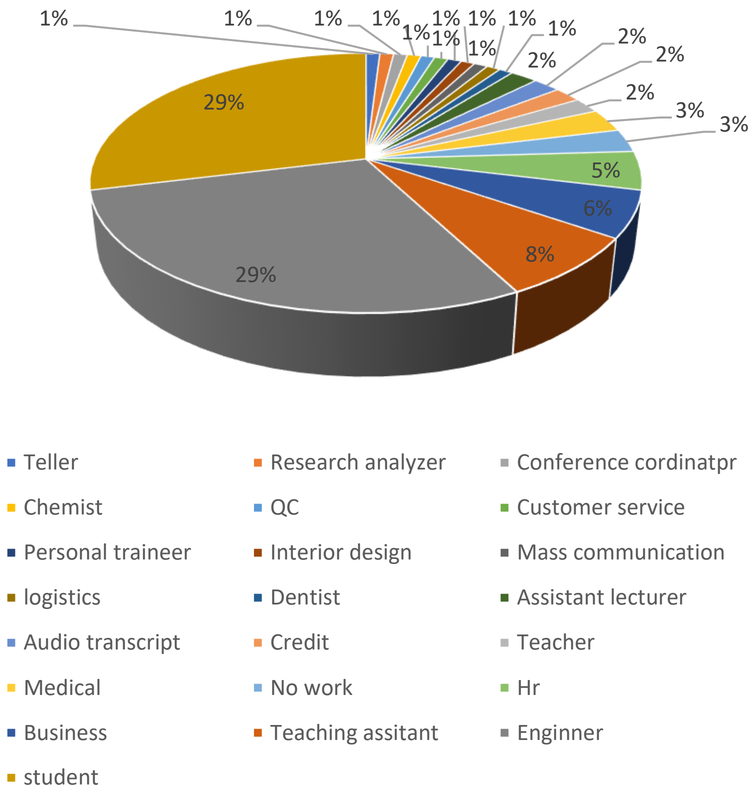


Figure 5. 12 Current profession 3D Pie chart, source: Author

The next part will discuss the environmental awareness of these respondents and their knowledge, skills, and motivation.

5.4.2 Knowledge

Nearly half of those who responded are thinking that projects in Egypt don’t meet the acoustical deadline, and some of them are a bit hesitant whether they will meet or not. 51.11% of respondents thought that most projects in Cairo unlikely satisfy acoustical guidelines. 11.11% of respondents, though it is very unlikely that projects satisfy guidelines. While 28.89% of respondents thought it was neither likely nor unlikely, 7.78% of respondents thought projects were likely to satisfy guidelines, and 1.11% of respondents thought projects were very likely to satisfy guidelines, as shown in Figure 5. 13 . Indeed, the findings show that respondents' knowledge levels in the average range are neither extremely high nor extremely low. To gauge the responders' general knowledge, another question was asked.

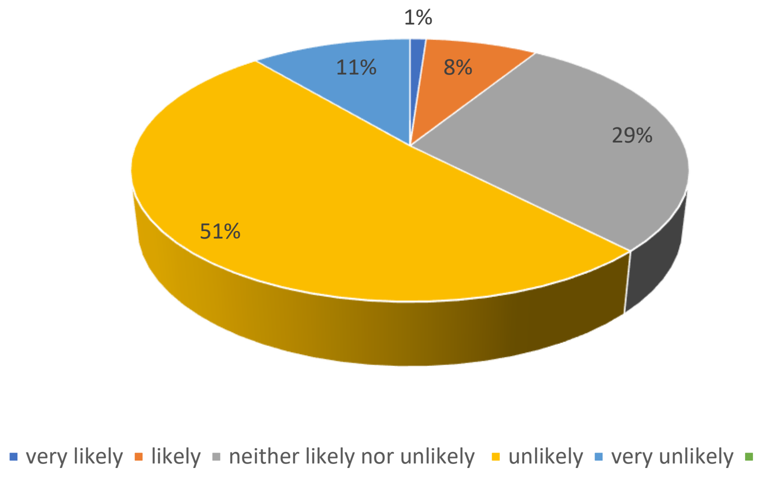


Figure 5. 13 respondents thought of projects acoustical guidelines satisfaction in Cairo satisfy based on your experience 3D Piechart, source: Author.

Respondents were asked to rank Cairo within other cities for noise pollution. The average result is 59 out of 100, although the truth is that Cairo, Egypt, is the second noisiest city in the world. This reflects that the level of knowledge is not very high because there is a gap between the answer and the true number. For a better understanding of knowledge about the problem, another question was placed that measured their satisfaction level with the current situation.

It was found that nearly half of respondents do not accept of the current noise performance in the city. As shown in Figure 5. 14, 58% of respondents are dissatisfied or very dissatisfied with the sound performance in Cairo, Egypt, while 26.67% of respondents are still accepting of the situation, and 14.44% of respondents are totally satisfied with the situation. This reflects that knowledge of noise performance is not that high to give respondents a feeling of dissatisfaction. The truth is, the majority of projects did not satisfy acoustical guidelines, so according to literature, they did not satisfy the user and decreased their productivity. The next part will discuss the skills of respondents to solve the issue.

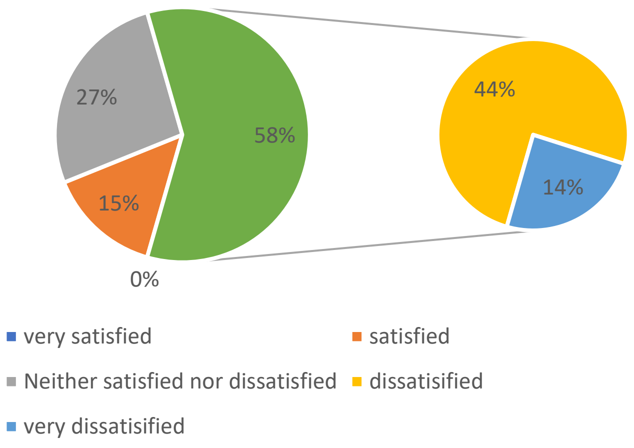


Figure 5. 14 satisfaction of respondents for the noise performance in Cairo pie chart , Egypt, Source: Author

According to literature knowledge sharing in education can be implemented through researchers, linked agencies and practitioners (Becheikh, Ziam, Fakhreddine, Castonguay, & Landry, 2010). In addition to that social media nowadays offered lots of online platforms with advanced technology and interaction techniques. Online courses , eLearning courses, interactive channels, tv chanels and mobile apps all that ease knowledge transfer (Ahmed, Ahmad, Ahmad , & Zakaria, 2019)

5.4.3 Skill

Respondents are asked about their experience dealing with projects that focus on noise pollution. As shown in Figure 5. 15, 1% of respondents state they are extremely professional, and 2% of respondents are very professional. 27.47% are somehow professional, while the majority (69%) do not have skills, 47.25% are not professionals, and 21.98% are not professionals at all, as shown in Figure 5. 16. Another question about evaluating their capability to use various techniques for noise pollution improvement is that the average range is 39 out of 100, which is interlinked with their experience. So, respondents do not have high-level experience and skills in solving noise pollution problems. The next part will discuss their willingness and openness to noise pollution.

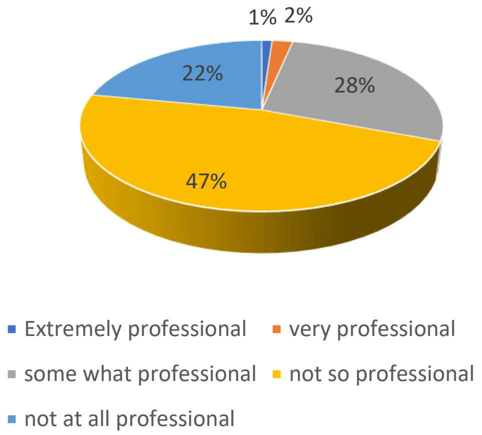


Figure 5. 15 respondents professionality about knowledge distribution 3D Piechart , Source: Author

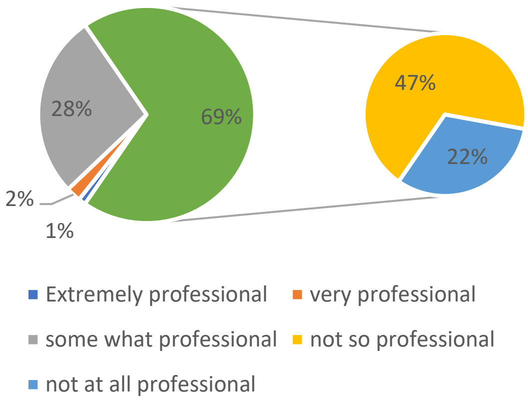


Figure 5. 16 respondents professionality about knowledge distribution pie chart analysis , Source: Author

Indeed, literature knowledge sharing through through researchers, linked agencies and practitioners (Becheikh, Ziam, Fakhreddine, Castonguay, & Landry, 2010). In addition to practical work shops and labs will increase skills . in parallel to other knowledge sharing platforms with advanced technology and interaction techniques. (Ahmed, Ahmad, Ahmad , & Zakaria, 2019)

5.4.4 Motivation

It was found that respondents have a fair amount of motivation. Results show that nearly 90% have a high or moderate level of passion, 36.26% have a moderate level of passion, and 53.85% have a high level of motivation. while only 10% have a low level of motivation. as shown in Figure 5. 17,Figure 5. 18. Also, another question was asked to estimate the level of openness to knowledge. Respondents have high openness, as the average value is 70 out of 100.

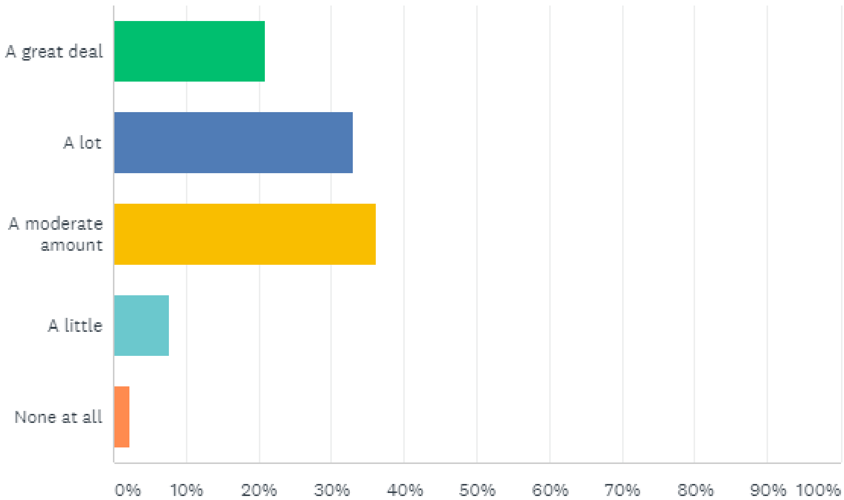


Figure 5. 17 respondents motivation percentage distribution bar , Source: Author

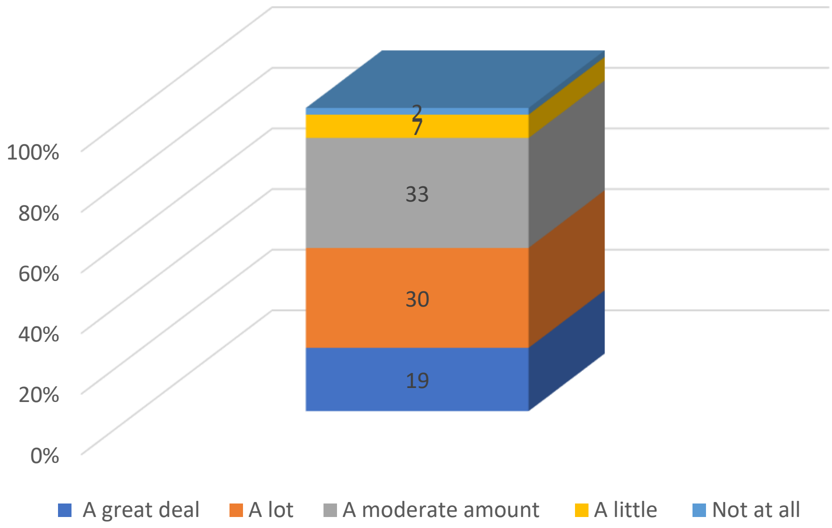


Figure 5. 18 respondents motivation percentage distribution 3d bar , Source: Author

Roads are listed as the primary source of noise in Cairo by some respondents, while shops have the highest levels of noise pollution, according to others. Some respondents cited Cairo's dense population as the cause, while others cited the city's poor educational system and high-budget noise projects. In another state, it is essential since it causes health issues.

***see Appendix 13 Questionnaire responds**

5.5 Summary

To conclude, the noise level is above the required guidelines as measured by the 2245 types 1 sound level meter. Also, the values of the fixed station placed by the Ministry of Environment are above the requirements. It was clear that traffic is the highest source of noise in Cairo that highly affects buildings, especially lower floors; moreover, some zones, as mentioned in the previous chapter, have an event source of noise, which is aircraft. In addition to that, when a street was analyzed by predictor-lima software as a sample, the results showed a high level of noise over the façade. Indeed, using those software requires high level of knowledge and expertise. Accordingly, a deeper understanding of people's awareness of that gap will indicate their role in the problem. The results of the questionnaire show that there is a quiet shortage of knowledge about the topic, which accordingly limits their skills, but still, their motivation level to change and understand is relatively high. There are ways to fill the gap of knowledge and skill in literature that can be used. Furthermore, The next chapter will use computer software to simulate various mitigation scenarios.

(6) Noise mitigation analysis and simulation for a case study

6.1 Inception

The research in this section introduces the mitigation of traffic parameters, building facades, and wall composition in a case study. Predictor-limA software is used to examine façade forms and traffic parameter changes. INSUL sound insulation prediction software is used to examine wall composition.

6.2 Traffic parameters

This part examines traffic parameter change through predictor lima to correlate the different scenarios deeply statistically. Traffic flow and traffic speed are the two selected parameters.

Traffic flow (3 scenarios)

The first scenario is the current 100% traffic flow (calculated actual flow), the second scenario is 70% traffic flow, and the third scenario is 50% traffic flow. The next part will show the receiver's sound pressure level (SPL), leaq dB (A) value results, and static analysis.

Results

<u>Results from street segment 1</u>

Reducing the traffic flow reduced the received noise level at the façades. figure 6. 1 shows the difference between the three scenarios of traffic flow (100%, 70%, and 50%) on plans and facades. The contour results of three scenarios showed a reduction in noise level as traffic flow decreased, which was apparent in the building layout. For instance, the contour plan explained the noise emitted from the road (the space between buildings). The majority of noise levels in the first scenario ranged from 70 to 71 dB, while the standard value in the second scenario was between 69 and 70 dB. In the third scenario, 67–69 dB was the most recognised level of the noise.

According to the numerical results, the noise level was measured at heights of 1.5, 4, 8, 12, 15, and 18 meters, with traffic flows of 100%, 70%, and 50%, respectively. Furthermore, receivers B and C also showed that the noise level decreased with height as one moved away from the source. For example, at 1.5 meters, receiver A. The day value was 71.9 dB, while at 18 meters, the result was 65.1 dB. Additionally, as traffic flow decreased, the noise level decreased, as evident from the receiver B value per day for 100% traffic flow (71.5 dB at 1.5-meter height), 69.7 dB for 70% traffic flow, and 68.2 dB for 50% traffic flow. All the results are shown in figure 6. 1,Table 6. 1 andTable 6. 2, which present the values of the Pearson statical analysis of height coefficient, noise levels during the day and night, and traffic flow.

Table 6. 1 Street segment 1 with results yielded from receivers' values at different traffic speeds, source: authors

		100% traffic flow		70% traffic flow		50% traffic flow	
Name	Building Height (meters)	Day (dB)	Night (dB)	Day (dB)	Night (dB)	Day (dB)	Night (dB)
Receiver A	18	65.1	64.5	63.7	63.8	61.3	61.6
	15	65.8	65.2	64.4	64.5	62.1	62.4
	12	66.7	66.1	65.3	65.4	63.1	63.5
	8	68.3	67.7	66.9	67	65.1	65.4
	4	70.5	70	69.2	69.3	68.5	68.8
	1.5	71.9	71.3	70.5	70.6	72.6	72.9
Receiver B	18	65.1	64.5	63.3	63.7	61.8	62.1
	15	65.8	65.2	64	64.4	62.5	62.8
	12	66.7	66.1	64.9	65.3	63.4	63.7
	8	68.2	67.6	66.4	66.9	64.9	65.2
	4	70.4	69.8	68.5	69	67	67.4
	1.5	71.5	71	69.7	70.2	68.2	68.6
Receiver C	18	64.8	64.2	63	63.4	61.5	61.8
	15	65.5	64.9	63.7	64.1	62.2	62.5
	12	66.4	65.8	64.6	65	63.1	63.4
	8	67.8	67.2	66	66.4	64.5	64.8
	4	69.6	69	67.8	68.2	66.3	66.6
	1.5	70.4	69.8	68.6	69	67.1	67.4

Table 6. 2 Street segment 1 with Pearson statical analysis of height with the noise level and noise level with flow percent, source: authors

	Name	Values	Absolute values
Pearson correlation coefficient (r)	height and night noise values	-0.89599904	0.895999044
	height and day noise values	-0.84970314	0.849703138
	Traffic flow percent and night noise values	0.317418335	
	Traffic flow percent and day noise values	0.440311404	
	N (count)	54	
T-statistics	T1	14.55028483	

	T2	11.62098447
	T3	2.413762415
	T4	3.536390189
	DF (degree freedom)	52
P-Value	P-Value 1	5.68003E-20
	P-Value 2	4.5174E-16
	P-Value 3	0.019345841
	P-Value 4	0.00086258

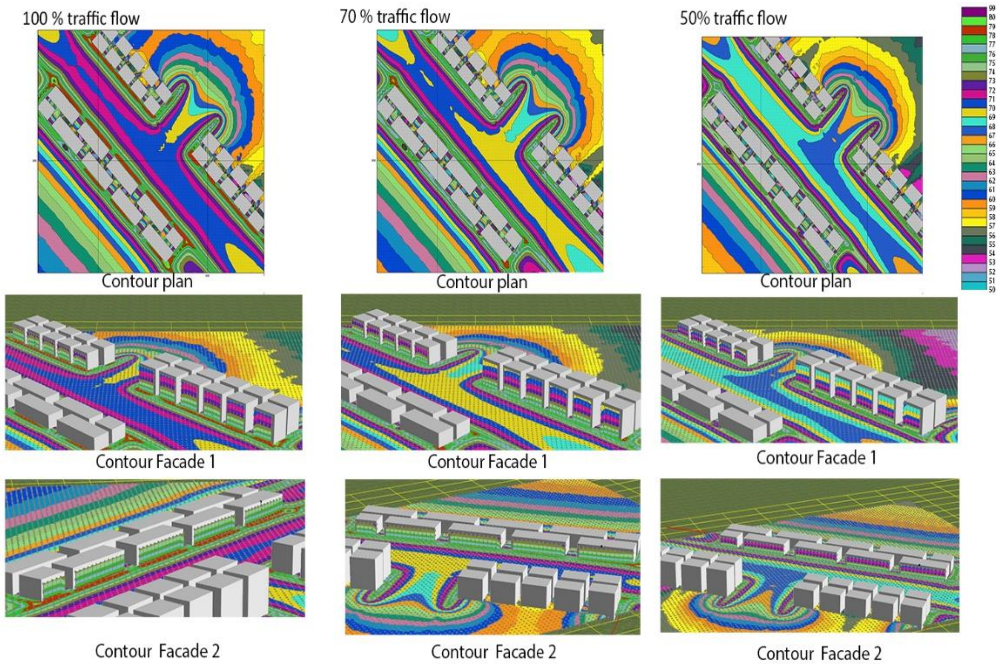


figure 6. 1 Noise contour results on plan and facade at street segment 1. The numbers in the legend indicate dB at 100%, 70%, and 50% traffic flow

<u>Results from street segment 2</u>

The contour results of the three scenarios showed noise reduction as traffic flow was dropped, which was evident in the layout plan. Consequently, the received noise level at the facades was reduced due to the decline in source noise value. Figure 6. 2 illustrates the difference between three scenarios (100%, 70%, and 50% traffic flow) on building layout and facades. For instance, the contour plan explained the noise emitted from the road. In 100% traffic flow, the majority of the noise levels ranged from 71 to 72 dB, while in 70% traffic flow, the standard value ranged between 70 and 71 dB, and in 50% traffic flow, it ranged from 68 to 70 dB.

The numerical results yielded from receiver 1 show exact noise level values at heights of 1.5, 4, 8, 12, 15, and 18 meters with a traffic flow of 100%, 70%, and 50%, respectively. Similarly, receivers 2, 3, 4, and 5 showed that noise levels were reduced as height increased since the distance from the source increased. For example, receiver 1 at 1.5 meters was at 70.3 dB per day, while at 18 meters, it was at 65.5 dB per day. Also, the noise level decreased as the flow decreased, which was evident as the receiver 2 value for a day with a height of 1.5 meters was 64.1, 62.6, and 60.8 dB for 100%, 70%, and 50% traffic flow, respectively. All result values are revealed in Table 6. 3.

Table 6. 3 Street segment 2 receivers' values at different traffic speed percentages, source: the authors

Receivers	Height (M)	100% traffic flow Day (dB)	100% traffic flow Night (dB)	70% traffic flow Day (dB)	70% traffic flow Night (dB)	50% traffic flow Day (dB)	50% traffic flow Night (dB)
Receiver 1	18	65.5	65	64.1	64.3	62.3	62.6
	15	66.1	65.6	64.7	64.9	62.9	63.2
	12	66.9	66.4	65.5	65.7	63.7	63.9
	8	68.2	67.6	66.8	66.9	64.9	65.2
	4	69.6	69	68.2	68.3	66.3	66.6
	1.5	70.3	69.7	68.9	69	67	67.3
Receiver 2	18	62.6	62	61.2	61.3	59.3	59.6
	15	62.7	62.2	61.3	61.4	59.5	59.8
	12	63.1	62.5	61.6	61.8	59.8	60.1
	8	63.4	62.8	62	62.1	60.1	60.4
	4	63.7	63.1	62.3	62.4	60.4	60.7
	1.5	64.1	63.5	62.6	62.8	60.8	61.1
Receiver 3	18	57	56.4	55.5	55.7	53.7	54
	15	55.9	55.4	54.5	54.6	52.7	53
	12	56	55.4	54.5	54.7	52.7	53
	8	56.1	55.5	54.6	54.8	52.8	53.1
	4	56.2	55.7	54.8	54.9	53	53.3
	1.5	56.7	56.1	55.2	55.4	53.4	53.7
Receiver 4	18	65.1	64.5	63.3	63.7	61.8	62.1
	15	65.8	65.2	64	64.4	62.5	62.8
	12	66.6	66	64.8	65.2	63.3	63.6
	8	68	67.4	66.2	66.6	64.7	65
	4	69.7	69.2	67.9	68.4	66.5	66.8
	1.5	70.6	70	68.8	69.2	67.3	67.6
Receiver 5	18	65.2	64.6	63.5	63.8	61.9	62.2
	15	65.8	65.2	64	64.4	62.5	62.8
	12	66.6	66	64.9	65.3	63.3	63.6
	8	68.3	67.7	66.5	66.9	65	65.3
	4	70.8	70.2	69	69.4	67.5	67.8
	1.5	72.4	71.9	70.6	71.1	69.1	69.5

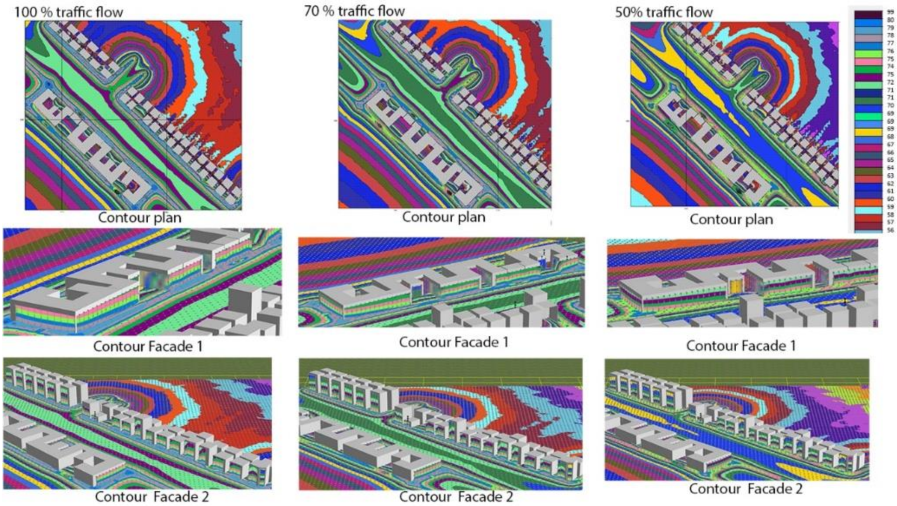


Figure 6. 2 Noise contour results in building layouts and facades in street segment 2. The numbers in the legend indicate dB at 100%, 70%, and 50% traffic flow.

Table 6. 4 shows the results using Pearson by calculating the Pearson coefficients of height with noise at night and traffic flow with noise. The values used in the following step should be absolute, and the t-statistical value should be produced by applying Equations 1 and 2. Since the lower the p-value, the greater the statistical significance of the observed difference, the results from our two street segments showed a strong correlation between height and noise levels. The correlation between noise and traffic flow is illustrated in Table 6. 5.

Table 6. 4 Street segment 2 with Pearson statical analysis of height with the noise level and noise level with flow percent. Source: the authors

	Name	Values	Absolute values
Pearson correlation coefficient	height and night noise values	-0.27689	0.276888371
	height and day noise values	-0.27315	0.273150583
	Traffic flow percent and night noise values	0.192545	
	Traffic flow percent and day noise values	0.265565	
	N (count)	90	
T-statistics	T1	2.70313	
	T2	2.663676	
	T3	1.840678	
	T4	2.583999	
	degree freedom (DF)	88	
P-value	P-Value 1	0.008243	
	P-Value 2	0.009192	
	P-Value 3	0.069039	
	P-Value 4	0.011414	

Table 6. 5P-Value summary of our two street segments, source: the authors

	P Values	
	Street segment 1	Street segment 2
P-Value 1	5.68003E-20	0.008243199
P-Value 2	4.5174E-16	0.009191522
P-Value 3	0.019345841	0.069038971
P-Value 4	0.00086258	0.011414443

As a result of the street in our case study in Cairo, the façades of many buildings are subjected to high noise levels. The flow created by bumps allows for acceptable noise exposure on the facades, according to our results from the methods we used. Based on the correlation, noise exposure increases as block length increases, whereas noise exposure on the face decreases as height increases. Because of its rise, Type 4 is the most advantageous, followed by Type 3, Type 1, and Type 2.

Adding a correlational analysis between noise and traffic flow to the design process with advantages and disadvantages is possible. Our analytical correlation enabled us to interpret the current situation and simulate different design scenarios. The second advantage enabled designers and urban planners to select designs with minor negative impacts and improve the quality of their plans. Authorities and urban planners can use our findings to develop strategies that support remote commuting by adjusting public spaces accordingly. However, one disadvantage of this correlation analysis was the high cost of solving the problem. This is because the morphological pattern was not designed to accommodate the current traffic pattern. Because this simulation analysis was part of the design process, any project might take longer to complete.

When linking results with previous literature, traffic flow and noise were examined differently when calculating the road traffic noise spectrum. The study divided vehicles into four categories, measured their range, and calculated overall traffic noise by overlaying all scopes (Yang, Cai, & Luo, 2020). Previous research studied the placement of traffic detection stations for traffic volume (Elshater, et al., 2022). Another previous study measured noise based on vehicle typology and its effect on the built environment (El-Bardisy, Rashed, Elmeligy, & Aboulnaga, 2022). The noise mapping software is developed based on noise estimation values, traffic volume, and geographic information data (Yang, He, He, & Cai, 2020). Another study estimated five-minute traffic flow in different categories and made noise measurements. Aside from traffic in the street canyon, other things, like air traffic noise and the width and shape of the street canyon, could affect the total amount of noise in the canyon (Elshater, et al., 2022). Our findings are aligned with previous studies, which have concluded that sound level harms people's daily activities in outdoor environments (Elshater, et al., 2022; Elshater & Abusaada, Exploring the types of blogs cited in urban planning research, 2022). As suggested in earlier research, public participation in the design process based on the soundscape is also essential for designing liveable places that can encourage public transportation usage (Ahmed, Elshater, & Afifi, 2019; Wael, Elshater, & Afifi, 2022).

Traffic speed (3 scenarios)

The first scenario is the speed 100 km/hr the second scenario is 70 km/hr, and the third scenario is 50 km/hr traffic speed. The next part will show the receiver's sound pressure level (SPL), leaq dB (A) value results, and static analysis.

Results

<u>segment 1 street results</u>

The results of the three scenarios indicate the following: there is a decrease in the level of noise because of traffic speed reductions, as indicated in the layout. Reducing the value of the source diminishes the façade-received noise. Figure 6. 3 shows the variation between the scenarios on the plan and façade. Using the contour plan, the noise emitted from the road is 76 decibels in the first scenario, between 73 and 77 decibels in the second scenario, and 72 to 76 decibels in the third scenario.

For receiver A, the numerical results indicate the accurate values of the noise level at various heights. These heights are 1.5 m, 4 m, 8 m, 12 m, 15 m, and 18 m at traffic speeds of 100 km/hour, 70 km/hour, and 50 km/hour. Similarly, receivers B and C produced different outcomes. The results show that the noise levels decrease as the height increases, since it has become an additional source. For instance, the Receiver A (100 km/hour) day value at 1.5 meters was 78.6 dB, while the 18-meter-high receiver recorded 71.9 dB. Additionally, the noise pollution level decreased as the speed dropped, as was evident in the value of receiver B at daytime at a height of 1.5 meters for 100 km/hour. In that context, the noise pollution levels were 78.6 dB for 70 km/hour and 71.9 dB for 50 km/hour traffic speeds. All of the result values are indicated in Table 6. 6

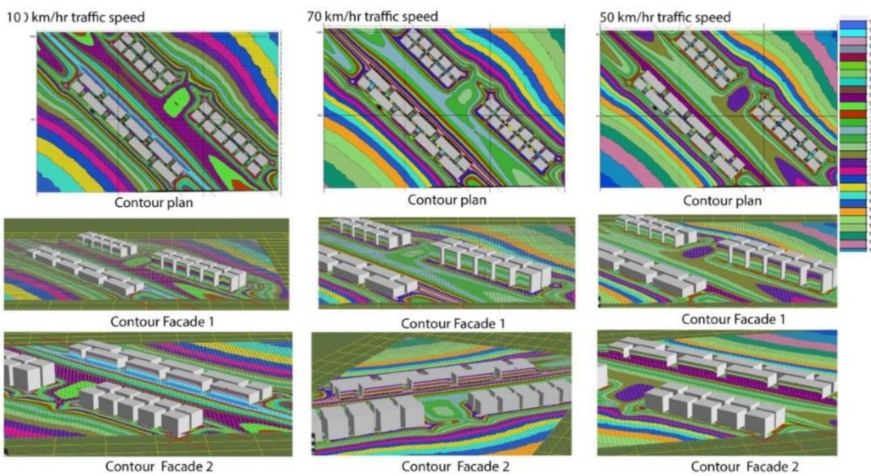


Figure 6. 3 Street segment 1 contour results in dB on plan and façade at 100 km/hr, 70 km/hr, and 50km/hr. Source: The authors.

Table 6. 6 Street segment 1 values of recievers with unique traffic speeds. Source: authors.

	Height values in meter	100 km/hr.		70 km/hr.		50 km/hr.	
		Day (dB value)	Night (dB value)	Day (dB value)	Night (dB value)	Day (dB value)	Night (dB value)
Receiver A	18	71.9	77	67.6	72.7	65.1	70.3
	15	72.6	77.9	68.2	73.5	65.8	71.1
	12	73.5	78.9	69.1	74.5	66.7	72.1
	8	75.1	80.6	70.7	76.3	68.3	73.8
	4	77.3	83	73	78.7	70.6	76.2
	1.5	78.6	84.3	74.3	80	71.9	77.6
Receiver B	18	71.9	73.3	67.5	68.9	65.1	66.5
	15	72.6	73.7	68.2	69.4	65.8	67
	12	73.5	74.3	69.1	70	66.7	67.6
	8	75	75.5	70.7	71.2	68.2	68.7
	4	77.1	77.2	72.8	72.9	70.4	70.5
	1.5	78.3	78.4	74	74.1	71.5	71.7
Receiver C	18	71.5	72.4	67.2	68.1	64.8	65.7
	15	72.3	73	67.9	68.6	65.5	66.2
	12	73.1	73.6	68.8	69.3	66.4	66.9
	8	74.6	74.8	70.3	70.5	67.8	68.1
	4	76.3	76.3	72	72	69.6	69.6
	1.5	77.2	77.2	72.8	72.9	70.4	70.5

Table 6. 7 analyses of results through Pearson theough calculating Pearson coefficient. In addition, traffic speed noises were analyzed during the day and the night.

Table 6. 7 the statical analysis of pearson for segment 1 , Source: authors.

	Name	Values	Absolute values
The coffecient of Pearson correlation	height and night noise values	-0.47893404	0.478934042
	height and day noise values	-0.62523299	0.62523299
	Traffic speed percent with values of night noise	0.644943653	
	Traffic speed percent with values of day noise	0.769836531	
	N	54	
T-statistics	T-1	3.934201738	
	T-2	5.777035892	
	T-3	6.08554239	
	T-4	8.697920087	
	DF	52	
P-Value	P -Value 1	0.000248671	
	P- Value 2	4.32163E-07	
	P -Value 3	1.41034E-07	
	P -Value 4	1.02163E-11	

Segment 2 street results

Figure 6. 4 illustrates the difference between three traffic speed scenarios (100 km/hour, 70 km/hour, and 50 km/hour) on plans and façades. The contour map of three scenarios showed noise pollution decline as the speed of traffic dropped, which was noticeable within the contour plan. The elimination of the source noise value is directly proportional to the façade noise received. The contour plan clarifies that the noise emitted from the first scenario falls between 78 and 81 dB. In the second scenario, common values fell in the range of 74–76 dB, and in the third scenario, 71–73 dB was most of the value.

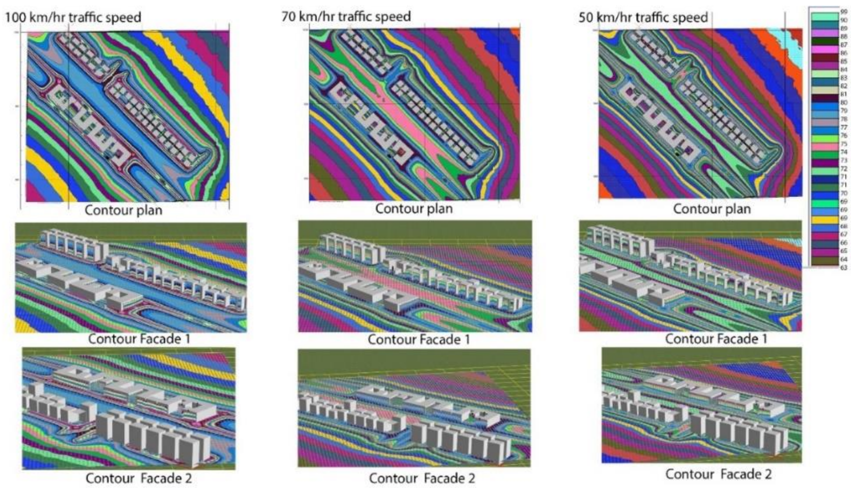


Figure 6. 4 Street segment 2 contour results in dB on plan and façade at 100 km/hour, 70 km/hour, and 50km/hour. Source: the authors.

The results of receivers indicated the noise levels at heights of 1.5m, 4m, 8m, 12m, 15m, and 18 meters within traffic speeds of 100 km/hour, 70 km/hour, and 50 km/hour, as well as receivers 2, 3, 4, and 5. As the height increases, the noise level decreases as the source is far from the receiver. Receiver 1 results at 1.5 metres in height for 100 km/hour; the speed value is 77.2 dB at 18 metres high, while it is 72.4

dB. In addition, the noise level decreased as the speed dropped, as is clear in the second receiver. The values at height 1.5 metres are 70.9, 66.6, and 64.1 dB at 100 km/hour, 70 km/hour, and 50 km/hour. Detailed results are in the Table 6. 8.

Table 6. 8 Street segment 2 receivers' values at different traffic speed percentages. Source: the authors

		100 km/hr.		70 km/hr.		50 km/hr.	
	Height values in meter	Day (dB value)	Night (dB value)	Day (dB value)	Night (dB value)	Day (dB value)	Night (dB value)
Receiver 1	18	72.4	71.8	68	67.4	65.6	65
	15	73	72.4	68.6	68.1	66.2	65.6
	12	73.7	73.1	69.4	68.8	66.9	66.4
	8	75	74.4	70.7	70.1	68.2	67.6
	4	76.5	75.9	72.2	71.6	69.6	69
	1.5	77.2	76.6	72.9	72.3	70.3	69.7
Receiver 2	18	69.5	68.9	65.1	64.5	62.7	62.1
	15	69.6	69	65.3	64.7	62.8	62.2
	12	69.9	69.3	65.6	65	63.1	62.5
	8	70.3	69.7	65.9	65.4	63.4	62.9
	4	70.6	70	66.2	65.6	63.7	63.2
	1.5	70.9	70.3	66.6	66	64.1	63.5
Receiver 3	18	63.9	63.3	59.5	59	57.1	56.5
	15	62.9	62.3	58.5	57.9	56.1	55.5
	12	62.9	62.3	58.6	58	56.1	55.5

	8	63	62.4	58.7	58.1	56.2	55.6
	4	63.2	62.6	58.8	58.2	56.4	55.8
	1.5	63.7	63.1	59.3	58.7	56.8	56.3
Receiver 4	18	71.9	71.3	67.5	66.9	65.1	64.5
	15	72.5	71.9	68.2	67.6	65.8	65.2
	12	73.4	72.8	69	68.5	66.6	66
	8	74.8	74.2	70.4	69.9	68	67.4
	4	76.5	75.9	72.2	71.6	69.7	69.2
	1.5	77.3	76.7	73	72.4	70.6	70
Receiver 5	18	72	71.4	67.7	67.1	65.3	64.7
	15	72.6	71.9	68.2	67.6	65.8	65.2
	12	73.4	72.8	69.1	68.5	66.6	66.1
	8	75	74.4	70.7	70.1	68.3	67.7
	4	77.5	76.9	73.2	72.6	70.8	70.2
	1.5	79.2	78.6	74.9	74.3	72.4	71.9

As shown in Table 6. 9,the results were analyzed using Pearson coefficients for daytime and night-time noise, in addition to traffic noise.

Table 6. 9 the statical analysis of Pearson for segment 1. Source: the authors.

	Name	Values	Absolute values
Pearson correlation coefficient	height and night noise values	-0.24666	0.246655855
	height and day noise values	-0.24581	0.245813049

	Traffic speed percent with values of night noise	0.504257
	Traffic speed percent with values of day noise	0.505824
	N	90
	T-1	2.387607
	T-2	2.378923
	T-3	5.477769
T-statistics	T-4	5.500634
	DF	88
	P -Value 1	0.019098
	P- Value 2	0.019525
	P -Value 3	4.04E-07
P-Value	P -Value 4	0.011414

It is important to note that the smaller the P-value, the greater the statistical meaning. The outcomes of segments 1 and 2 strongly correlate height with noise levels. Besides, noise along with traffic speed correlation, as summarised in Table 6. 10.

Table 6. 10 P-value summary. Source: the authors.

P-values		
	Segment 1	Segment 2
P -Value 1	0.000249	0.019098
P -Value 2	4.32E-07	0.019525
P -Value 3	1.41E-07	4.04E-07
P- Value 4	1.02E-11	0.011414

This research introduces the correlation between noise pollution and traffic speed as traffic parameters. Traffic is considered the primary source of noise in today's cities. The morphological pattern changes in Cairo, Egypt, cause an increase in noise pollution levels due to traffic flow growth and road widening. This research outlines the shift and how it could mitigate limited car speed. The change in the pattern of urban morphology in the present case study and the street networks has a positive and negative impact. The research prefers to solve one negative consequence to achieve the optimum benefits of this update. Urban morphology changes in Cairo, Egypt, are a two-sided coin. From a practical perspective, they reduce the time to transfer between two locations in the city, create a more organised traffic system, and modernise the city to better adapt to population growth. From a disadvantageous perspective, they cause some environmental pollution, such as noise pollution, which is a vital problem based on monitoring reports and evaluation. There are lots of methods of noise mitigation. Accordingly, the research focuses on the sources and one specific parameter to find a solution. Noise control has been achieved at the source, at the receiver, and along the path, and research is now focusing on our resource (traffic roads) as the element that has been changed.

Noise mitigation and various techniques increase the applicability of different solutions. Thus, the research will recommend other solutions if changing car speeds does not achieve the requirements. In a highly interlinked world of noise and traffic, the challenge is eliminating noise in parallel with traffic development. That was clear when the research expressed this idea by reviewing the literature, finding the connections between them, and then profoundly analysing the statistical correlations between them.

On the one hand, the purpose of this reserch was to examine the relationship between traffic and noise. Current situations show a high degree of noise exposure to façades in many buildings. On the other hand, controlling the speed led to acceptable noise exposure levels on the façades. According to the linkage, the exposure to noise increases along with block length, although façade noise exposure drops when height increases. Accordingly, Type-4 is beneficial, followed by Type-3, Type-1, and Type-2.

When comparing results with the previous literature, traffic and noise were analyzed from different perspectives. The present research discusses the traffic noise map method based on speed clusters (Xue, et al., 2021). After obtaining an initial traffic noise map, it is pre-treated with road clustering, and finally, the noise map is updated after the calculation (Xue, et al., 2021). Another article discusses dynamic traffic noise maps based on noise monitoring and traffic speed data. A study considered traffic flow and speed as the main factors contributing to traffic noise. It was predicted by using the historical monitoring of noise data for noise and speed, and then updating the values and combining the shapes to make a dynamic traffic noise map (Lan & Cai, 2021).

6.3 Facades configuration

This section analyses several façade designs using prediction lima to fully grasp their distinctions, making it simple to choose the best option for any unique building design dependent on context. On the basis of a survey of a few publications in the literature, five TYPES are suggested. (Azkorra, et al., 2015; Thomazelli, Caetano, & Bertoli, 2017; Dodig, Radic, & Auer, 2019; Busa, Secchi, & Baldini, 2010)

The first type: normal -flat and craves.

This type was introduced in a previous chapter. In conclusion, it was found that the craves and recesses (u-shaped buildings) of buildings decrease the noise level that reaches the building façade.

The second type: different reflective index

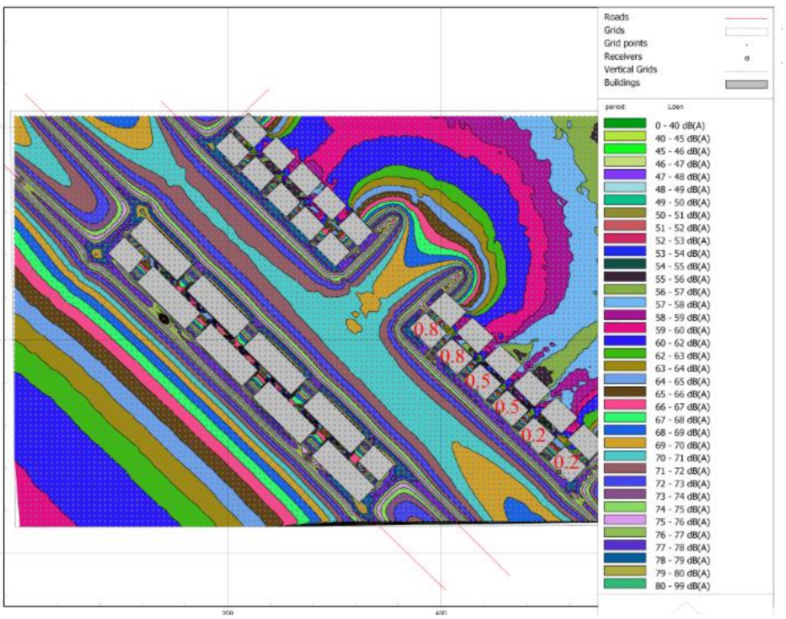


Figure 6. 5 contour plan of various building reflection index, source: Author

Various reflection coefficients were analyzed through a predictor on the same street. The values of reflection are 0.2, 0.5, and 0.8, as shown in Figure 6. 5. Six receivers were located as shown in figure 6. 6.

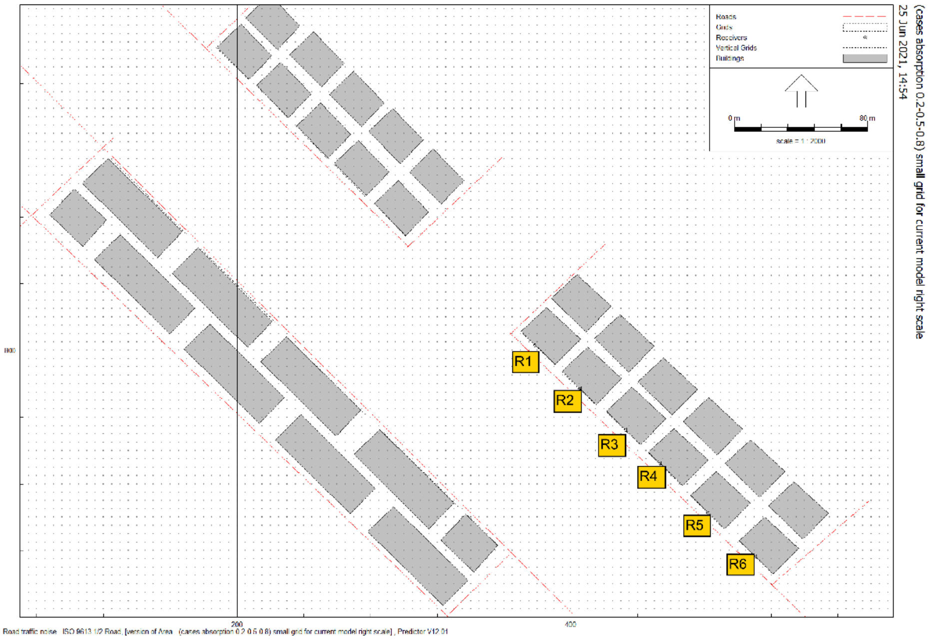


figure 6. 6 receiver point location, source: Author

It is found that the reflective will not reduce the amount of noise targeted, as expressed in Table 6. 11 .figure 6. 6 , figure 6. 7 shows that the amount of received noise is nearly the same with different reflection indexes, which means the value of noise is the same as the reflection index value. All receivers have values of 64.8 dB at height 18 m, 65.5 dB at height 15 m, 66.3 dB at height 12 m, 67.7 at height 8 m, 69.3 at height 4 m, and 69.9 dB at height 1.5 m.

Table 6. 11 Receivers values at various heights, Source: Author

Name	Height	Day	Night

Receiver 1	18	64.5	64
Receiver 1	15	65.3	64.7
Receiver 1	12	66.2	65.6
Receiver 1	8	67.6	67.1
Receiver 1	4	69.3	68.8
Receiver 1	1.5	70.1	69.6
Receiver 2	18	64.8	64.3
Receiver 2	15	65.6	65
Receiver 2	12	66.4	65.8
Receiver 2	8	67.8	67.3
Receiver 2	4	69.5	69
Receiver 2	1.5	70.4	69.8
Receiver 3	18	64.9	64.3
Receiver 3	15	65.5	65
Receiver 3	12	66.3	65.8
Receiver 3	8	67.6	67
Receiver 3	4	69	68.4
Receiver 3	1.5	69.6	69
Receiver 4	18	64.8	64.2
Receiver 4	15	65.5	64.9
Receiver 4	12	66.3	65.7
Receiver 4	8	67.6	67
Receiver 4	4	69	68.4
Receiver 4	1.5	69.7	69.1
Receiver 5	18	64.8	64.2
Receiver 5	15	65.5	64.9
Receiver 5	12	66.4	65.8
Receiver 5	8	67.9	67.3

Receiver 5	4	69.7	69.1
Receiver 5	1.5	70.6	70
Receiver 6	18	64.7	64.1
Receiver 6	15	65.5	64.9
Receiver 6	12	66.3	65.7
Receiver 6	8	67.7	67.1
Receiver 6	4	69.3	68.7
Receiver 6	1.5	69.9	69.4

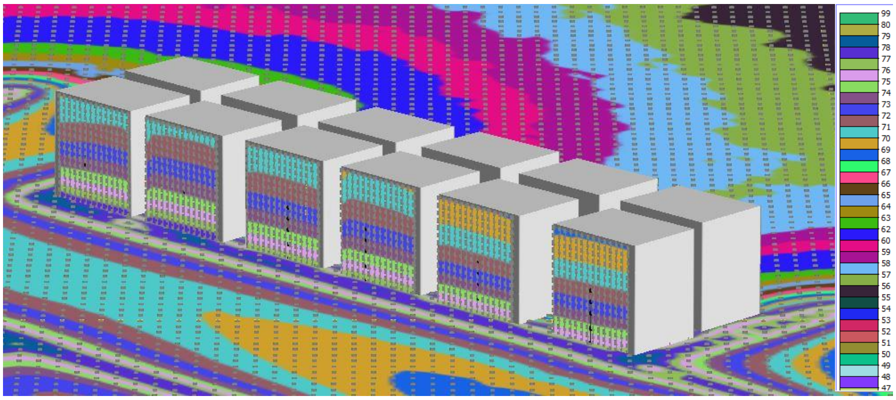


figure 6. 7 various reflection index façade analysis, source: Author

The third type: convex and concave shape façade

This part examines whether there is a change in noise level for concave and convex facades or not. figure 6. 8, figure 6. 9 show that convex and concave façades change the surface area exposed to noise more than normal flat façades. Also, it is clear from receivers' values that noise values increase as illustrated in Table 6. 12, where receivers are allocated as shown in figure 6. 10. Concave and convex façade can be done buy modular steel structure over façade.

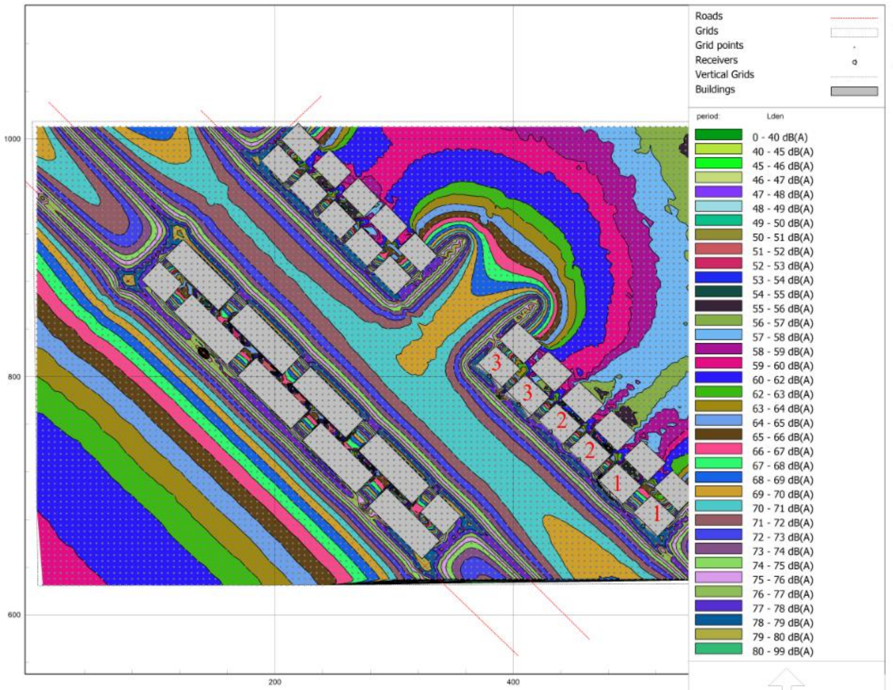


figure 6. 8 contour plan for concave and convex building shapes, Source: Author

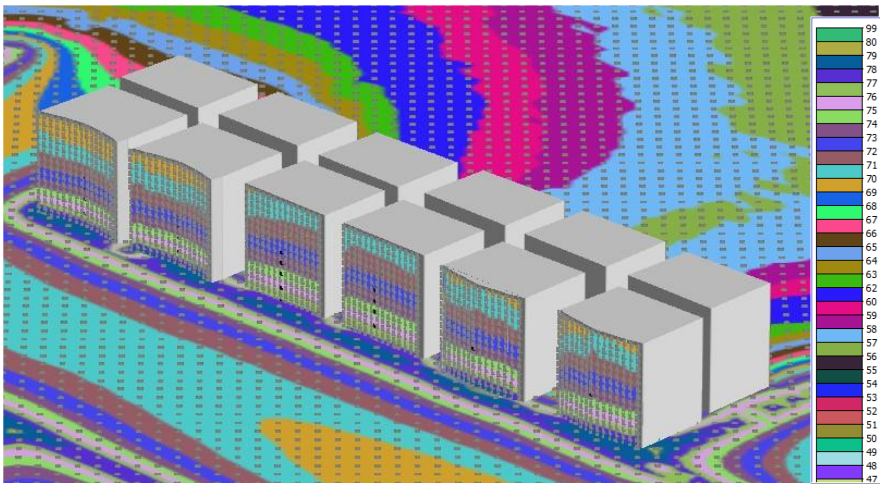


figure 6. 9 concave and convex facade analysis, source: Author

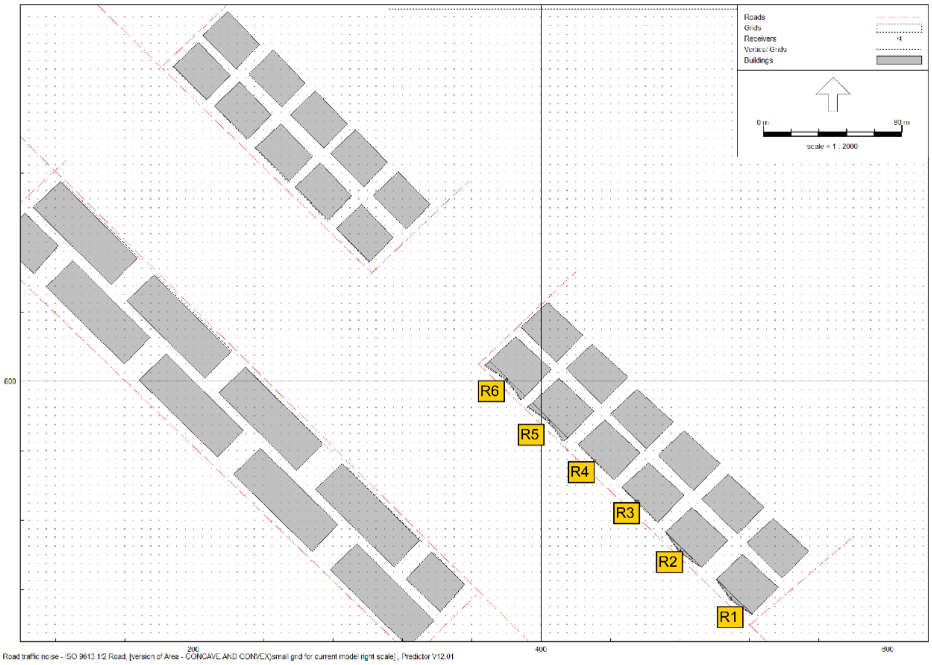


figure 6. 10 receiver plan location, Source: Author

Receivers have values of 64.5 to 65 dB at height 18 m, 65.3 to 65.9 dB at height 15 m, 66.1 to 67 dB at height 12 m, 67.4-68.8 at height 8 m, 68.8 to 71.1 at height 4 m, and 69.4-73.1 dB at height 1.5 m, as shown in Table 6. 12 .

Table 6. 12 receivers' values at various level source: Author

Name	Height	Day	Night
Receiver 1	18	64.8	64.2
Receiver 1	15	65.6	65
Receiver 1	12	66.6	66
Receiver 1	8	68.3	67.7
Receiver 1	4	70.7	70.1

Receiver 1	1.5	72.2	71.6
Receiver 2	18	64.8	64.2
Receiver 2	15	65.6	65
Receiver 2	12	66.6	66
Receiver 2	8	68.3	67.8
Receiver 2	4	71.1	70.5
Receiver 2	1.5	73.1	72.5
Receiver 3	18	64.6	64
Receiver 3	15	65.3	64.7
Receiver 3	12	66.1	65.5
Receiver 3	8	67.5	66.9
Receiver 3	4	68.9	68.3
Receiver 3	1.5	69.5	69
Receiver 4	18	64.5	64
Receiver 4	15	65.3	64.7
Receiver 4	12	66.1	65.5
Receiver 4	8	67.4	66.8
Receiver 4	4	68.8	68.2
Receiver 4	1.5	69.4	68.9
Receiver 5	18	65	64.4
Receiver 5	15	65.9	65.3
Receiver 5	12	67	66.4
Receiver 5	8	68.8	68.2
Receiver 5	4	71	70.5
Receiver 5	1.5	72.2	71.6
Receiver 6	18	64.7	64.1
Receiver 6	15	65.6	65.1

Receiver 6	12	66.7	66.2
Receiver 6	8	68.6	68
Receiver 6	4	70.8	70.2
Receiver 6	1.5	71.8	71.3

Table 6. 13 show statical correlation of second and third type, source: Author

	Name	Values	Absolute values
Pearson correlation coefficient	height and night noise values - second type	-0.99158318	0.991583183
	height and night noise values - third type	-0.9500874	0.9500874
	height and day noise values- second type	-0.99192678	0.991926785
	height and day noise values- third type	-0.94907715	0.949077152
T-statistics	N (count)	36	
	T1	44.65760702	
	T2	17.75705263	
	T3	45.60990091	
	T4	17.56588837	
P-Value	DF (degree freedom)	34	
	P Value 1	8.91991E-32	
	P Value 2	9.0042E-19	
	P Value 3	4.40321E-32	
	P Value 4	1.25602E-18	

The static analysis in Table 6. 13 shows a strong correlation between noise exposure and height in reflective index change due to material change and shape change in concave and convex

(7) Noise mitigation analysis and simulation for a case study Cont.

7.1 Facades configuration

The fourth type: Green Façade and stepping.

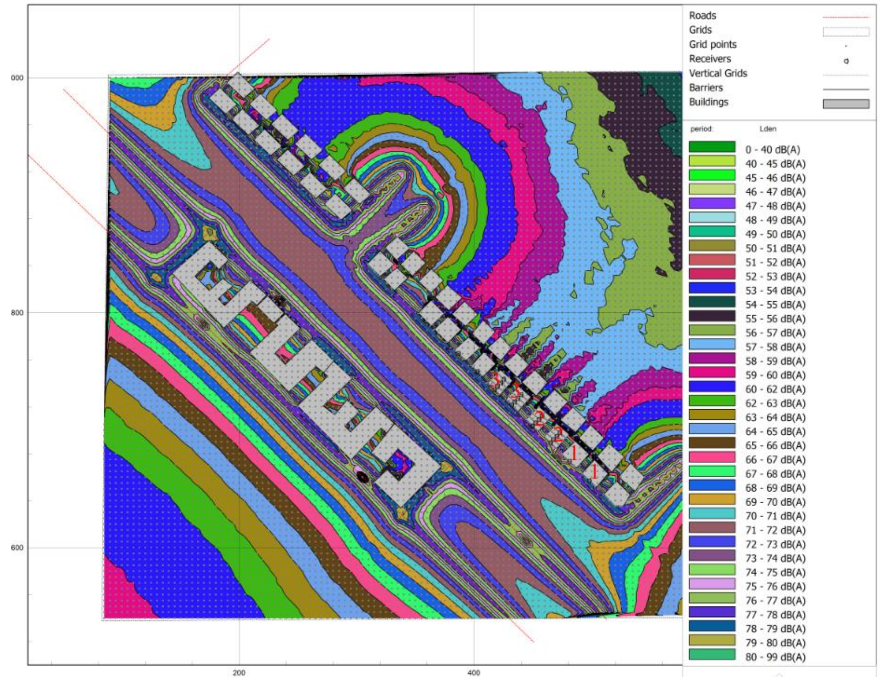


Figure 7. 1 Green facade and steps plan contour, source: Author

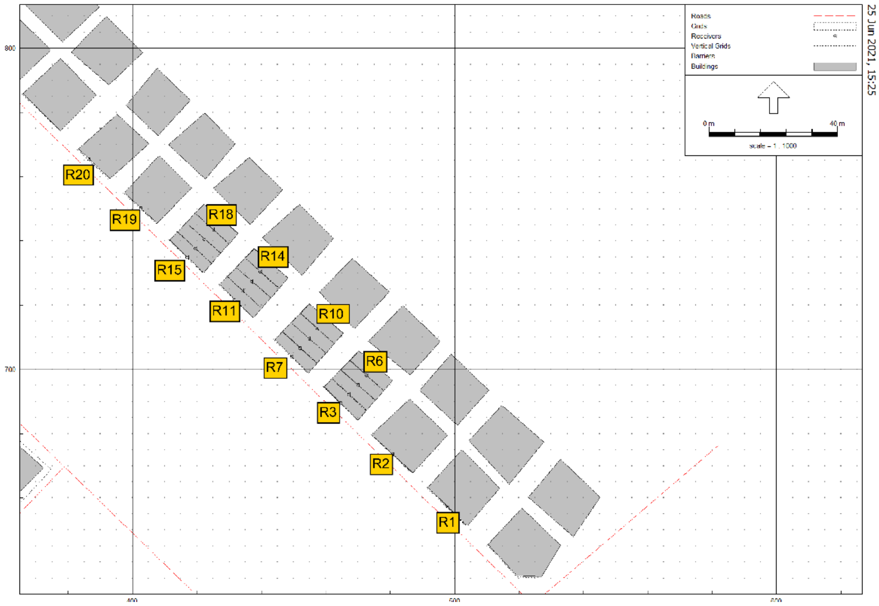


figure 7. 2 receivers location, source ,author

The fourth type examines the results of green façade and steeping with three options: green facade only (1), green with stepping façade (2), and stepping façade (3), as shown in Figure 7. 1,figure 7. 2. The plan shows no difference in the perceiving of noise at receivers as shown in figure 7. 2,,Table 7. 1.

Table 7. 1 noise values of receivers at different heights, Source: Author

Name	Height	Day	Night
Receiver 1	18	66.7	66.1
Receiver 1	15	67.5	66.9
Receiver 1	12	68.4	67.9
Receiver 1	8	70.1	69.6
Receiver 1	4	72.6	72
Receiver 1	1.5	74	73.5
Receiver 2	18	51.5	50.9
Receiver 2	15	51.6	51.1

Receiver 2	12	52	51.5
Receiver 2	8	52.8	52.2
Receiver 2	4	54.2	53.6
Receiver 2	1.5	55.2	54.7
Receiver 3	15	63.5	63
Receiver 3	12	55.6	55.1
Receiver 3	10	55.8	55.3
Receiver 3	8	56.1	55.6
Receiver 3	4	57.1	56.5
Receiver 3	1.5	57.8	57.2
Receiver 4	18	61.2	60.6
Receiver 5	21	60.1	59.6
Receiver 6	24	44.5	43.9
Receiver 7	15	67.6	67
Receiver 7	12	68.7	68.1
Receiver 7	10	69.4	68.8
Receiver 7	8	70.4	69.8
Receiver 7	4	72.9	72.4
Receiver 7	1.5	74.7	74.1
Receiver 8	18	61.4	60.8
Receiver 9	21	60.2	59.7
Receiver 10	24	56.6	56.1
Receiver 11	15	65.9	65.3
Receiver 11	12	66.7	66.1
Receiver 11	10	67.4	66.9
Receiver 11	8	68.4	67.8
Receiver 11	4	70.8	70.2

Receiver 11	1.5	72.4	71.8
Receiver 12	18	60	59.4
Receiver 13	21	58.6	58.1
Receiver 14	24	55.2	54.7
Receiver 15	15	66.1	65.5
Receiver 15	12	66.9	66.3
Receiver 15	10	67.7	67.1
Receiver 15	8	68.6	68
Receiver 15	4	71.4	70.9
Receiver 15	1.5	73.8	73.3
Receiver 16	18	60	59.4
Receiver 17	21	58.6	58.1
Receiver 18	24	55.1	54.6
Receiver 19	18	65.3	64.7
Receiver 19	15	66.1	65.5
Receiver 19	12	66.9	66.3
Receiver 19	8	68.5	67.9
Receiver 19	4	70.9	70.4
Receiver 19	1.5	72.5	72
Receiver 20	18	65.3	64.8
Receiver 20	15	66.1	65.5
Receiver 20	12	66.9	66.4
Receiver 20	8	68.6	68
Receiver 20	4	71.2	70.6
Receiver 20	1.5	73.1	72.5

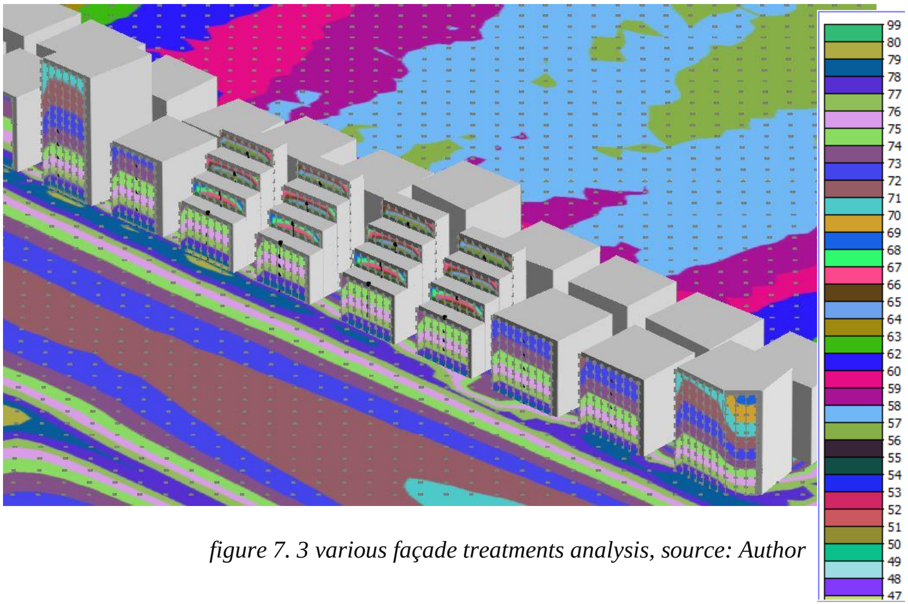


figure 7. 3 various façade treatments analysis, source: Author

While on the façade, there is a great difference between a stepped façade and a flat façade, as shown in Table 7. 1, Figure 7. 1. The green wall has the same impact of reflection index 0.5 as shown in figure 7. 3. According to that next type, investigate the green barrier with a 1.5-meter distance from the façade.

The fifth type: Green Façade and stepping with green barrier at 1.5 m.

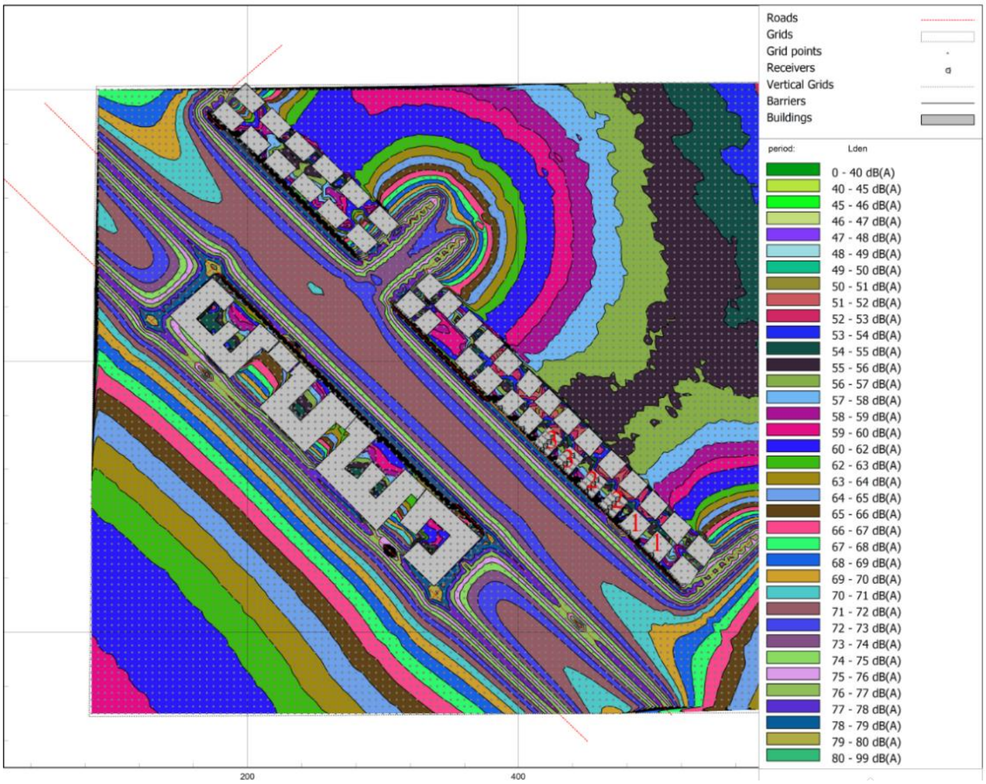


Figure 7. 4 Green facade and steps plan with green barrier contour, source: Author

The fifth type is the same as the fourth type, with the addition of a green barrier at 1.5 meters from the façade and 5 meters in height. There are three options: green facade only (1), green with stepping façade (2), and stepping façade (3), in addition to the green barrier. Figure 7. 4 reveal a clearer difference in noise level than the fourth type. Moreover, the first few floors have a lower noise level than the fourth type, as shown in Figure 7. 5.,Table 7. 2.

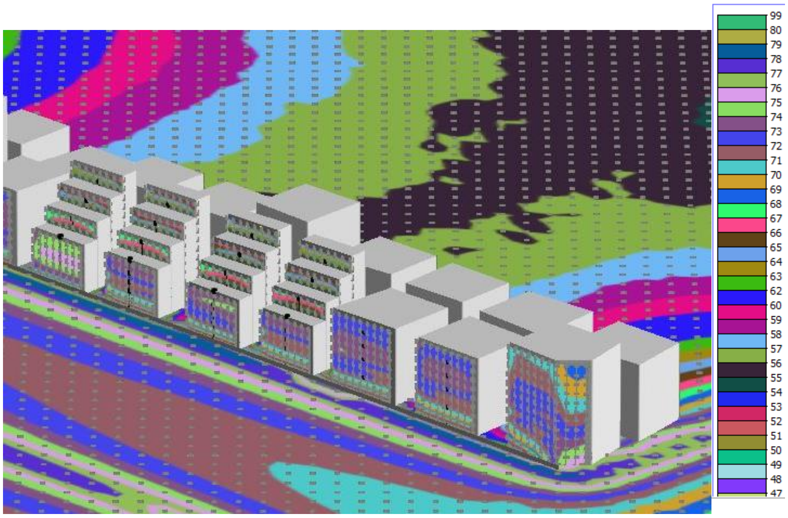


Figure 7. 5 various façade treatments analysis, source: Author

Table 7. 2 difference between receiver values with and without barrier, Source: Author

Name	Height	Day	Night	difference of barrier at day	difference of barrier at night
Receiver 1	18	66.7	66.1	-2	-2
Receiver 1	15	67.5	66.9	-2.2	-2.2
Receiver 1	12	68.4	67.9	-3.8	-3.8
Receiver 1	8	70.1	69.6	-6.5	-6.5
Receiver 1	4	72.6	72	-17	-17
Receiver 1	1.5	74	73.5	-19.6	-19.7
Receiver 2	18	51.5	50.9	-0.6	-0.5
Receiver 2	15	51.6	51.1	-1	-1.1
Receiver 2	12	52	51.5	-4	-4
Receiver 2	8	52.8	52.2	-3.5	-3.5
Receiver 2	4	54.2	53.6	-2.8	-2.8
Receiver 2	1.5	55.2	54.7	-2.4	-2.5
Receiver 3	15	63.5	63	0	-0.1

Receiver 3	12	55.6	55.1	-3.3	-3.4
Receiver 3	10	55.8	55.3	-5.4	-5.5
Receiver 3	8	56.1	55.6	-5.2	-5.3
Receiver 3	4	57.1	56.5	-4.8	-4.8
Receiver 3	1.5	57.8	57.2	-4.5	-4.5
Receiver 4	18	61.2	60.6	-0.1	-0.1
Receiver 5	21	60.1	59.6	-0.1	-0.1
Receiver 6	24	44.5	43.9	-0.1	-0.1
Receiver 7	15	67.6	67	-0.1	-0.1
Receiver 7	12	68.7	68.1	-0.5	-0.5
Receiver 7	10	69.4	68.8	-2.7	-2.6
Receiver 7	8	70.4	69.8	-3.6	-3.6
Receiver 7	4	72.9	72.4	-15.4	-15.4
Receiver 7	1.5	74.7	74.1	-18.3	-18.2
Receiver 8	18	61.4	60.8	-0.1	-0.1
Receiver 9	21	60.2	59.7	-0.1	-0.1
Receiver 10	24	56.6	56.1	-0.1	-0.1
Receiver 11	15	65.9	65.3	-0.2	-0.1
Receiver 11	12	66.7	66.1	-1	-0.9
Receiver 11	10	67.4	66.9	-1.5	-1.5
Receiver 11	8	68.4	67.8	-3.9	-3.9
Receiver 11	4	70.8	70.2	-15.3	-15.3
Receiver 11	1.5	72.4	71.8	-18.2	-18.1
Receiver 12	18	60	59.4	-0.2	-0.1
Receiver 13	21	58.6	58.1	-0.1	-0.1
Receiver 14	24	55.2	54.7	-0.1	-0.1
Receiver 15	15	66.1	65.5	-0.1	-0.1
Receiver 15	12	66.9	66.3	-0.1	-0.1
Receiver 15	10	67.7	67.1	-0.2	-0.2
Receiver 15	8	68.6	68	-1.8	-1.7

Receiver 15	4	71.4	70.9	-14.7	-14.8
Receiver 15	1.5	73.8	73.3	-18.2	-18.3
Receiver 16	18	60	59.4	-0.1	-0.1
Receiver 17	21	58.6	58.1	-0.1	-0.1
Receiver 18	24	55.1	54.6	0	-0.1
Receiver 19	18	65.3	64.7	-0.1	-0.1
Receiver 19	15	66.1	65.5	-0.2	-0.2
Receiver 19	12	66.9	66.3	-0.8	-0.8
Receiver 19	8	68.5	67.9	-3.7	-3.7
Receiver 19	4	70.9	70.4	-15.2	-15.3
Receiver 19	1.5	72.5	72	-18.2	-18.3
Receiver 20	18	65.3	64.8	0	-0.1
Receiver 20	15	66.1	65.5	-0.1	-0.1
Receiver 20	12	66.9	66.4	-0.3	-0.3
Receiver 20	8	68.6	68	-2.2	-2.1
Receiver 20	4	71.2	70.6	-14.9	-14.9
Receiver 20	1.5	73.1	72.5	-18	-18

The static analysis in Table 7. 3 shows a strong correlation between noise exposure and height in both green stepping fourth type and green stepping with green barrier in the fifth type.

Table 7. 3 fourth and fifth type pearson statical analysis values during day and night, source: authors

	Name	Values	Absolute values
Pearson correlation coefficient	height and day noise values - fourth type	-0.53298011	0.532980105
	height and day noise values - fifth type	0.177024178	0.177024178
	height and night noise values- fourth type	-0.53290895	0.532908954

	height and night noise values-fifth type	0.178492909	0.178492909
	N (count)	60	
T-statistics	T1	4.797213474	
	T2	1.369810068	
	T3	4.796319026	
	T4	1.38154749	
	DF (degree freedom)	58	
P-Value	P Value 1	1.16478E-05	
	P Value 2	0.176026128	
	P Value 3	1.16851E-05	
	P Value 4	0.172409668	

After analysis of various techniques to minimize noise level on the outer façade surface, it was found that the best designs are: U-shaped buildings (buildings that are recessed and have enclosures), stepping of the building form, and green barriers within a distance from the building. It is recommended to not use concave and convex forms. The next section deeply examines the composition of the wall as a path that transfers noise inside the building to meet requirements based on space type, as shown.in Figure 7. 6. The STC (sound transmission class) is analyzed through sound insulation prediction software.

CATEGORY OF SPACE	SPECIFIC USES	NC, NCB OR RC(N) RANGE	dBA LIMIT
Sensitive listening spaces	Broadcast and recording studios, concert halls	15 to 20	25 dBA
Performance spaces	Theaters, churches, video and teleconferencing	20 to 25	30 dBA
Presentation spaces	Large conference rooms, small auditoriums, movie theaters, courtrooms, meeting and banquet rooms, executive offices	25 to 30	35 dBA
Private spaces	Offices, small conference rooms, classrooms, private residences, hospitals, hotels, libraries	30 to 35	40 dBA
Public spaces	Restaurants, lobbies, open-plan offices, clinics	35 to 40	45 dBA
Service and support spaces	Computer equipment rooms, public circulation areas, arenas, convention centers	40 to 45	50 dBA

Figure 7. 6 Recommended background noise criteria for common spaces. For more information, consult the Springer Handbook of Acoustics, edited by Thomas Rossing, and published in 2014.

7.2 Wall composition

Façade composition plays an important role in controlling noise inside a room after using various techniques to reach the minimum possible noise level on the façade, because each use has requirements as shown in Figure 7. 6. Sound insulation software (insul) will be used to analyze various wall compositions. Assuming the noise source is traffic with an average noise level of 70 dB and inner room dimensions of 4 m x 4 m x 3 m, target to reach 25 dB. Note: Room sound pressure level includes some other factors. not only façade; these factors are HVAC and any equipment.

Scenario 1: Normal brick has a 12.5 cm thickness and a density of 980 kg/m3.

A normal brick with a standard density can reach STC 41 as calculated.in Figure 7. 8 , Since façade is a mix of wall, glass, etc., the value of FSTC may decrease depending on the quality of the bricks and their surface area, as expressed in Figure 7. 7. The next scenario will change the density of brick to 2300 kg/m3 to show the impact of the density increase.

	Octave Band Centre Frequency (Hz)																					
Source		63			125			250			500			1k			2k			4k		Overall dBA
Incident sound level (freefield)	75	73	71	69	66	65	65	63	62	62	61	61	62	62	60	59	58	56	54	53	51	70
Path																						
Element 1 , STL	-32	-32	-33	-34	-33	-29	-27	-29	-32	-34	-37	-40	-42	-45	-47	-50	-52	-54	-56	-57	-59	
Facade Shape factor Level diff.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Insertion Loss	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Area(+10LogA) [10 m^2]	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
Element sound level contribution	44	42	39	36	34	37	39	35	31	29	25	22	21	18	14	10	7	2	-1	-3	-7	34
Room volume(-10LogV) [50 m3]	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	
Reverberation time (s)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
RT (+10LogT)	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	
Equation Constant	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	
Room sound level	44	42	39	36	34	37	39	35	31	29	25	22	21	18	14	10	7	2	-1	-3	-7	34

Figure 7. 7 normal brick noise reduction, Source: Author

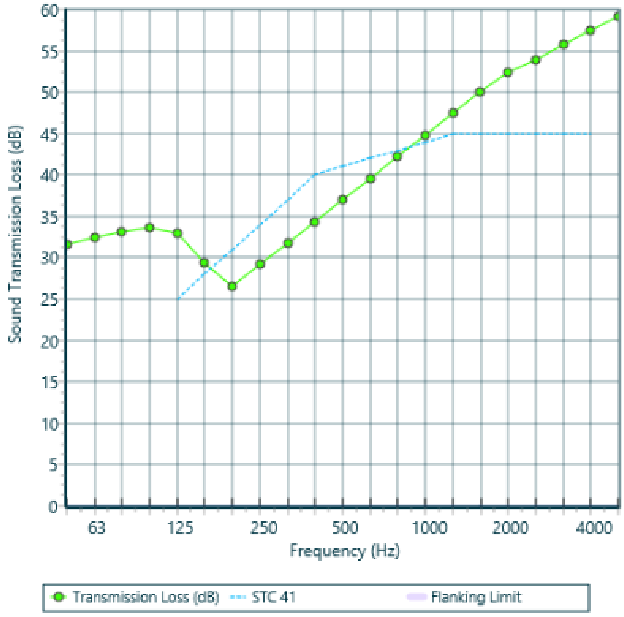


Figure 7. 8 sound transmission loss graph, source: Author

Scenario 2: Normal brick 12.5 cm thick and density 2300 kg/m3

Figure 7. 9,Figure 7. 10 highlight a significant difference between a normal-density brick and a high-density brick, which is nearly 10 dB. As decibels are logarithmic calculations, that is considered a large difference.

	Octave Band Centre Frequency (Hz)																					
Source		63			125			250			500			1k			2k			4k		Overall dBA
Incident sound level (freefield)	75	73	71	69	66	65	65	63	62	62	61	61	62	62	60	59	58	56	54	53	51	70
Path																						
Element 1 , STL	-39	-40	-42	-43	-43	-44	-43	-40	-41	-43	-46	-48	-51	-54	-56	-58	-59	-61	-62	-64	-66	
Facade Shape factor Level diff.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Insertion Loss	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Area(+10LogA) [10 m^2]	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
Element sound level contribution	36	33	31	27	23	22	22	25	23	19	16	13	12	9	5	2	-1	-4	-8	-10	-13	23
Room volume(-10LogV) [50 m3]	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	
Reverberation time (s)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
RT (+10LogT)	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	
Equation Constant	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	
Room sound level	36	33	31	27	23	22	22	25	23	19	16	13	12	9	5	2	-1	-4	-8	-10	-13	23

Figure 7. 9 normal brick with high density noise reduction, Source: Author

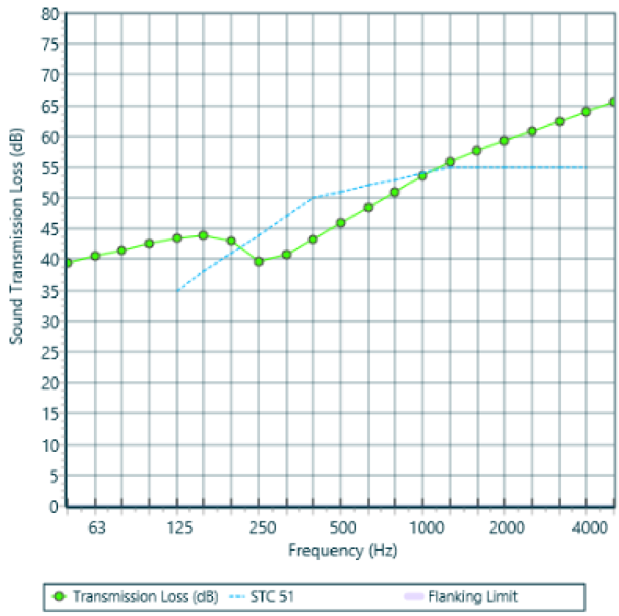


Figure 7. 10 sound transmission loss graph, source: Author

Scenario 3: Double normal brick 12.5 cm thick with a density of 980 kg/m3 and rock wool in between with a density of 100 kg/m3.

Figure 7. 11,Figure 7. 12 Clearly show that using 2 walls and rock wool highly increases STC level since rock wool plays an important role in noise reduction.

	Octave Band Centre Frequency (Hz)																					
Source		63			125			250			500			1k			2k			4k		Overall dBA
Incident sound level (freefield)	75	73	71	69	66	65	65	63	62	62	61	61	62	62	60	59	58	56	54	53	51	70
Path																						
Element 1 , STL	-41	-48	-54	-59	-62	-63	-76	-81	-88	-92	-97	-101	-105	-109	-103	-109	-113	-117	-120	-123	-127	
Facade Shape factor Level diff.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Insertion Loss	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Area(+10LogA) [10 m²]	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
Element sound level contribution	35	26	18	11	4	3	-10	-17	-25	-30	-35	-39	-42	-46	-42	-49	-55	-60	-65	-70	-75	7
Room volume(-10LogV) [50 m3]	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	
Reverberation time (s)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
RT (+10LogT)	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	
Equation Constant	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	
Room sound level	35	26	18	11	4	3	-10	-17	-25	-30	-35	-39	-42	-46	-42	-49	-55	-60	-65	-70	-75	7

Figure 7. 11 Double normal brick and rock wool noise reduction, Source: Author

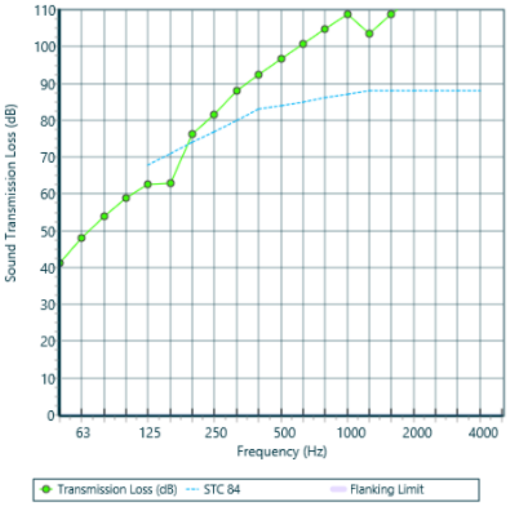


Figure 7. 12 sound transmission loss graph, source: Author

Scenario 4: Normal brick 12.5 cm thick with a density of 980 kg/m3, rock wool with a density of 100 kg/m3, and gypsum board with a density of 705 kg/m3.

Figure 7. 13, Figure 7. 14 show that the composition of the wall with normal density, rock wool, and gypsum board has a higher STC than the normal wall but a lower STC than the wall with high density.

	Octave Band Centre Frequency (Hz)																					
Source		63			125			250			500			1k			2k			4k		Overall dBA
Incident sound level (freefield)	75	73	71	69	66	65	65	63	62	62	61	61	62	62	60	59	58	56	54	53	51	70
Path																						
Element 1 , STL	-31	-30	-27	-29	-35	-37	-51	-57	-62	-68	-73	-78	-85	-90	-90	-93	-95	-91	-92	-97	-102	
Facade Shape factor Level diff.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Insertion Loss	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Area(+10LogA) [10 m²]	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
Element sound level contribution	44	43	45	40	32	29	15	8	1	-5	-11	-17	-22	-27	-29	-33	-36	-35	-38	-43	-50	27
Room volume(-10LogV) [50 m3]	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	
Reverberation time (s)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
RT (+10LogT)	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	
Equation Constant	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	
Room sound level	44	43	45	40	32	29	15	8	1	-5	-11	-17	-22	-27	-29	-33	-36	-35	-38	-43	-50	27

Figure 7. 13 normal brick, rock wool and gypsum medium density noise reduction, Source: Author

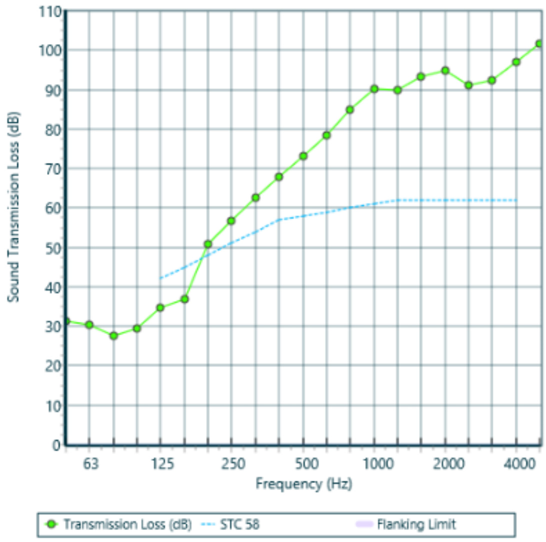


Figure 7. 14 sound transmission loss graph, source: Author

Scenario 5: Normal brick 12.5 cm thick with a density of 980 kg/m3, rock wool with a density of 100 kg/m3, and gypsum board with a density of 720 kg/m3.

Figure 7. 15, Figure 7. 16 show that the composition of the wall with a normal density, rock wool, and gypsum board with a higher density is nearly the same as in Scenario 4. It has a higher STC than a normal wall but a lower STC than a wall with a high density.

	Octave Band Centre Frequency (Hz)																					
Source		63			125			250			500			1k			2k			4k		Overall dBA
Incident sound level (freefield)	75	73	71	69	66	65	65	63	62	62	61	61	62	62	60	59	58	56	54	53	51	70
Path																						
Element 1 , STL	-31	-30	-28	-30	-35	-37	-51	-57	-63	-68	-73	-78	-85	-90	-90	-93	-95	-92	-92	-97	-102	
Facade Shape factor Level diff.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Insertion Loss	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Area(+10LogA) [10 m^2]	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	
Element sound level contribution	45	44	44	40	32	29	15	7	0	-5	-11	-16	-22	-27	-29	-33	-36	-36	-37	-43	-50	26
Room volume(-10LogV) [50 m3]	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	-17	
Reverberation time (s)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
RT (+10LogT)	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	
Equation Constant	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	
Room sound level	45	44	44	40	32	29	15	7	0	-5	-11	-16	-22	-27	-29	-33	-36	-36	-37	-43	-50	26

Figure 7. 15 normal brick, rock wool and gypsum high density noise reduction, Source: Author

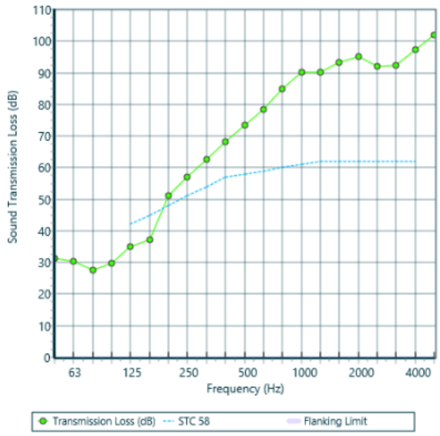


Figure 7. 16 sound transmission loss graph, source: Author

To conclude, the case design requirement requires the highest STC possible while having a very high noise level outside. Double brick and rock wool in between are recommended. If you need a medium noise level and have a medium noise level outside the wall, a high brick density can be used, or a normal wall density with rock wool and gypsum board. If requirements do not require high SPL, normal brick density can be used. Figure 7. 17 show the difference between the 5 Scenario s.

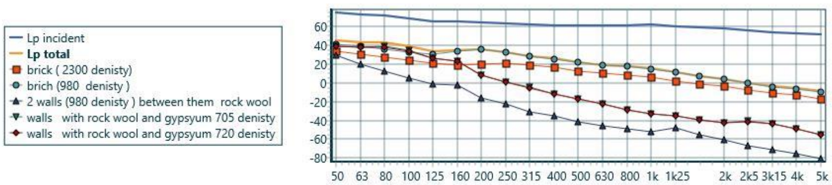


Figure 7. 17 all Scenario s room SPL in various hertz graph, source: Author

Of course, architecture acoustic is not only STC; reverberation time (RT) is also important but depends on the absorption coefficient of room materials, not outside noise sources as STC. The next part discusses mixed scenarios, which came as a result of best-case scenarios from previous analysis in addition to feasibility studies and observations. This approach will lead to an increase in HDI index and a healthy acoustic environment. It will also increase knowledge about acoustics and create a comfortable environment.

7.3 holistic mixed scenario

This part discusses the results of the mixed scenario, which is traffic flow 50%, traffic speed 50 km/hr, a 5 m green barrier at a distance of 1.5 m from the façade, and a double wall with rock wool in between. Simulation results were divided into the two street segments identified previously.

Street Segment 1 results

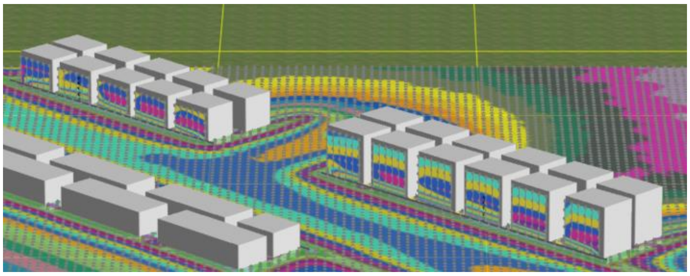


figure 7. 18 facade part 1 vertical analysis results segment 1 ,source : author

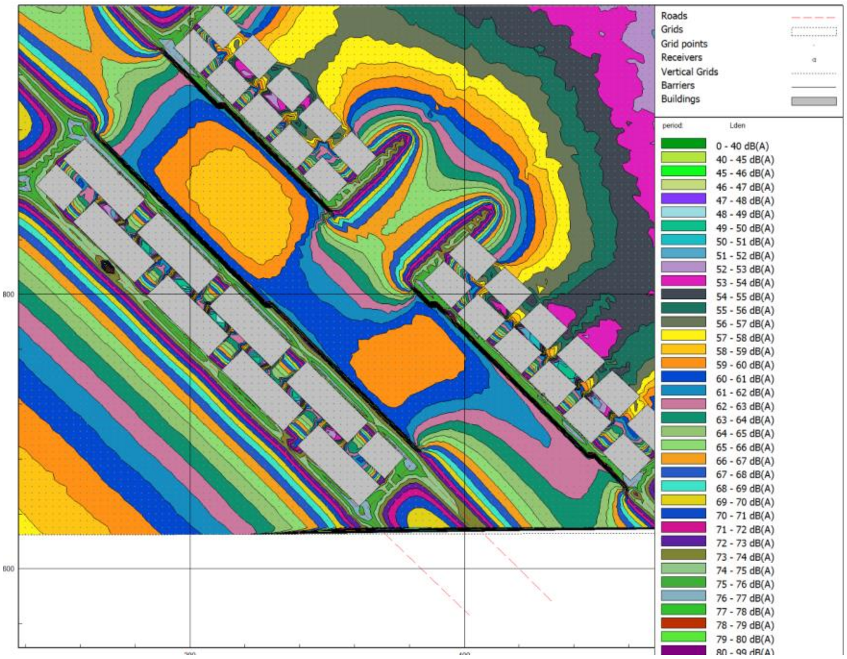


figure 7. 19 noise contour mapping of holistic scenario segment 1, source :author

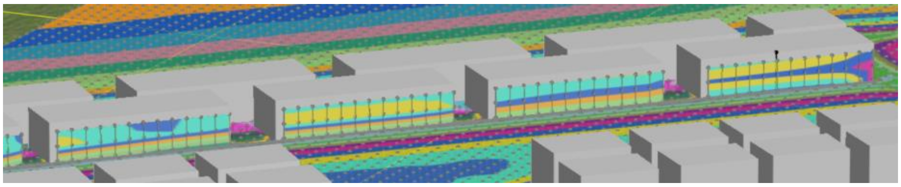


figure 7. 20 facade part 2 vertical analysis results segment 1 ,source : author

Table 7. 4 receivers' values of holistic scenario segment 1, source: author

Name	Height	Day	Limit required	achievability	Night	Limit required
Receiver 1	18	61.1	55		61.4	45
Receiver 1	15	61.5	55		61.8	45
Receiver 1	12	60	55		60.3	45
Receiver 1	8	61.6	55		62	45
Receiver 1	4	54.3	55		54.6	45
Receiver 1	1.5	55.4	55		55.7	45
Receiver 2	18	61.7	55		62.1	45

Receiver 2	15	62.3	55		62.7	45
Receiver 2	12	61.9	55		62.2	45
Receiver 2	8	60.4	55		60.7	45
Receiver 2	4	52.5	55		52.8	45
Receiver 2	1.5	51.2	55		51.5	45
Receiver 3	18	61.4	55		61.8	45
Receiver 3	15	62.1	55		62.4	45
Receiver 3	12	61.8	55		62.2	45
Receiver 3	8	59.4	55		59.7	45
Receiver 3	4	51.3	55		51.6	45
Receiver 3	1.5	49.4	55		49.7	45

Based on segment 1 analysis that is shown in figure 7. 18,figure 7. 19,figure 7. 20, Table 7. 4. It is clear that values are reduced during the day, achieving the required limit. Other value issues could be solved by reducing the composition of the façade partitions by using a double wall each 12.5 cm and a rock wool density of 100 kg/m3 in between.

Street Segment 2 results

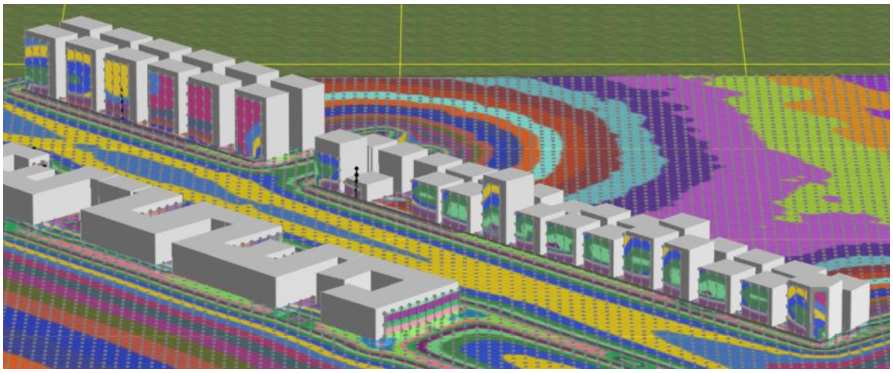


figure 7. 21 facade part 1 vertical analysis results segment 2,source : author

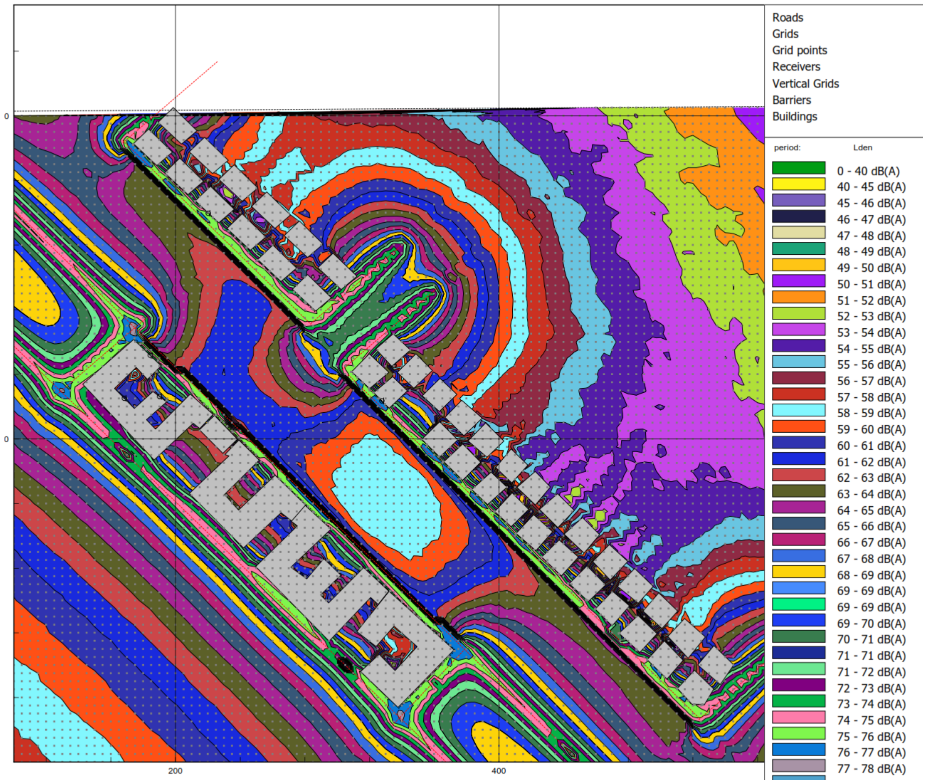


figure 7. 22 noise contour mapping of holistic scenario segment 2 , source :author

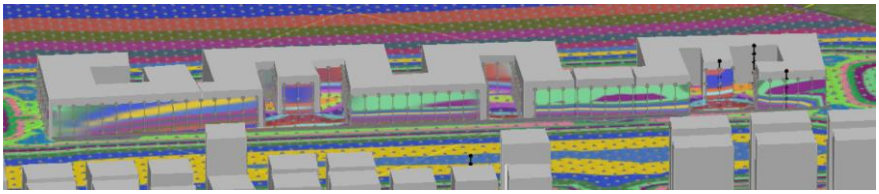


figure 7. 23 facade part 2 vertical analysis results segment 2 ,source : author

Table 7. 5 receivers values of holistic scenario segment2, source: author

Name	Height	Day	Limit required	achievability	Night	Limit required
Receiver 1	18	62.1	55		62.4	45
Receiver 1	15	62.7	55		63	45
Receiver 1	12	63.5	55		63.8	45
Receiver 1	8	62.3	55		62.6	45

Receiver 1	4	55.7	55		55.9	45
Receiver 1	1.5	55	55		55.3	45
Receiver 2	18	55.2	55		55.5	45
Receiver 2	15	54.2	55		54.5	45
Receiver 2	12	53.7	55		53.9	45
Receiver 2	8	53.2	55		53.4	45
Receiver 2	4	48.1	55		48.4	45
Receiver 2	1.5	46.2	55		46.4	45
Receiver 3	18	50.8	55		51	45
Receiver 3	15	48.2	55		48.4	45
Receiver 3	12	47.8	55		48.1	45
Receiver 3	8	46.5	55		46.7	45
Receiver 3	4	43.7	55		43.9	45
Receiver 3	1.5	43	55		43.2	45
Receiver 4	18	59.8	55		60.1	45
Receiver 4	15	60	55		60.3	45
Receiver 4	12	59.1	55		59.4	45
Receiver 4	8	57.4	55		57.7	45
Receiver 4	4	51.5	55		51.7	45
Receiver 4	1.5	50.3	55		50.6	45
Receiver 5	18	61.6	55		61.9	45
Receiver 5	15	62.2	55		62.5	45
Receiver 5	12	62.7	55		63	45
Receiver 5	8	61.5	55		61.8	45
Receiver 5	4	52.9	55		53.1	45
Receiver 5	1.5	52	55		52.3	45

Based on segment 2 analysis that is reflected in figure 7. 21,figure 7. 22,figure 7. 23,Table 7. 5. It is clear that values are reduced during the day, achieving the required limit. Other value issues could be solved by reducing the composition of the façade partitions by using a double wall each 12.5 cm and a rock wool density of 100 kg/m3 in between. table 7. 6 show analysis of correlation between scenarios *table 7. 6 transability matrix of all scenarios, source :Author*

		Traffic Flow			Traffic speed			Façade typologolgies					Wall partation					holistic Scenario
		Scenario.1	Scenario.2	Scenario.3	Scenario.1	Scenario.2	Scenario.3	Type 1	Type 2	Type 3	Type 4	Type 5	Scenario.1	Scenario.2	Scenario.3	Scenario.4	Scenario.5	
		100%	70%	50%	100km/hr	70 km/hr	50km/hr	current	different reflective index Various reflection coefficients were analyzed thro	: convex and concave shape façade	Green Façade and stepping	Green Façade and stepping with green barrier	Normal brick has a 12.5 cm thickness and a density of 980 kg/m3.	Normal brick 12.5 cm thick and density 2300 kg/m3	Double normal brick 12.5 cm thick with a density of 980 kg/m3 androck wool in between with a density of 100 kg/m3.	Normal brick 12.5 cm thick with a density of 980 kg/m3, rock woolwith a density of 100 kg/m3, and gypsum board with a density of 705 kg/m3.	Normal brick 12.5 cm thick with a density of 980 kg/m3, rock woolwith a density of 100 kg/m3, and gypsum board with a density of 720 kg/m3.	Traffic flow 50%, traffic speed 50 Km/hr, greem barrier and dounble wall inbetwee n rock wall
Traffic flow	Scenario.1																	
	Scenario.2																	
	Scenario.3																	
Traffic Speed	Scenario.1																	
	Scenario.2																	
	Scenario.3																	
façade typologies	Type 1																	
	Type 2																	
	Type 3																	
	Type 4																	
	Type 5																	
wall partations	Scenario.1																	
	Scenario.2																	
	Scenario.3																	
	Scenario.4																	
	Scenario.5																	
	holistic case																	

7.4 Summary

Traffic analysis confirmed that the relationship between traffic flow and noise was robust, which means noise levels increase as traffic flow increases. The results also indicate that the existing street design requires changes in traffic flow to reduce noise exposure and in the types of streets. The results also confirmed that buildings with a u-shape with an inner court have less noise exposure than rectangular buildings. The relationship between noise and traffic flow can be used to design traffic flow reduction strategies. These strategies could include remote online communication to reduce unnecessary traffic. Future design challenges may also pose challenges due to their complexity. After analysing the statistical correlation, a positive connection was found between traffic and noise exposure. The relationship is positive, which means that as the speed increases, the noise level also increases. Furthermore, height has a negative correlation, which means that the noise difference decreases when the building height increases. The present results reveal that the existing street layout needs changes in traffic speed and traffic flow to eliminate noise exposure and that Type 4 has lower noise exposure compared to other types. When linking this relationship with the urban morphological change in Cairo, Egypt, it is recommended to analyse and understand any traffic flow changes that occur to respond to street modification and to find ways to mitigate them in case they exceed the required limit. Reducing car speed is one technique that can limit noise from traffic sources, as has been prescribed in the research. This is one of many mitigation techniques. Different approaches can be used, such as including barriers, façade isolation, and many others. It is preferable to use the toolkit for existing and new projects, which include various scales, from urban planning to urban design and the building itself, in addition to the engagement of the community.

The façade analysis reveals that the building form has an effect on the noise exposure level. The study suggests using green barriers, stepping in the building form, and a U-shaped building to slightly reduce facade noise exposure. Moreover, the simulation shows that the sound transmission class is an important factor in reducing noise received inside buildings. The study points out that to achieve the highest isolation of noise through façade partitions, it is recommended to use a double brick wall, placing rock wool in between. Also, to reach an acceptable STC design, it is preferable to use a normal wall density with rock wool and gypsum board. The holistic scenario accordingly summarize inclusive optimized solution contextualized for case study .Accordingly, it is important to form an action plan for current noise problem improvement and awareness; this will be discussed in the next part.

Next chapter explain an action plan that can increase environmental awareness and improve noise problem.

(8) The action plan for noise mitigation in the Egyptian context

8.1 Inception

This section deeply explains an action plan to overcome the gap found through literature and empirical study. This plan is answer main question “How to reduce noise environmental stress and enhance noise environmental awareness in public spaces?”. At last, it explains full action plan for noise mitigation and awareness on various scales and the long term impact of this action plan .

8.2 Research outcome and gaps

8.2.1 literature outcome

Noise reduction and socio-morphology are intricate systems. Humans and nature serve as the cornerstones of a society where social behavior and the study of urban form are closely related. Environmental characteristics related to human use include ecological footprint, earth shooting day, and biocapacity. Environmental psychology elaborates the interchangeable relationship between humans and nature. In this relationship, we found that environmental pollution, specifically noise, brought by human activity, puts people in stressful situations and creates environmental stressors such as crowding or pollution.

We concluded that the combination of environmental management strategies, such as awareness-raising and protection tactics, can solve this problem. With the specific focus on the Noise pollution and its correlated impacts on humans as an environmental pollutant and stressors, this research examines and hypothesize the noise mitigation in urban spaces can lead to fostering noise environmental awareness in the community in addition to noise stress reduction. Thus, environmental awareness and protection strategies were taken into consideration.

Based on this, a thorough analysis of the source, path, and recipient is the fundamental idea of noise pollution. where noise is expressed as any undesired sound with high intensity, which is measured in decibels as stated by the Environmental pollution center, 2022. Noise occurs when a source emits noise that passes through a path and reaches a receiver affecting the humans. Also, we encountered that knowledge, skill, and motivation are the key three indicators to evaluate noise awareness level among the community.

Given that Egypt is the second-noisiest city in the world, it faces the challenge of noise pollution which is a serious issue as stated by the world economic forum in year 2022. There are governmental attempts towards noise pollution monitoring, evaluation, and reduction. For instance, the EEAA executed laws and regulations for allowable noise limits day and nighttime. In addition to, constructing 29 real-time fixed noise monitoring stations all over Egypt. However, a significant difference is found between the desired and actual state.

Thus, this research conducted an in-depth examination of noise sources in the Egyptian context to select the most vulnerable case to analyze, propose mitigation attempts and evaluate them. The outcome of this analysis is studied deeply to close this gap.

8.2.2 Methodology outcome

The research investigated the most vulnerable case study using a variety of methods, tools and software packages to bridge the gap and reach a comprehensive solution. Most academics, in the research platform, employ a certain method and resource with specific focus on one noise mitigation technique discarding the other aspects.

Therefore, this research focused on applying an inclusive solution through mitigating source, path, and receiver altogether. The research utilized validated certified internal standard tools and software including Type 1: *B&K 2245 sound level meter, AEDT, and predictor LimA, INSUL to* measure, map and predict noise. In addition to other research methods such as online questionnaire, context mapping, observation, and statistical analysis. These research tools and methods applied to get the most dependable validated outcomes in accordance with requirements with static verification.

Hence, executing this research requires a substantial investment of time, financial resources, and expertise. The research outcome aimed to get beyond upcoming research restrictions. The recommended action plan comprises extensive research and study of those software packages. In addition to filling the research gap as there are only four contextual case studies—roughly speaking—specifically discussing the ambient noise in Egypt. However, research in other countries is pioneering in this field.

8.2.3 Case study outcome

Using noise contour mapping and measurements, the case study confirms the difference between the existing condition and the desired state based on the regulations and law by EEAA. Additionally, observation demonstrates the lack of active behavior in the community. This evidence was also highlighted in the questionnaire, as people are highly motivated to change despite having low levels of knowledge and skills. This could be interpreted as experiencing the health problems this issue is causing.

To overcome this problem the research simulated mitigation of different scenarios mined from deep literature analysis. The mitigation approaches focus on the three main noise elements: source, path, and receiver. These scenarios have been analyzed and concluded in an inclusive holistic solution that could meet the desirable state based on the regulations and law by EEAA. Indeed, that lead us to the importance of distributing responsibilities which was taken into consideration when forming the action plan

8.3 The concept of action plan

The action plan tackles various perspectives. **The first perspective** is the recommended mitigation, which clarifies how to enhance the situation of current and future buildings. The technique used will either be the source, path, or receiver based on previous simulations. **The second preceptive** is how to improve the environmental awareness of people through their knowledge, skills, and motivation. The aim of this perspective is to make individuals active actors, not passive ones. **The third perspective** focuses on the future action plan; this part explains the recommended plan that could decrease the gap between the required and desired states to prevent future environmental problems. **The fourth part** will recommend future research questions. This is summarized in figure 8. 1

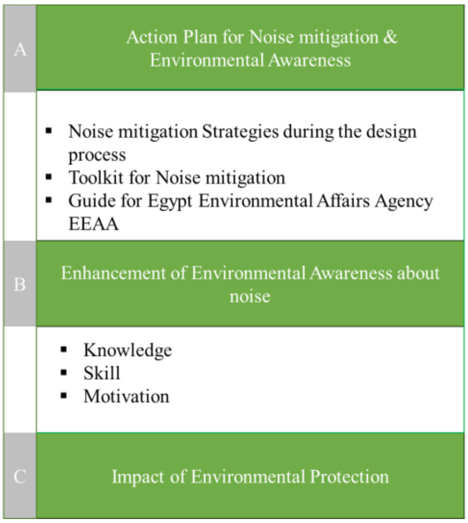


figure 8. 1 action plan summary, source: author

8.4 Noise mitigation

8.4.1 Noise mitigation strategies during design process

1. There should be guidelines for the noise level of a building's facade.
2. As part of the design process, computer simulation studies for predicting noise exposure level should be performed.
3. STC values for interior spaces should be attained using acoustic materials, wall compositions, etc..
4. It is necessary to do a computer study to assess the design wall composition.
5. The Ministry of the Environment (EEAA) should create an improvement plan in addition to measuring the current state using the current stations.
6. Other architectural acoustic factors, such as the RT and NC of HVAC systems, should be determined during the design phase.
7. HVAC Noise criterion curve, RT, and other parameters should be within acceptable limits.
8. Utilizing computer software, simulate noise brought into the building during traffic flow and traffic speed design.
9. Placement techniques to attain the computer-simulated tolerable noise range

8.4.2 Tool kits for noise mitigation

Guidelines for the building's façade noise level should be placed. Computer simulation analysis should be done for noise exposure level prediction as part of the design process. STC values of inner spaces should be achieved with the help of wall composition, acoustic material, etc. Computer analysis should be done to evaluate the design wall composition. The Ministry of Environment (EEAA) should not only measure the existing state through the existing stations but also form an improvement plan. Other acoustic parameters should be calculated during the design process, such as RT and NC of HVAC. Noise criteria curve: RT should be in the acceptable range. Simulate noise received in buildings during traffic flow and traffic speed design using computer software. Place strategies to achieve an acceptable noise range simulated by computer software.

The findings presented in Figure 8. 2 suggest a toolkit for soundscapes at various levels. To reduce the demand for public transportation, the government should improve the quality of public transit at the urban planning level. Moreover, the government and companies should divide the allowable working hours throughout the day into two or three sections to reduce rush hour and traffic flow. Second phase: the government should hire companies to study the effects of road improvements on traffic parameters (traffic flow, speed, and density). Also, experts should analyse the noise impact of existing and upcoming projects. Urban designers and building levels should make noise predictions in their designs. In addition to using acoustic barriers, façade designs eliminate noise. Noise monitoring can encourage people to participate in solving the problem at the community level.

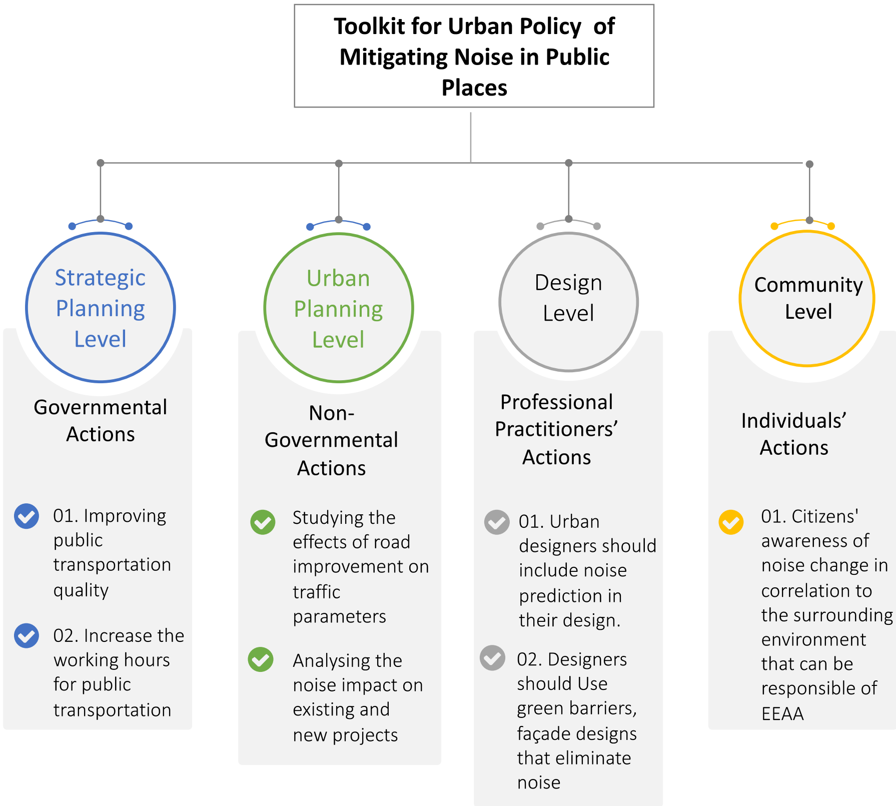


Figure 8. 2 Proposed toolkit for urban policy for noise mitigation technique

In this study, we demonstrate the benefits of a dynamic system of noise monitoring that displays noise level variations with speed. Consequently, adding noise and speed correlational analysis to the design process has benefits and drawbacks. Using the analytical correlation, we could understand the current situation and also examine design scenarios based on our findings. Secondly, the advantage allowed designers as well as urban planners to pick designs with lower negative impacts and improve the quality of their plans. Authorities and urban planners can develop strategies that support speed limits by fine-tuning public spaces accordingly, based on the results of our study. The disadvantage of the analysis was the elevated cost of resolving the current noise issue since it was not planned to adapt to the existing traffic speed. In addition, it increases the design process time as the simulation is part of it.

As a result of the investigation of the case study in Egypt, five lessons have been identified regarding the impact of noise levels on outdoor environments. Firstly, authorities should study the road effect improvements for traffic parameters and then analyse the influence on noise. The second learned lesson is about placing speed bumps to limit speed. The third learned lesson is that other mitigation techniques were needed to reach the required limit, which is 50 dB at night and 60 dB during the day. The fourth learned lesson is that landscape designers and urban planners must involve noise prediction. By keeping track of noise, people can become more aware of how noise changes in response to environmental changes. The fifth learned lesson is that monitoring noise can increase citizens' awareness of noise change in correlation to ecological change.

The concluding observations from examining the case study demonstrated a tool kit for soundscape design on various levels. On the urban planning level, in the first phase, the government should increase the number of car speed bumps. Moreover, the government should restrict fines for speed crossing limits. In the following phase, the government must appoint specialists towards investigating consequence of road enhancement on traffic parameters, and examine the noise impacts of existing and new projects. The designer must recommend mitigation techniques to reach the required limit, such as acoustic barriers and façade designs. On the community level, community awareness of noise pollution is being boosted through the continuous monitoring of noise by EEAA. Figure 8. 3 shows a brief about the toolkit.

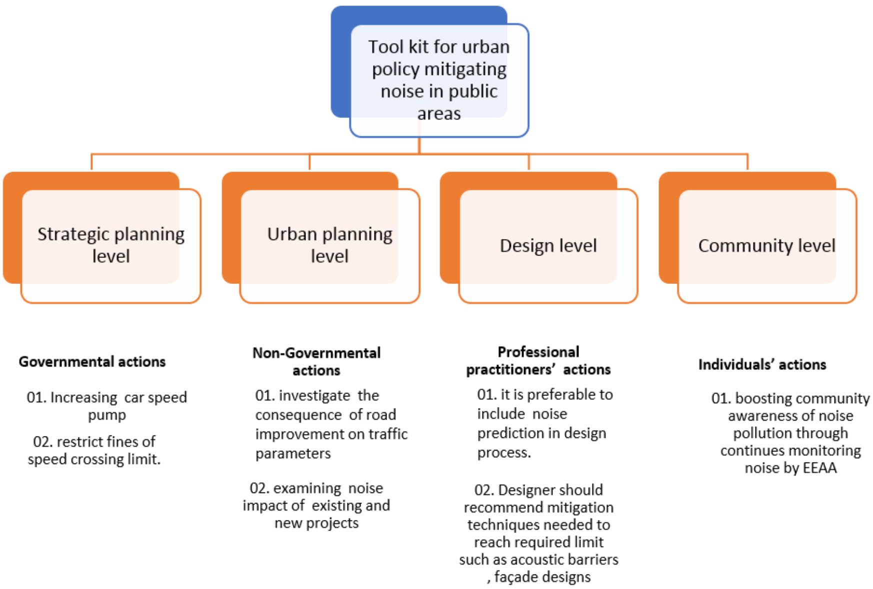


Figure 8. 3 Suggested toolkit intended for noise mitigation techniques as an urban policy

8.4.3 Guide for Egypt Environmental Affairs Agency EEAA

1. Develop a research program for local acoustic Eco materials, devices, and software packages as they are all imported, so most owners thought of it as expensive (*see details in the next section, “Enhancement of environmental awareness about noise“).

2. To ensure ease of implementation, a development plan should target a variety of people.

3. Enhance awareness of community to support the process (* see details in next section “enhancement of environmental awareness about noise “).

4. Find different ways to apply regulations to make their implementation more feasible.

5.

8.5 Enhancement of environmental awareness about noise

Knowledge

1. Dynamic noise monitoring system establishment
2. Increase knowledge about noise in high schools
3. For university students studying closely connected disciplines like engineering, environmental science, and software , it is important to have detailed modules with interactive applications and workshops about noise are available.
4. general information modules for fields connected to noise in calm (medical, sociology, etc)
5. Online YouTube channels for acoustics
6. Awareness campaigns occasionally about noise pollution
7. Tv shows by governmental involved institutes.

Skill

1. Labs to test alternative of designs in highly related university fields.
2. Labs for testing various local eco-material that have high acoustic performance.
3. Research institutes should work on producing measurement devices and software packages.
4. Practical Training courses for engineers (construction engineer, civil, environmental engineers, etc) by expertise.

Motivation

The monitoring and assessment phases should be transparent in order to preserve the high level of motivation.

8.6 Implementation of action plan on various environmental problems in Egypt

It is recommended to follow the same concept for each environment problem as shown in Figure 8. 4. he first step is to understand the problem deeply. Step two is to find mitigation for the existing situation and test it. Step three is to enhance community awareness about the problem. step four to place restricted regulations. Step four is to implement these regulations. Last but not least, monitor and evaluate the progress.

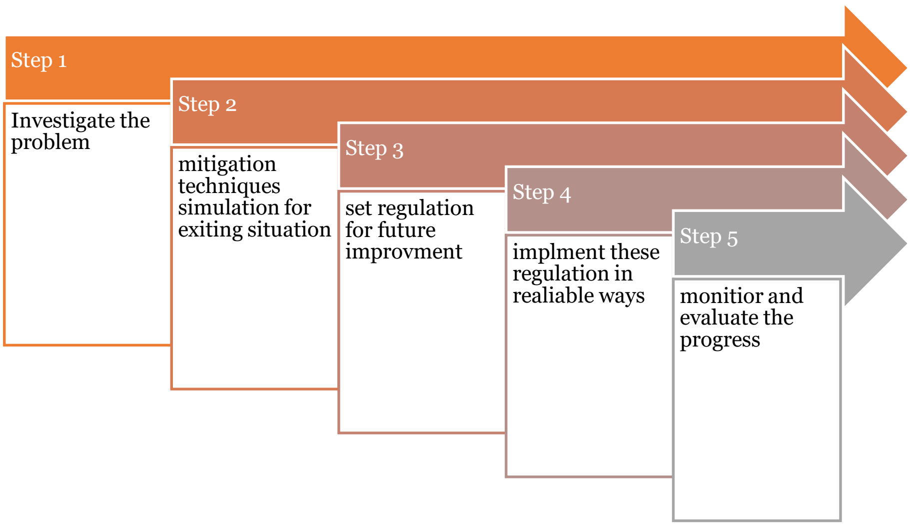


Figure 8. 4 recommended action plan for rest of environmental problems, source: Author

8.7 The future impact of this action plan on ecological footprint

Improvement of environmental awareness, environmental problems (stressors), and ecological footprint are interlinked loops, as explained in the literature review part (Chapter 2 and Chapter 3). So it is the long-term vision of the research after the medium-term vision, which is environmental problem improvement and awareness, and the short-term vision, which is noise problem improvement and awareness, as shown in Figure 8. 5. So, it is recommended for future research to step by step reach the main long-term vision.

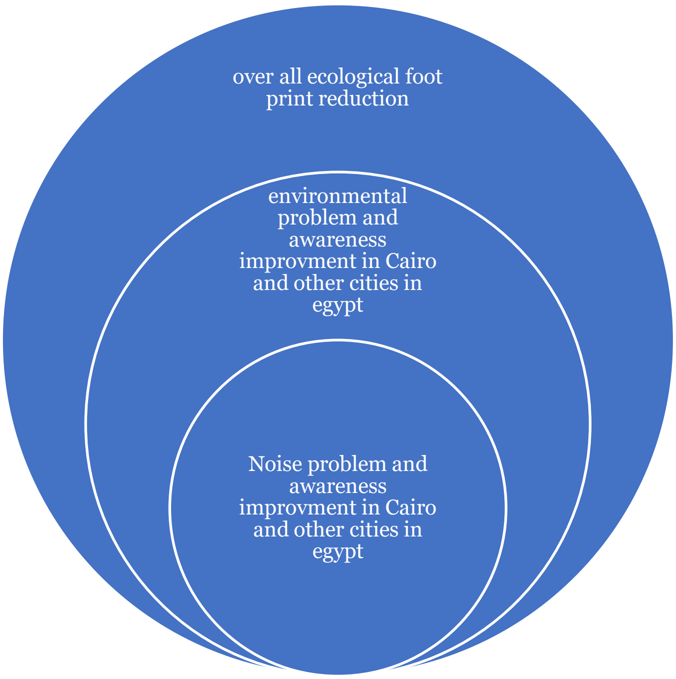


Figure 8. 5 various vision scales of the research and recommended future research , Source: Author

8.8 Research limitation

One of the limitations is that there are only two parts to the case study to overcome the fact that deep scenarios for traffic speed and flow were done, in addition to five different façade typology analyses and various cases for façade partition sections. Additionally, the research was limited in comparing the size of the present study with the data available from the General Authority for Roads and Bridges and the Ministry of Transportation. Research counts cars during measurements for the reliability of the data. It is recommended in the future to link noise, speed, and flow together simultaneously in cases where data is available. Environmental awareness mitigation is a long-term aspect that may take up to 10 years, so research focuses on having an overview through a questionnaire and setting recommended strategies. In addition to the physical simulation and analysis of the case study,

8.9 The future recommended research questions

A. How do you improve the building acoustics with all its parameters?
B. How can we eliminate visual pollution and activate awareness in Egypt?
C. How can we adjust water pollution and activate awareness in Egypt?
D. How to mitigate any other pollution and activate the awareness in Egypt?

(9) Thesis summary

Humans seek to have an adequate life; thus, they use nature for their sake in different ways. Technology and research increase the use of nature, which is the reason for the environmental crisis. Nature starts to respond with unpredictable events. So, it is clear there is urgency to act and stop destroying nature through environmental protection techniques. Environmental protection gets the attention of the world. Policies and laws were done on various scales, from the local to the global level, reaching the individual level. Individual responses to environmental policies depend on their environmental awareness. Environmental awareness focuses on the knowledge, motivation, and skill of individuals to protect nature.

The balance between the human-environment connection This interaction needs to be positive. Pro-environmental activities occur to improve the knowledge, skills, and motivation of individuals. It is an interlinked cycle between environmental awareness, environmental protection, and environmental stressors. Research contextualizes this interrelation by analyzing the Egyptian context to come up with the suitable environmental pollution that needs more investigation based on specific criteria.

The ecological foot of Egypt is higher than its biocapacity, which is the main contributor to environmental problems. After analyzing these problems in correlation with environmental protection techniques, it was found that there is a gap. Although there are an enormous number of environmental protection organizations, there is still a difference between the current and required state. So, research focuses on understanding and enhancing this problem in parallel with measuring environmental awareness.

Noise pollution was selected since Cairo, Egypt, is the second-nosiest city in the world. Accordingly, current state and environmental awareness analyses were performed through various tools (measuring devices, prediction software, observation, and questionnaires). To select a specific location for analysis, well-developed selection criteria were used. This criterion depends mainly on the allocation of noise sources and the expected locations with a high noise level. 4 zones were selected based on those criteria: Zone 1 encompasses Salah Salem Street and part of Masr El Gdeida; Zone 2 includes Al Ahly Club and part of Nasr City; Zone 3 is located from the airport, passing through Suez Road and Ezbet Hgana; and Zone 4 is near El-Obour Industrial Zone. All current analyses were compared to the desired state, in addition to the environmental awareness study.

Research found that the noise level is above the required guidelines based on the Egyptian national research center, which states that the average noise level in Caro, Egypt, is 90 dB. Moreover, the 29 fixed stations By EEAA show the gap between requirements and guidelines;

Furthermore, the results of the measurements of the case study To summaries the problem, traffic is considered the main factor in noise. In addition to that, some of the four zones mentioned above are affected by aircraft noise. A deeper analysis of one of these zones was done, which shows a high level of noise over facades. When analyzing the environmental awareness of the community about the gap between the current and desired state, it is clear that individual knowledge and skills are relatively low, but motivation is high.

Certainly, different migration techniques are implemented in this study. The first technique is traffic parameters, where traffic flow and traffic speed are included. After analyzing different scenarios for each parameter, it was found that these factors have a great impact on noise elimination, so it is highly recommended to follow strategies for traffic flow and speed reduction.

The second technique used is façade configuration, considering different scenarios, for instance, reflective index changes and finish material change. Also, green stepping with and without green barriers, and last but not least, convex and concave facades. It is recommended to use U-shaped configurations of buildings and green barriers because they have an effective impact.

The third technique is the wall composition of the facades involving normal brick with different densities, double brick with rock in between, brick and gypsum with rock in between. It is recommended to use double brick for high performance, and brick with a high density or brick with gypsum board with rock wool in between for medium performance.

The action plan is divided into five steps. The first step is the improvement of the existing building, which clarifies how to enhance the situation of the current building and the technique used. The second step is to improve the environmental awareness of people by enhancing their knowledge, skills, and motivation. The third step is to focus on the future, which clarifies the recommended policies that could decrease the gap between the required and desired states. The fourth step concentrates on the implementation of regulations to guarantee the quality of implementation and how they can be continuously improved. The last perspective focuses on monitoring and evaluating the progress.

References

Abas, S., & Tamura, A. (2003). Analysis of road traffic noise level and control in Greater cairo,Egypt. *Acoustical Science and Technology*, 358-364.

Ahmed, N., Elshater, A., & Afifi, S. (2019). The community participation in the design process of livable streets. *Lecture Notes of the Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering, LNICST.* Cairo.

Ahmed, Y., Ahmad, M., Ahmad , N., & Zakaria, N. (2019). Social media for knowledge-sharing: A systematic literature review. *Telematics and Informatics*, 72-112.

Andrew Baum, Tracey A. Revenson, & Jerome Singer. (2011). *Handbook of Health Psychology* . Routledge.

Attia, F. A. (1999). Water and Development in Greater Cairo (Egypt). *Revista CIDOB d Afers Internacionals* , 4-23.

Azkorra, Z., Pérez, G., Coma, J., Cabeza, L., Bures, S., Álvaro, J., . . . Urrestarazu, M. (2015). Evaluation of green walls as a passive acoustic insulation system for buildings. *Applied acoustics*, 46-56.

Baiardi, D., & Morana, C. (2021). Climate change awareness: Empirical evidence for the European Union. *Energy ecnomics*.

Balkan green energy news. (2022). *Earth Overshoot Day is July 29: resource consumption rebounds after pandemic*. Retrieved from https://balkangreenenergynews.com/earth-overshoot-day-is-july-29-resource-consumption-rebounds-after-pandemic/

Becheikh, N., Ziam, S., Fakhreddine, M., Castonguay, Y., & Landry, R. (2010). How to improve knowledge transfer strategies and practices in education? Answers from a systematic literature review. 1-21.

Bechtel, R. B., & Churchman, A. (2002). *Handbook of Environmental Psychology.* Wiley.

Benedetto , R., & Dario , C. (2020). Impact of COVID-19 outbreak measures of lockdown on the Italian Carbon Footprint. *Science of The Total Environment*, 1-14.

Beutel, M. E., Jünger, C., Klein, E. M., Wild, P., Lackner, K., Blettner, M., . . . Münzel, T. (2016). Noise Annoyance Is Associated with Depression and Anxiety in the General Population- The Contribution of Aircraft Noise. *pubmed*, 11-16.

Bressane, A., Mochizuki, P. S., Caram, R. M., & Roveda, J. A. (2016). A system for evaluating the impact of noise pollution on the population's health. *pubmed*, 32-37.

Brüel & Kjær. (2022, may). *BKSV*. Retrieved from B&K 2245 Sound level meter with noise partner: https://www.bksv.com/en/instruments/handheld/sound-level-meters/2245-series

Brüel & Kjær. (2022, may). *BKSV*. Retrieved from B&K 2245 Sound level meter with noise partner: https://www.bksv.com/en/instruments/handheld/sound-level-meters/2245-series

Brüel & Kjær. (2022, April 10). *BSKV*. Retrieved from Predictor-LimA: https://www.bksv.com/en/services/downloads/environmental-software/predictor-7810

Brüel & Kjær. (2022a, May). *BSKV*. Retrieved from Predictor-LimA: https://www.bksv.com/en/services/downloads/environmental-software/predictor-7810

Brüel & Kjær. (2022b, May). *BKSV*. Retrieved from B&K 2245 Sound level meter with noise partner: https://www.bksv.com/en/instruments/handheld/sound-level-meters/2245-series

Brüel &Kjær. (2022). *BKSV*. Retrieved April 1, 22, from The Loudest Cities In The World: https://www.bksv.com/en/knowledge/blog/sound/noisiest-city-in-the-world

Brüel &Kjær. (2022, may). *BKSV*. Retrieved from The Loudest Cities In The World: https://www.bksv.com/en/knowledge/blog/sound/noisiest-city-in-the-world

Busa, L., Secchi, S., & Baldini, S. (2010). Effect of Façade Shape for the Acoustic Protection of Buildings. *Building acoustics*, 317-338.

Dodig, M. B., Radic, M., & Auer, T. (2019). Green Facades and Living Walls—A Review Establishing the Classification of Construction Types and Mapping the Benefits. *sustainability*, 11-17.

Earth over shoot day . (2022). *Past Earth Overshoot Days - #MoveTheDate of Earth Overshoot Day*. Retrieved from Earth over shoot day : https://www.overshootday.org/#:~:text=This%20year%2C%20Earth%20Overshoot%20Day,re%20right%20there%20with%20you.

EEAA. (2022). Retrieved from reports and studies: https://www.eeaa.gov.eg/ar-eg/%D9%85%D9%88%D8%B6%D9%88%D8%B9%D8%A7%D8%AA%D8%A8%D9%8A%D8%A6%D9%8A%D8%A9/%D8%A7%D9%84%D9%87%D9%88%D8%A7%D8%A1/%D8%A7%D9%84%D8%B6%D9%88%D8%B6%D8%A7%D8%A1/%D8%A7%D9%84%D8%AA%D9%82%D8%A7%D8%B1%D9%8A%D8%B1%D9%88%D8%A7%D9%84%D8%AF

EEAA. (2022). Retrieved from Noise: https://www.eeaa.gov.eg/ar-eg/%D9%85%D9%88%D8%B6%D9%88%D8%B9%D8%A7%D8%AA%D8%A8%D9%8A%D8%A6%D9%8A%D8%A9/%D8%A7%D9%84%D9%87%D9%88%D8%A7%D8%A1/%D8%A7%D9%84%D8%B6%D9%88%D8%B6%D8%A7%D8%A1.aspx

EEAA. (2022). *AIR QUALITY*. Retrieved from https://www.eeaa.gov.eg/ar-eg/%D9%85%D9%88%D8%B6%D9%88%D8%B9%D8%A7%D8%AA%D8%A8%D9%8A%D8%A6%D9%8A%D8%A9/%D8%A7%D9%84%D9%87%D9%88%D8%A7%D8%A1/%D9%86%D9%88%D8%B9%D9%8A%D8%A9%D8%A7%D9%84%D9%87%D9%88%D8%A7%D8%A1.aspx

EEAA. (2022). *climate change*. Retrieved from https://www.eeaa.gov.eg/ar-eg/%D9%85%D9%88%D8%B6%D9%88%D8%B9%D8%A7%D8%AA%D8%A8%D9%8A%D8%A6%D9%8A%D8%A9/%D8%A7%D9%84%D9%87%D9%88%D8%A7%D8%A1/%D8%A7%D9%84%D8%AA%D8%BA%D9%8A%D8%B1%D8%A7%D8%AA%D8%A7%D9%84%D9%85%D9%86%D8%A7%D8%AE%D9%8A%D8%A9.aspx

EEAA. (2022). *noise monitiring*. Retrieved from https://www.eeaa.gov.eg/ar-eg/%D9%85%D9%88%D8%B6%D9%88%D8%B9%D8%A7%D8%AA%D8%A8%D9%8A%D8%A6%D9%8A%D8%A9/%D8%A7%D9%84%D9%87%D9%88%D8%A7%D8%A1/%D8%A7%D9%

84%D8%B6%D9%88%D8%B6%D8%A7%D8%A1/%D8%B1%D8%B5%D9%80%D8%AF%D8%A7%D9%84%D8%B6%D9%88%D8%B6%D9%80%D8%A7%D8%A1

EEAA. (2022). *Ozone*. Retrieved from https://www.eeaa.gov.eg/ar-eg/%D9%85%D9%88%D8%B6%D9%88%D8%B9%D8%A7%D8%AA%D8%A8%D9%8A%D8%A6%D9%8A%D8%A9/%D8%A7%D9%84%D9%87%D9%88%D8%A7%D8%A1/%D8%A7%D9%84%D8%A3%D9%88%D8%B2%D9%88%D9%86.aspx

Efut, E. N., Akpo, D., Okpashi, V. E., & Asuquo, E. N. (2017). Farmers' demographic variables: An insight into environmental conservation in Calabar. *international journal of modern biological research* , 56-63.

El sevier. (2022). *EMGINEERING VILLAGE*. Retrieved from https://www.engineeringvillage.com

El-Bardisy, N., Rashed, A. N., Elmeligy, E. A., & Aboulnaga, H. H. (2022). Ergonomic design for pedestrians' safety in regenerative cities: Heliopolis, Cairo, Egypt. In H. Abusaada, A. Elshater, & M. Khalifa, *Remapping Urban Heat Island Atlases in Regenerative Cities* (pp. 169–186). Hershey: IGI Global.

Elshater, A., & Abusaada, H. (2022). Exploring the types of blogs cited in urban planning research. *Planning Practice and Research*, 1–20.

Elshater, A., Abusaada, H., Alfiky, A., El-Bardisy, N., Elmarakby, E., & Grant, S. (2022). Workers' satisfaction vis-à-vis environmental and socio-morphological aspects for sustainability and decent work. *Sustainability (Switzerland), 14*(3), 1–26.

Environment. (2022). *Environmental Organizations - List*. Retrieved from http://www.environment.gen.tr/environment-organisations/211-environmentalorganizations-list.html

Environmental Performance Index. (2022). *Environmental Performance Index | Environmental Performance Index*. Retrieved from Environmental Performance Index | Environmental Performance Index: https://epi.yale.edu/

Environmental pollution center . (2022). *What Is Noise Pollution?* Retrieved from Environmental pollution center : https://www.environmentalpollutioncenters.org/noise-pollution/

Faiyetole, A. A., & Ibrahim, T. T. (2019). Predicting the aircraft take-off noise level. *Journal of Vibroengineering* , 129-134.

Federal aviation adminstration . (2022). *AEDT*.

Federal Aviation Adminstration. (2022). *Aviation Environmental Tools Suite*. Retrieved from Aviation Environmental Design Tool: https://www.faa.gov/about/office_org/headquarters_offices/apl/aee/research/models

Gifford, R. (2013). Environmental Psychology Matters. *PubMed*, 65.

Global foot print network. (2020). *Strategies for one-planet prosperity How to build lasting success on our finite.* roscongress. Retrieved from https://roscongress.org/upload/medialibrary/6ea/Earth-Overshoot-Day-_-Final.pdf

Global footprint network. (2023). *ecological foot print*. Retrieved from https://www.footprintnetwork.org/our-work/ecological-footprint/

Global footprint network. (2023). *open data platform*. Retrieved from https://data.footprintnetwork.org/?_ga=2.234971393.1249693403.1577170718114931 6931.1577170718#/

Global footprint netwrok. (2023). *Global footprint netwrok advancing the science of sustainability*. Retrieved from Global footprint netwrok.

Hahad, O., Beutel, M. E., Gilan, D. A., Michal, M., Daiber, A., & Münzel, T. (2020). [Impact of environmental risk factors such as noise and air pollution on mental health: What do we know?]. *Dtsch Med Wochenschr,* 1701-1707.

Halmatov, M., & Ata, S. (2017). An Assessment of the Contribution of Parents to Environmental Awareness for Children in the Preschool Age of 5-6 Years. *international journal of education ,science and technology*, 78-87.

Ham, M., Mrčela, D., & Horvat, M. (2016). Insights for measuring environmental awareness. *Ekonomski vjesnik/Econviews - Review of Contemporary Business, Entrepreneurship and Economic Issues,*, 159-176.

Hill, P. (2017). *Environmental Protection: What Everyone Needs To Know.* uk: oxford univeristy press.

Human development reports. (2022). *Human devolpment index*. Retrieved from https://hdr.undp.org/data-center/human-development-index#/indicies/HDI

International Year of Sound. (2022). *the control of noise*. Retrieved from https://sound2020.org/society/control/

IPCC. (2022). Retrieved from https://www.ipcc.ch/about/#:~:text=Created%20in%201988%20by%20the,use%20to%20develop%20climate%20policies.

IQ AIR. (2022). Retrieved from https://www.iqair.com/earth

IQ AIR. (2022). *Air quality in Egypt*. Retrieved from https://www.iqair.com/egypt

Ismail, M. R. (2014). Sound preferences of the dense urban environment: Soundscape. *Frontiers of Architectural Research*, 55-68.

Ismail, M. R., & Oldham, D. (2002). The effect of the urban street canyon on the noise from low flying aircraft. *Building Acoustics, 9*(2), 223–251.

Kaiser, W., & Meyer, J.-H. (2016). *nternational Organizations and Environmental Protection: Conservation and Globalization in the Twentieth Century.* New York, Oxford: Berghahn.

Klatte, M., Spilski, J., Mayerl, J., Moehler, U., Lachmann, T., & Bergström, K. (2016). Effects of Aircraft Noise on Reading and Quality of Life in Primary School Children in Germany: Results From the NORAH Study. *Environment and Behavior,* 390-424.

Kokkinen, E. (2013). Measuring environmental awareness in the world. University of Oulu Faculty of Technology.

Lan, Z., & Cai, M. (2021). Dynamic traffic noise maps based on noise monitoring and traffic speed data. *Transportation Research Part D, 94*, 1–20.

Lauesen, L. M. (2013). Environmental Protection Agencies (All Countries). In S. O. Idowu, N. Capaldi, & L. Zu, *Encyclopedia of Corporate Social Responsibility* (pp. 1006–1016). berlin : Springer.

Lee, K. (2021). Urban Public Space as a Didactic Platform: Raising Awareness of Climate Change through Experiencing Arts. *sustainability*.

Martinelli, L. (2022). *Global Noise Pollution Map*. Retrieved from Global Noise Pollution Map: http://lukasmartinelli.ch/gis/2016/04/03/openstreetmap-noise-pollution-map.html

Mrkva, K., Cole, J. C., & Boven, L. V. (2021). Attention increases environmental risk perception. *pubmed*, 83-102.

Münzel, T., Sørensen, M., & Dai, A. (2021). Transportation noise pollution and cardiovascular disease. *Nat Rev Cardiol*, 619-636.

national justice social and ecnomic justice authority. (2019). *خريطة النشاط البيئي في مصر*. cairo.

New and Renewable Energy Authority. (2006). *15OMWe KURAYMAT INTEGRATED SOLAR COMBINED CYCLE POWER PLANT PROJECT.* cairo: Energy & Environment Consultant (E&E).

Okokon, E. O., Tuomi, T. Y., Turunen, A. W., Tiittanen, P., Juutilainen, J., & Lanki, T. (2018). Traffic noise, noise annoyance and psychotropic medication use. *Environ Int*, 287-294.

Riva, M., Plusquellec, P., Juster, R.-P., Sidi, E. A., Abdous, B., Lucas, M., . . . Dewailly, E. (2014). Household crowding is associated with higher allostatic load among the Inuit. *Epidemiol Community Health*, 363-369.

Sen, L. T., Bond, J., Phuong, L. T., Winkel, A., Tran, U. C., & Le, N. V. (2021). The importance of climate change awareness for the adaptive capacity of ethnic minority farmers in the mountainous areas of Thua Thien Hue province. *Taylor francis*, 239-251.

Simsar, A. (2021). Young Children’s Ecological Footprint Awareness and Environmental Attitudes in Turkey. *springer*, 1-27.

S'teg, L., Van den Berg, A. E., & De Groot, J. I. (2018). *Environmental psychology: An introduction.* washintigon: BPS Blackwell.

Stokols, D., & Altman, I. (1987). *Handbook of Environmental Psychology*. Wiley-Interscience.

survey mokey. (2022). *Sample size calculator*. Retrieved from https://www.surveymonkey.com/mp/sample-size-calculator/

Tawfeek, F. (2018, March 14). Retrieved from Cairo ranked second noisiest city in the world - Egypt Independent: https://egyptindependent.com/cairo-ranked-second-noisiest-city-world/

The Climate Change Guide. (2022). *The Kyoto Protocol*. Retrieved from https://www.climate-change-guide.com/kyoto-protocol.html

Thomazelli, R., Caetano, F. D., & Bertoli, S. R. (2017). Acoustic properties of green walls: Absorption and insulation. *Proceedings of meetings on acoustics Acoustical Society of America* .

Transport Planning Authority. (2012). *The comprehensive study on the master plan for nationwide transport system in the arab republic of Egypt.* CAIRO. Retrieved from https://openjicareport.jica.go.jp/pdf/12057584.pdf

United nations environmental programme. (2022). *We're gobbling up the Earth's resources at an unsustainable rate*. Retrieved from unep: https://www.unep.org/news-and-stories/story/were-gobbling-earths-resources-unsustainable-rate#:~:text=George%20Monbiot%2C%20a%20correspondent%20for,cent%20over%20the%20next%20decade.

United Nations Framework Convention on Climate Change. (2022). *What is the Kyoto Protocol?* Retrieved from United Nations Framework Convention on Climate Change: https://unfccc.int/kyoto_protocol

UN's global development network. (2023). Retrieved from Global knowlege index: https://www.knowledge4all.com/dashboard

Uribe, D. A., Daniels, D., Álvare, Á., & Pereira, A. M. (2020). influence of vehicular traffic on environmental noise spectrum in the tourist route of santa marta city. *Energy report*, 818-824.

Valentín, J., & Gamez, L. (2010). *Environmental psychology new development.* New york: Nova science publisers .

Wael, S., Elshater, A., & Afifi, S. (2022). Mapping user experiences around transit stops using computer vision technology: Action priorities from Cairo. *Sustainability*, *14*(17), 1–20.

Wakil, K., Naeem, M. A., Anjum, G. A., Waheed, A., Thaheem, M. J., Hussnain, M. Q., & Nawaz, R. (2019). A Hybrid Tool for Visual Pollution Assessment in Urban Environments. *sustainability*, 11-19.

World Bank. (2013). *Cairo Traffic Congestion Study : Final Report.* CAIRO. Retrieved from http://hdl.handle.net/10986/18735

world ecnomic forum. (2022, june). *Which countries do the most to protect the environment? | World Economic*. Retrieved from https://www.weforum.org/agenda/2015/09/which-countries-do-the-most-to-protect-the-environment/

Xue, W., Huang, Z., Zhao, B., Yang, W., lan, Z., & Cai, M. (2021). Updated traffic noise map method based on speed cluster. *Applied Acoustics*.

Yang, w., Cai, M., & Luo, P. (2020). the calculation of road traffic noise spectrum based on the noise spectral characteristics of single vehicle. *applied acoustics*, 107128.

Yang, W., Cai, M., & Luo, P. (2020). The calculation of road traffic noise spectrum based on the noise spectral characteristics of single vehicle. *Applied Acoustics, 60,* 1–17.

Yang, w., He, J., He, C., & Cai, M. (2020). Evaluation of urban traffic noise pollution based on noise maps. *Transportation Research Part D: Transport and Environment*, 1–14.

Yang, w., He, J., He, C., & Cai, M. (2020). Evaluation of urban traffic noise pollution based on noise maps. *Transportation Research Part D: Transport and Environment, 87,* 1–14.

Yuan, K.-S., & Wu, T.-J. (2021). Environmental stressors and well-being on middle-aged and elderly people: the mediating role of outdoor leisure behaviour and place attachment. *pubmed*.

Appendix

Appendix 1 environmental protection organization in Egypt details

Category	Name	TYPE	year established
I.Right and justice organization	Green peace International	independent international not for profit foundation	1971
	Hurghada Environmental Protection and Conservation Association (HEPCA)	non-governmental organization	1992
	Land center for human rights	Non for profit organization	1996
	Habi center for environmental rights	non-governmental organization	2001
	Egyptian Initiative for personal rights	non-governmental organization	2002
	Egyptian Center for Economic and Social Rights (ECESR)	Non for profit legal entity	2009
	350.org EgypT	Non for profit legal entity	2009
	Egyptian Center for Civil and Legislative Reform ECCLR	non-governmental organization	2009
	Arab Youth Climate Movement (AYCM)	non-governmental organization	2012
	ASSOCIATION FOR THE PROTECTION OF THE ENVIRONMENT (APE)	non-governmental organization	1985
	Spirit of youth association	non-governmental organization	2004
	Ice Cairo	Non-profit organization- international	2012
	Nahdet el Mahrosa	non-governmental organization	2003
	Center for sustainable development solutions (CSDS)	Non for profit organization	2011
	Nature conservation Egypt	non-governmental organization	2005
	Arab Network for Environment and Development "RAED	Regional organization	1990
	Arab office for Youth and Environment (AOYE)	non-governmental central organization	1978
	CleanTech Arabia	non-governmental organization	2011
	EcoMENA's	educational website	2012
	Arab Forum for Environment and Development (AFED)	Regional non-for profit non governmental organization	2006
	Peace and plenty association	Non for profit organization	2004
	Ain- El-Bee'ah	Community organization	2014
	Coptic evangelical organization for social services (CEOS)	non-governmental organization	1950
	Habiba community	non-governmental organization	1994
	Hemaya- Nuwaiba –Sini	Non for profit organization	1997
	Future Eve foundation- Minia governorate	non-governmental organization	2001
	Our hands Minia governorate	non-governmental organization	NA
Environmental Protection Organizations	Mansoura for environmental protection Organization	non-governmental organization	2007
	The Egyptian Association for comprehensive Development	non-governmental organization	1995
	The Environmental NGO federation in Quena-Quena governorate	non-governmental organization	2001
	Child care and environmental protection in Etay Elbaroad- Damanhor governorate	non-governmental organization	NA
	Green Maadi	non-governmental organization	NA
	Recyclina	community organization	NA
	Egypt Tourism and environmental development.	non-governmental organization	2006
	Ras Ghareb for Environmental Protection- Red sea	non-governmental organization	NA
	Handcraft project- Gebraa	social enterprise	NA
	Egyptian federation of organizations working on environment protection	non-governmental organization	1999
	Tadweer Egypt- recycling company tadweer masr	Company	2012
	Center for Environment and Development for The Arab Region and Europe (CEDARE)	international inter-governmental Organization with diplomatic status.	1992
	ARAB FEDERATION FOR WILDE LIFE PROTECTION (AFWP)	non-governmental Arab federation	2006
	Arab union for sustainable development & environment	international non-governmental organization in affiliated to Ministry of Exterior and Arab league	NA
	The Regional Organization for the Conservation of the Environment in the Red Sea and Gulf of Aden- Inter governmental(PERSGA)	Regional Governmental organization	1997
	Environics for management of environmental – company	COMPANY	1999
	The Path Corporate for Sustainable Development (PSCD) – company	non-governmental organization	2013
	the Regional Solid Waste Exchange of Information and Expertise Network (Sweepnet)	Regional non-for profit organization	2009

Sustainable agriculture	Fayoum Agro Organic Development Association (FAODA	non-governmental organization	2003
	Nawaya	non-governmental organization	2011
	Dayma		2011
	Green Zone Egypt		2013
	Schaduf- urban mirco farms	Company	2011
	The Egyptian Biodynamic Association	non-governmental organization	NA
	Shagara	non-governmental organization	2011
	Mahali	Company	NA
Renewable energy	Youthink green Egypt	International non-profit organization	2013
	Oasis renewable energy	Company+ training academy	2010
	SEDA – SOLAR ENERGY DEVELOPMENT ASSOCIATION	Non-profit Association	NA
	Egyptian Association for Energy and Environment (EAEE	Non-profit organization	1984
	Egypt green Energy association	non-governmental organization	2012
	Egyptian Wind Energy Association	organization	NA
	Regional center for renewable energy and energy efficiency	on-profit regional organizations	2008
	Egypt Solar Industry Association (Egypt-SIA)	business organization. Affiliated with Solar GCC alliance	NA
	Sun Infinite energy-	Private company	2011
Sustainable Urban Environment	10 Tooba/ Applied research on built Environment	non-governmental organization	NA
	Ezbat project	development project	2012
	Built environment collective- Megawra	non profit organization combined	NA
	Kayan community builders academy	Edcational academy	NA
	Tadamun Cairo Urban Solidarity Initiative	website	NA
	REMAL Foundation for urban development	Non for profit foundation	2011
	Housing and land rights network (habitat international coalition)	international non-profit organization	1984
	Friends of Environment and development association FEDA	Non-profit organization	2005
	Egyptian Earth Construction Association	Non-profit organization	1997
	Egypt Green Building Council EGGB	Community organization	NA
	Participatory development program in urban areas	Inter -Governmental . The PDP is an Egyptian-German development measure implemented by the Ministry of Planning)MoP(and the German Ministry for Economic Cooperation and Development)BMZ(	2004
	Egypt green building council	Governmnetal counicl	2009
	Takween integrated community development	company	2009
	urbanics : for sustainable nature and built environment	Non-profit organization	NA
	Integrated zero net carbon housing INCH	company	NA
Research &Academia	CENTER FOR SUSTAINABLE DEVELOPMET – AUC	educational	NA
	Climate change information center and renewable energy –	Research Center Ministry of agriculture)	NA
	Egyptian National Oceanographic Data Center at NIOF-	Governmental	NA
	Institute of environment studies and research- Ain Shams University	Governmental	1988
	National research Center, Environmental Sciences	Governmental	NA
	National Water Research Center -	Governmental	NA
	NEW & RENEWABLE ENERGY AUTHORITY (NREA), MINISTRY OF ELECTRICITY & ENERGY	Governmental	1986
	Research Institute for Sustainable Development (RISE) AU	Research and educational unit. Academia- AUC	NA
	Water institute for the Nile-	research organization	2011
	EGYPTIAN SOCIETY FOR ENVIRONMENTAL SCIENCI	non-governmental organization	2004
	Chemonics Egypt	Consulting Firm	1992
	EcoConServ Environmental Solutions	Consulting Firm	1991
	Green land for environmental consultations	Consulting Firm	2008

Appendix 2 devices and software data

B&K 2245 Sound level meter

PRODUCT DATA

B&K 2245 Sound Level Meter with Noise Partner

The core of the B&K 2245 series

B&K 2245 Sound Level Meter with Noise Partner is a complete solution for basic noise measurements.

Whether you are a complete novice, occasional user or an acoustics specialist – sometimes all you need is a simple sound level meter – one that provides you with reliable, accurate results without all the fuss. That is what B&K 2245 delivers.

This robust, class 1 sound level meter puts functionality, ease-of-use and versatility into the palm of your hand together with the reliability and confidence that is ensured with the Brüel & Kjær brand.

Uses and Features

Uses

- Basic noise measurements
- Broadband measurements requiring IEC 61672 compliant instrumentation
- Simple product testing

Features

- Single measurement range: 16 – 141 dB(A) from noise floor to maximum level
- Frequency range: 6 Hz – 20 kHz
- 16 GB internal storage
- Automatic measurement transfer for network storage for backup and analysis
- Robust design for both indoor and outdoor measurements
- Wireless connectivity for remote control of measurements and data transfers
- Simplified user interface using either the sound level meter or your iPhone®
- Measurement annotation using photos, audio, text or video
- PC software for data storage, viewing and reporting
- GPS for time and position
- Calibrator auto-detection
- Windscreen auto-detection and compensation

Brüel & Kjær

A Complete Solution

B&K 2245 Sound Level Meter is a complete package solution that includes the Noise Partner app for both mobile measurement control, display and data transfer and a PC-based application for analysis and documentation.

Fig. 1 *The complete solution: B&K 2245 Sound Level Meter and the Noise Partner app installed on a mobile phone and PC*

The Sound Level Meter

B&K 2245 provides effortless usability with a rubberized body that is dust- and water-resistant for a more secure grip and ensured compliance to IP 55. The seven control buttons can be comfortably operated with one hand, and the instrument's clear, bright display shows you the most important information at a single glance. With a 14-hour battery life, you can be sure it will not let you down.

Fig. 2 *The sound level meter's lightweight design and user-friendly display*

Wireless Connectivity

Using the Noise Partner app on your mobile phone, you can wirelessly connect to B&K 2245, providing the flexibility to control your measurements via your mobile phone, avoiding possible body reflections or unsafe environments. Once the app has connected to the sound level meter, it will remember the instrument and automatically connect to it when in range.

B&K 2245 has Bluetooth®, Wi-Fi® and a USB-C connector.

The App

Noise Partner app is an intuitive mobile app that extends the measurement environment to your mobile phone. Monitor and control the measurement from the phone and easily add photos, text, voice or videos to document the setup and/or particular events and situations.

Fig. 3 *Control, view and annotate measurements directly from your mobile phone*

Transfer Data for Analysis

When you are done measuring, you can quickly and securely transfer data to your PC. All data is stored in the instrument, which can be set up to automatically transfer data whenever it connects to your local network.

The Noise Partner PC software, which is simple to install and use with preconfigured, user-friendly tools for presenting and sharing results, organizes the data intuitively, ready for further analysis and reporting.

Smart Accessories

Smart Docking Station

B&K 2245 connects to an optional smart docking station that not only acts as a high-speed charger but also automatically transfers stored data and annotations to your network for reporting and analysis. This means the unit is always charged and ready to go, and you never have to worry about saving the information you need or about someone deleting your data by accident – everything is done securely for you.

Fig. 4 *B&K 2245 with its optional docking station*

Other Accessories

From tripods, calibrators, mobile phone holders, and more – Brüel & Kjær provides you with the accessories you need to complete any measurement task using B&K 2245.

See "Ordering Information" for a complete overview.

Hassle-free Licencing

Each B&K 2245 licence is installed in the instrument, enabling measurement functions on the instrument as well as:

- Allowing connections to licenced mobile apps
- Embedding licences in measurement files for editing in licenced desktop apps

This means there are no licence files to install on the PC, and no dongles. Mobile and desktop apps can be freely downloaded and installed on any iPhone and PC, and measurements made with embedded licences can be edited by the desktop app on any PC, forever.

A Platform that Helps You Get the Job Done

The B&K 2245 platform includes a range of apps, each tailored to assist a specific job-to-do. Each instrument can be licenced for more than one app, so switching tasks is as easy as – switching apps.

All available mobile apps can be downloaded from the App Store®. PC apps can be downloaded at www.bksv.com.

- **Enviro Noise Partner** – for environmental noise surveys that includes markers to isolate sounds (for example, removing a barking dog or identifying the moment when a sound source is operating) and checklists to ensure each step is completed to local requirements
- **Work Noise Partner** – for workplace noise surveys that guides you through a full work day noise exposure calculation. Frequency analysis is also included, which is perfect for selecting hearing protectors

AEDT (Aviation Environmental Design Tool) software

Guidance on Using the Aviation Environmental Design Tool (AEDT) to Conduct Environmental Modeling for FAA Actions Subject to NEPA

Purpose

This guidance document provides information on the use of AEDT to conduct environmental modeling of aircraft noise, fuel burn, and emissions for FAA actions subject to the National Environmental Policy Act (NEPA).

Applicability

Aircraft noise, fuel burn, and emissions are interdependent and occur simultaneously throughout all phases of flight. AEDT is a comprehensive software tool that provides information to FAA and its stakeholders on each of these specific environmental impacts. AEDT facilitates environmental review activities required under NEPA by consolidating the modeling of these environmental impacts in a single tool.

As published in the *Federal Register* (80 FR 27853), AEDT 2b replaced previous versions of AEDT, the Integrated Noise Model (INM) and the Emissions and Dispersion Modeling System (EDMS) as the required tool for noise, fuel burn, and emissions modeling of FAA actions. Guidance on AEDT version determination for project use is available on the AEDT website. (https://aedt.faa.gov/Documents/AEDT_Version_Guidance_Memo.pdf).

While the AEDT User Guide provides information on default data and how to use AEDT, this document provides information on how to use the tool to satisfy the requirements of NEPA in accordance with FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures* and related FAA guidance documents.

This document is organized to reflect the ways in which AEDT is used to conduct different types of studies (or use cases), depending on the metric(s) of interest. There are five sections:

- Emissions Inventory Only
- Emissions Inventory and Emissions Dispersion
- Emissions Inventory and Noise
- Emissions Inventory, Emissions Dispersion, and Noise
- Non-Default Methods and Data

4 Emissions Inventory, Emissions Dispersion, and Noise

An emissions inventory provides the total amount or mass of pollutants generated by various sources during a specific period of time. More advanced inventories may also spatially allocate emissions for specific source purposes.

Emissions dispersion modeling is used to further refine the results of an emissions inventory. Emissions dispersion modeling is the process by which the dispersal of atmospheric pollutants is simulated and assessed under the effects of meteorological, terrain, and other influencing factors.

AEDT can model the following types of emission sources:[33]

- Point sources: stacks from boilers, turbines, generators, and cooling towers;
- Area sources: activity at aircraft gate aprons (aircraft at startup, GSE operations, and APU activity), aircraft taxiing, queuing, accelerating on the runway, and in takeoff, climb-out, and approach modes; and
- Volume sources: any source with both area and height elements, e.g., fuel storage facility.

Emissions from on-road mobile ground sources (such as ground access vehicles) cannot be modeled with AEDT but may be modeled independently using the EPA MOVES model. A detailed explanation of emissions dispersion requirements is provided in the *Air Quality Handbook* in section 7 and Appendix D.

Noise exposure modeling identifies locations exposed to specified levels of aircraft-generated noise, both in and outside the project location. The standard noise metric is the yearly day-night average sound level (DNL). Community Noise Equivalent Level (CNEL) may be used in lieu of DNL for noise analysis of FAA actions in California.

While aircraft emissions are primarily a function of aircraft fleet mix and operational schedules, the noise generated by aircraft and emissions dispersion are affected by additional factors, including weather, the local terrain, the locations and usage of specific flight paths, and the weight of departing aircraft (as heavier aircraft have a slower rate of climb and wider noise dispersion).

This section provides guidance on the following elements of an analysis that includes emissions inventory, emissions dispersion, and noise:

- Representation of results;
- Aircraft operations and schedules;
- Use of weather information;
- Flight paths;
- Use of terrain information; and
- Use of lateral attenuation for propeller aircraft and helicopters.

Section 1 provides details on conducting an emissions inventory. Section 2 provides details on conducting a study that includes an emissions inventory and emissions dispersion. Section 3 provides details on conducting an emissions inventory and a noise study. This section provides information applicable to a study that includes noise, an emissions inventory, and emissions dispersion.

4.1 Representation of results

When an emissions inventory and emissions dispersion of criteria pollutants[34] is conducted,[35] it should be reported within the study area (i.e., the area potentially affected by criteria pollutant emissions from the proposed action and alternative(s)) extending from the ground surface up to the local mixing height (or 3,000 ft. AGL where the mixing height is not identified in the applicable SIP or TIP). The mixing height is the top of the vertical region of the atmosphere in which pollutant mixing occurs and affects ground level concentrations. Above this height, pollutants that are released generally do not mix with ground level emissions and do not have an effect on ground level concentrations in the local area.

For noise analysis of airport actions, the study area must be large enough to include the area within the DNL 65 dB contour, and may be larger.[36] For noise analysis of air traffic airspace and procedure actions, the study area may extend vertically from the ground to 10,000 ft. AGL, or up to 18,000 ft. AGL if the proposed action or alternative(s) are over a national park or wildlife refuge where other noise is very low and a quiet setting is a generally recognized purpose and attribute.[37]

If fuel burn and GHG emissions are computed as part of a NEPA analysis,[38] they should be reported for the full extent of aircraft movements as part of the project changes with no altitude restriction (not constrained by the mixing height). Fuel burn and GHG evaluation should include the same emission sources that are included in the air quality analysis.

Section 2.1 provides information on receptor locations and reporting results for emissions dispersion. Section 3.1 provides this information for noise.

[34] *Air Quality Handbook*, section 3.2.1.
[35] Section 4.1.2 of the *Air Quality Handbook* provides guidance on selecting an appropriate air quality assessment methodology. Aircraft emissions above the mixing height (or 3,000 ft. AGL when the mixing height is not identified in the applicable SIP or TIP) are exempt from study as they have been determined to be *de minimis*. 40 CFR §93.153(c)(2)(xxii); see also 75 Fed. Reg. 17257-17258 (April 5, 2010).
[36] If DNL 1.5 dB increases are documented within the DNL 65 dB for an action in the immediate vicinity of an airport, the NEPA document must also identify noise sensitive areas where noise is projected to increase by DNL 3 dB or more within the DNL 60-65 dB contours. Disclosure of noise impacts outside the DNL 65 dB contour may also be warranted in connection with the consideration of noise impacts in areas where the land use compatibility guidelines in 14 CFR part 150 may not be relevant. See FAA Order 1050.1F, Appendix B, paragraph B-1.4.
[37] See FAA Order 1050.1F, Appendix B, paragraph B-1.3; FAA Order 7400.2K, section 32-2-1.b.2.
[38] For NEPA reviews, GHG emissions should be quantified when fuel burn is computed and reported in the NEPA document. See Chapter 3 of the 1050.1F Desk Reference..

4.2 Aircraft operations and schedules

Aircraft operations are the flight schedule information input to AEDT to compute aircraft performance and affect environmental results. Inputs include fleet mix (i.e., airframe, engine), number of operations, and operational profile (i.e. the distribution of operations over time).

Aircraft operations inputs to compute noise, an emissions inventory, emissions dispersion, fuel burn, or GHG emissions may include:

- Number of operations by aircraft type in the year(s) of study;
- Fleet mix, specifying each airframe and engine, based on annual operations;
- Aircraft flight paths;
- Aircraft ground movements, represented in time and space, for emissions;
- Airport layout and capacity parameters;
- Number of day and night operations by aircraft for the Day-Night Average Sound Level (DNL) noise metric. For the Community Noise Equivalent Level (CNEL) noise metric only, also include the number of evening operations by aircraft; and
- Operational profile(s) (i.e., number of flights in the month, day, and hour or quarter-hour relative to the peak). AEDT will run the operational profiles for emissions dispersion. Information must be provided on the split between day, evening, and night operations, as appropriate for the noise metric.

As an alternative to the aircraft operations information listed above, a detailed schedule of annual operations (i.e., time-stamped flights for the year of study, which includes the fleet and operations for the entire year) may be provided. AEDT will run the detailed schedule for emissions inventory and emissions dispersion, and annualize the data to an average annual day for noise.

For an emissions dispersion analysis, AEDT's ground delay and sequencing function should be used, which models aircraft ground locations in time and space based on airport layout and capacity parameters.

If delay and sequencing is applied to the aircraft operations in a noise metric result, the scheduled and actual time for each operation should be compared to determine whether there is a change. Coordinate with the AEE-100 if there are differences between scheduled and actual times for noise operations that occur across the day and night time periods for the DNL metric or day, evening, and night time periods for the CNEL metric.

For emissions only, non-aircraft operations inputs may include:

- Auxiliary power units;
- Ground support equipment, e.g., aircraft tugs, air start units, loaders, tractors, fuel or hydrant trucks;
- Stationary sources, e.g., boilers, heaters, generators, snowmelters, incinerators, fire training facilities, fuel storage tanks, painting operations, de-icing and anti-icing operations, salt/sand storage.

4.3 Use of weather information

This section describes the use of weather data and atmospheric absorption.

4.3.1 Weather data

AEDT default weather data include average annual weather (i.e., based on 30-year normals and 10-year averages) for each airport,[39] as well as International Standard Atmosphere (ISA) conditions.[40] In addition, AEDT accepts more detailed weather data (in space and/or time). Default or more detailed weather for each airport may be selected, depending on the type of analysis.

For airport actions, AEDT default airport-specific average weather conditions should be used to compute noise for the airport to be studied. Use of non-default weather data requires written approval from AEE (see Section 5, Non-Default Methods and Data).

For air traffic airspace and procedure actions, AEDT default airport-specific average weather conditions for the airport(s) to be studied should be used to compute noise. Use of non-default weather data requires written approval from AEE (see section 5).

When emissions dispersion analysis is conducted, surface and upper air weather data must be used to compute both the emissions inventory and emissions dispersion analyses. There is no singular, standard weather data source for emissions inventory or dispersion computation. The weather data needed to compute emissions dispersion must meet EPA guidance[41] and the AERMOD format. Use of AERMET to form compliant weather input for AERMOD allows use of data sets from the NWS, on-site data, or detailed one-minute data. For example, NCDC ASOS/Upper Air format meets the requirements to compute emissions dispersion. Conduct interagency coordination to determine the appropriate weather data to use for the analysis of emissions dispersion.

The same weather source used to compute the emissions inventory of criteria pollutants should be used to compute fuel burn and CO_2 emissions.

In this use case, there could be differences between the source of weather data applied (i.e. for noise and emissions) where appropriate. Coordinate with the appropriate FAA office if there is uncertainty regarding the use of weather and its potential influence in a specific study.

4.3.2 Atmospheric absorption [noise only]

Atmospheric absorption is the calculation of the absorption of sound by the atmosphere due to weather conditions (temperature, relative humidity, atmospheric pressure, etc.). In AEDT, the airport average weather conditions in the study are used to calculate atmospheric absorption adjustments to standard Noise-Power-Distance (NPD) curves.

---

[39] Data acquired from NOAA National Climatic Data Center website.

[40] The International Standard Atmosphere is an atmospheric model of how the pressure, temperature, density, and viscosity of the Earth's atmosphere change over a wide range of altitudes.

[41] US EPA, "Meteorological Monitoring Guidance for Regulatory Modeling Applications," EPA-454/R-99-005, February 2000.

For noise analyses of FAA actions, the atmospheric absorption type "*SAE-ARP-5534*" must be selected in AEDT Processing Options. This function uses the method described in Society of Automotive Engineers' (SAE) Aerospace Recommended Practice (ARP) 5534, taking into account changes in atmospheric absorption due to airport specific temperature, relative humidity, and atmospheric pressure.

4.4 Flight paths

4.4.1 Ground track geometry

Aircraft operations are modeled on ground tracks. AEDT allows for the development of studies with ground track geometry that include both straight and curved flight paths. For analyses that include emissions inventory, emissions dispersion, and noise, modeled ground tracks should approximate actual flight paths in the study area. Coordinate with the appropriate FAA office if there is uncertainty regarding the use of ground tracks.

4.4.2 Track dispersion

Ground tracks are typically consolidated, or "bundled," to represent average movements around an airport in an analysis. The potential effects that the modeling technique of bundling ground tracks may have on study results should be considered, as there are different implications on noise, fuel burn, and emissions results. Specifically, care should be taken to ensure that bundled ground tracks and the aircraft types that are modeled on those tracks represent actual operations in the study area in terms of flight path dispersion around the airport and the aircraft types that fly those flight paths.

4.5 Use of terrain information

AEDT allows users to import terrain files and use terrain data in emissions dispersion and noise computations. When terrain is not applied in AEDT, the model computes receptor-to-source distances in the noise and emissions dispersion calculations based on flat ground.

In regions where topography is relatively flat, use of terrain is not required for environmental studies. If there is uncertainty in the use of terrain and its potential influence on pollutant concentrations or noise exposure in a specific study, coordinate with the appropriate reviewing authority. If terrain files are used in a study that includes both emissions dispersion and noise, then the same terrain data should be applied for relevant noise and emissions dispersion metrics.

For noise analyses, terrain files can be applied with or without line-of-sight blockage. Although line-of-sight blockage is not required for environmental studies, it should be considered for analyses that have substantial terrain features located between the aircraft noise sources and the noise receptors. Coordinate with the appropriate FAA office if there is uncertainty regarding the use of line-of-sight blockage and its potential influence on noise exposure in a specific study.

4.6 Use of lateral attenuation for propeller aircraft and helicopters [noise only]

For noise analyses, lateral attenuation describes the difference in sound level between the sound directly under an aircraft's flight path and at a location to the side of the aircraft. In AEDT, the lateral attenuation adjustment is based on the methods described in the SAE Aerospace Information Report (AIR) 5662 "Method for Predicting Lateral Attenuation of Airplane Noise." It takes into account the following effects on aircraft sound due to over-ground propagation: (1) ground reflection effects; (2) atmospheric refraction effects; and (3) airplane shielding effects, as well as other ground and engine/aircraft installation effects.

AEDT assumes that sound propagation occurs over acoustically soft ground (i.e. grass/trees), which is appropriate for the majority of analyses. AEDT also has a setting to turn off lateral attenuation for flights from helicopters and propeller-driven airplanes, effectively assuming propagation over acoustically hard ground (i.e., pavement/water), while soft ground effects would still apply to other aircraft types.[42]

For noise analyses of FAA actions, lateral attenuation must be modeled for all aircraft types, including helicopters and propeller-driven airplanes, assuming acoustically soft ground (ensure that the box "*Use hard ground attenuation for helicopters and propeller aircraft*" is unchecked in AEDT Processing Options). Written approval from AEE-100 is required if the default lateral attenuation setting is not used. See section 5 on Non Default Methods and Data for information on request and approval processes.

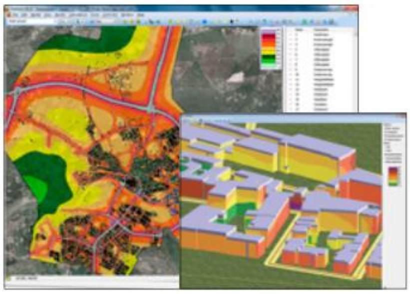
Predictor -lima software

envirosuite

PRODUCT INFORMATION:

PREDICTOR™–LIMA™ SOFTWARE SUITE VERSION 2021

The Predictor-LimA Software Suite is the complete solution for all environmental noise projects. Noise predictions for industry, roads, railways, aircraft and wind turbines are all supported. The software is used by acoustic consultants, environmental authorities, heavy industries and educational institutes.



The suite bundles the intuitive Predictor software and flexible LimA system in one powerful, integrated, state-of-the-art package that provides the best solution for whichever project you have, from small-scale industrial situations to large-scale city noise mapping. Predictor-LimA use the state-of-the-art LimA calculation cores with huge capacity and high calculation speed so that you get results quickly while reducing your investment in computing power.

Depending on the task, you can use the tool that suits you and the task best for efficient, powerful environmental noise prediction and analysis. The suite allows you to do most of your projects quickly and easily, with the intuitive functionality of Predictor and the flexibility of LimA. In addition, the LimA system provides the tools to fully integrate environmental noise predictions in other Geographical Information Systems (GISs).

USE AND FEATURES

Uses

- Environmental noise prediction, mapping, management, action planning and impact assessment
- Noise prediction for industry, road traffic, rail traffic, air traffic and wind turbines
- Fulfilment of European Commission directives such as Environmental Noise Directive (2002/49/EC) in accordance with Guidelines on Revised Interim Computation Methods (2003/613/EC) and revised Annex II (Directive 2015/996/EC)
- Fulfilment of Industrial Emissions (IPPC) Directive 2010/75/EU and similar
- Integration in other (GIS/management) systems
- Educational purposes

Features

- User friendly and easy to learn
- Fast and accurate calculations, extremely powerful and professional
- State-of-the-art 64-bit and WMS support for direct use of online georeferenced maps as background maps
- Time-saving integrated and automated bookkeeping for model data and results
- Automated reverse engineering and instant noise maps using noise measurements to help create accurate noise calculations
- Make use of automated workflows (import, clean, calculate, plot, etc.) to reduce the risk of human error on larger projects
- Network modelling and calculation license included in all configurations is a very cost-effective solution for multi- person use
- English, Chinese, Spanish, and Russian interfaces

envirosuite

THE SOFTWARE SUITE

The suite bundles the following software in one state-of-the-art software package:

- Predictor: Intuitive software for environmental noise prediction and mapping; uses the powerful LimA calculation cores. Predictor supports 20 calculation standards.
- LimA: Modular and flexible system for environmental noise prediction and mapping. LimA supports 30 calculation standards.
- Acoustic Determinator: Software for the determination of sound power levels according to several Measurement methods including ISO 3744, 3746 and 8297.

Predictor and LimA can be used as separate stand-alone applications or as one integrated application by using the Analyst method in Predictor. Because Predictor and LimA both use the same fast LimA calculation cores, there is no difference in calculation speed or capacity.

The suite offers three implementations:

1. Predictor: For all calculation standards supported by Predictor. With the intuitive and powerful Predictor user interface, projects that require the calculation standards supported by Predictor, can be handled quickly and easily.
2. LimA: For calculation standards not supported by Predictor. In addition to the calculation standards supported by Predictor, LimA also supports German and Central European standards.
3. LimA integrated in other (GIS) systems: For implementing environmental noise calculation and analysis functionality in other systems. Modular and flexible, LimA is the preferred software for system integration.

Acoustic Determinator can be used as stand-alone software as well as in conjunction with Predictor and LimA.

FAST AND ACCURATE CALCULATIONS

Predictor and LimA use LimA calculation cores – Among the Fastest on the Market

Predictor and LimA use LimA's state-of-the-art calculation cores, which have been independently proven to be the fastest calculation cores available for Calculation of Road and Traffic Noise (CRTN) calculations. LimA calculation cores have a huge capacity, high calculation speed and support 64-bit systems, for even the most demanding tasks, providing results quickly while reducing your investment in computing power.

Accurate Calculations using the method of projection – Unique 3D Geometry Analysis

The 'method of projection' used in the LimA calculation cores is widely seen as the most accurate approach to source segmentation in environmental acoustics. Stapelfeldt introduced it to the market with LimA in 1989, and since then it has been included in all major commercial calculation software. Unlike other software, however, Predictor and LimA also apply this method for reflection analysis, so that this is also analysed in 3D. Another unique feature is the geometry analysis for lateral diffraction – this allows you to find the shortest sound path in complex 3D situations.

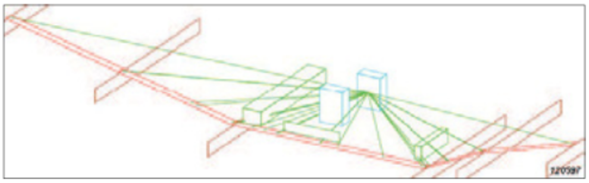


Fig. 1 The method of projection ensures correct segmentation (in 3D) into sections with the same propagation conditions. Results are less sensitive to small changes in receiver point position. These factors lead to more realistic results

Fast Learning Curve

Predictor has the most intuitive interface available. More than any other noise calculation software, Predictor has been designed according to the Windows® software design guide, helping you to be familiar with it from the very start. Predictor's intuitive interface and well organized project structure is designed to guide and support you, so you can spend your time more efficiently and focus on the project and not on the software. All scenarios and action plans are maintained within one Predictor project. This enables you to focus on your work and not spend valuable time searching for the correct files on the network.

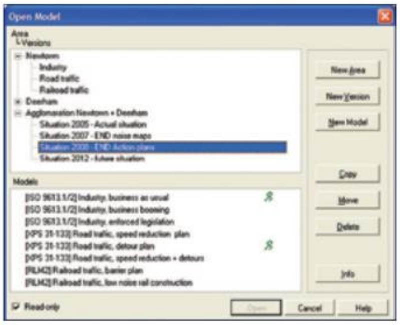


Fig. 2 *The unique Model Manager is the central point for all data access in a Predictor project*

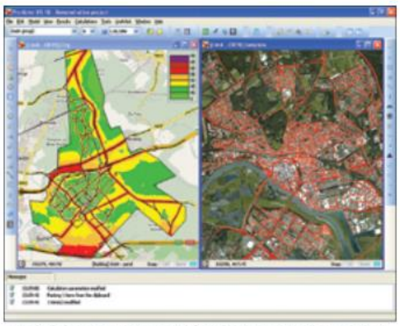


Fig. 3 *The intuitive multi-model view enables you to have several models open at the same time*

Accurate and Straightforward Modelling

Predictor's intuitive functionality, including powerful (GIS) import and 2D/3D edit options, will enable you to handle all kind of projects in an efficient manner. Complex situations with undulating terrain, flyovers, bridges and indoor/outdoor calculations, or large projects with hundreds of thousands of objects, can be set up just as easily and straightforwardly as a simple noise map for an industry or a stretch of road.

Time-saving Integrated Bookkeeping for Model Data and Results

Any noise calculation project comprises both input data and results, requiring a consistency between the two at all times, so that the results you report are what you modelled. To ensure this consistency, Predictor monitors the results at all times and new input data are validated immediately at entry time. This unique and automated validation feature not only reduces recalculation time but, more importantly, ensures that results are always up-to-date and consistent with the input data. This is unlike any other noise calculation software.

Powerful Result Analysis and What-if Scenarios

By using intuitive tables, Predictor ranks the individual noise sources (or groups of noise sources) on demand, clearly showing the importance of each source (or group of sources). Predictor immediately makes available what-if results, for example, "What if the speed of traffic is increased from 10 km/h to 100 km/h?" Or, "What happens if all exhaust ventilators are reduced by 6 dB?" This functionality enables rapid troubleshooting and notifications on noise reduction activities.

Integrated GIS functionality for demographic analysis

Within a Predictor project Analyst models can be created. An Analyst model enables you to obtain data that is required according to the EU Environmental Noise Directive without the need for an expensive GIS system. Cumulative and difference maps can be created. All maps can be confronted with demographic GIS data files to determine noise exposure (of people/ dwellings). Calculated results from different calculation software can be imported.

PREDICTOR USER INTERFACE EXAMPLES

Fig. 4 (Left) *Model view with multi-layer DXF background as snap option for items (buildings, roads etc.), enabling faster modelling*
Fig. 5 (Right) *Model view of Arnhem, Holland, with 70,000 buildings and 2500 roads on a satellite image as background*

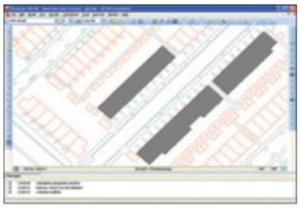
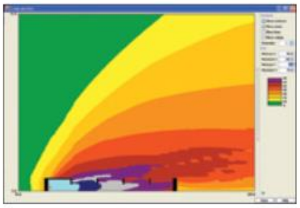


Fig. 6 (Left) *2D Cross section with noise contours of a shooting range with 3D source directivity and hanging barriers*
Fig. 7 (Right) *2D Cross section with noise contours of road with a cantilever barrier*



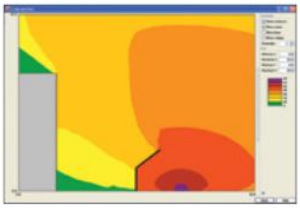
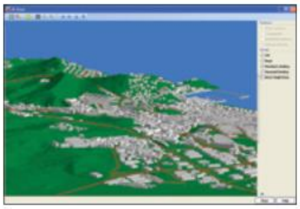


Fig. 8 (Left) *3D view of Blanes in Spain with terrain model. Items such as buildings are mapped on top of the terrain model making it easy to create real-life models from the input data*
Fig. 9 (Right) *3D view with vertical contours on the facades of buildings*



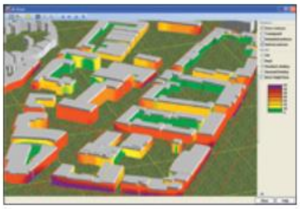
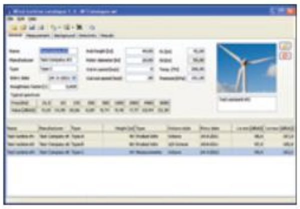
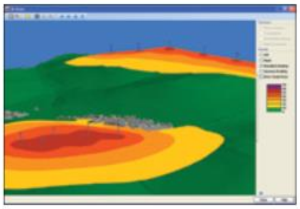


Fig. 10 (Left) *Wind turbine database with option to calculate sound power level based on IEC 61400-11. Equivalent sound power level at turbine height, calculated using various different parameters: turbine height, cut-in and cut- out speed, etc.*
Fig. 11 (Right) *3D model: wind turbine noise contours*





Insul

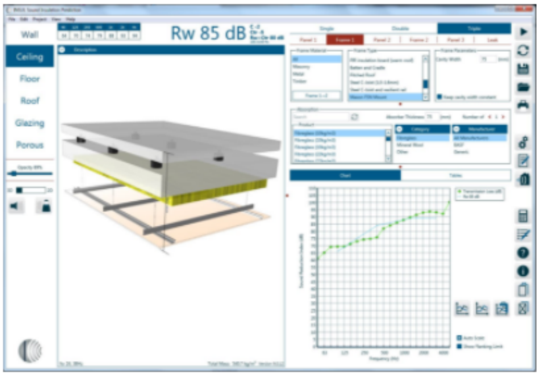
Predict transmission loss, impact sound, and rain noise

INSUL is a program for predicting the sound insulation of walls, floors, roofs, ceilings and windows. Impact sound and rain noise of floors and roof. The programme can make good estimates of the Transmission Loss (TL) or Impact Sound (Ln) in 1/3 octave bands and Weighted Sound Reduction Index (STC or Rw) or Impact Rating (IIC/LnTw) for use in noise transfer calculations or acoustical design or specification.

Evaluate material or design changes

INSUL can be used to quickly evaluate new materials and systems, or to investigate the effects of changes to existing designs. It models materials using well known elastic plate theory including allowances for thick panel effects as published by Ljunggren, Rindell and others. More complex partitions are modelled using work by Sharp, Cremer and others.

Constantly evolving



INSUL has been available for over 20 years, and has undergone considerable improvements over this time. It has evolved over many releases and into a very easy to use tool that takes advantage of the Windows and Mac environments, and has been refined by continued comparison with laboratory tests to provide acceptable accuracy for a wide range of constructions.

Test data can be entered for easy comparison with predictions and constructions can be saved for later recall.

INSUL takes account of finite size effects which are very important when predicting small samples such as windows and also for normal elements at low frequencies.

Like any prediction tool INSUL is not a substitute for measurement. However, comparisons with test data indicate that INSUL reliably predicts STC values to within 3dB for most constructions.

INSUL will greatly enhance the ability of acoustic consultants and product manufacturers to quickly and confidently specify constructions in order to achieve a desired airborne sound insulation.

Specify construction with speed & confidence

INSUL takes account of finite size effects which are very important when predicting small samples such as windows and also for normal elements at low frequencies.

Like any prediction tool INSUL is not a substitute for measurement. However, comparisons with test data indicate that INSUL reliably predicts STC values to within 3dB for most constructions.

INSUL will greatly enhance the ability of acoustic consultants and product manufacturers to quickly and confidently specify constructions in order to achieve a desired airborne sound insulation

Multi Lingual

INSUL can be switched to display information in English, French, German, Polish, Spanish, Swedish or Mandarin. The translation have been carried out by acoustic professionals so as to most closely suit the technical terms commonly used in each Country.

The materials databases can be filtered to include or exclude materials from UK, USA, Germany, France, Spain, Sweden, Poland, Middle East, Australia, New Zealand, Netherlands, Belgium, Italy, and Korea.

So INSUL is adapted to most regions in the world. The databases are updated regularly and feedback from users is always welcome to extend and improve the material selections.

Appendix 3 domestic flights

User ID	Airframe	Engine	Engine Mo	Equipment	Departure	Departure	Arrival Airp	Arrival Lay	Operation	Operation	Operation	Stage Leng	Aircraft Ty	Profile	Profile Typ	Track	Departure	Arrival Runway End
23C-RUN WAY 1	Airbus A320-200 Series	2CM018	NONE				HECA	HECA Defa	Arrival	########	77	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C-RUNWAY 1	Airbus A330-200 Series	CF680C	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C-RUNWAY1	Boeing 737-100 Series	1PW006	NONE				HECA	HECA Defa	Arrival	########	26	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C-RUNWAY1	Embraer EMB120 Brasilia	PW118	NONE				HECA	HECA Defa	Arrival	########	208	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23L-RUN WAY 3	Airbus A320-200 Series	2CM018	NONE				HECA	HECA Defa	Arrival	########	77	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L-RUNWAY 3	Airbus A330-200 Series	CF680C	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L-RUNWAY3	Boeing 737-100 Series	1PW006	NONE				HECA	HECA Defa	Arrival	########	26	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L-RUNWAY3	Embraer EMB120 Brasilia	PW118	NONE				HECA	HECA Defa	Arrival	########	208	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23R-RUN WAY 2	Airbus A320-200 Series	2CM018	NONE				HECA	HECA Defa	Arrival	########	77	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A		23R
23R-RUNWAY 2	Airbus A330-200 Series	CF680C	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A		23R
23R-RUNWAY2	Boeing 737-100 Series	1PW006	NONE				HECA	HECA Defa	Arrival	########	26	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A		23R
23R-RUNWAY2	Embraer EMB120 Brasilia	PW118	NONE				HECA	HECA Defa	Arrival	########	208	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A		23R
RUN WAY 1	Airbus A320-200 Series	2CM018	NONE				HECA	HECA Defa	Arrival	########	77	1	Fixed Wing	STANDARD	ANP	DEFAULT_05C_A		05C
RUN WAY 2	Airbus A320-200 Series	2CM018	NONE				HECA	HECA Defa	Arrival	########	77	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A		05R
RUN WAY 3	Airbus A320-200 Series	2CM018	NONE				HECA	HECA Defa	Arrival	########	77	1	Fixed Wing	STANDARD	ANP	DEFAULT_05L_A		05L
RUNWAY 1	Airbus A330-200 Series	CF680C	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_05C_A		05C
RUNWAY 2	Airbus A330-200 Series	CF680C	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A		05R
RUNWAY 3	Airbus A330-200 Series	CF680C	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_05L_A		05L
RUNWAY1	Boeing 737-100 Series	1PW006	NONE				HECA	HECA Defa	Arrival	########	26	1	Fixed Wing	STANDARD	ANP	DEFAULT_05C_A		05C
RUNWAY1	Embraer EMB120 Brasilia	PW118	NONE				HECA	HECA Defa	Arrival	########	208	1	Fixed Wing	STANDARD	ANP	DEFAULT_05C_A		05C
RUNWAY2	Boeing 737-100 Series	1PW006	NONE				HECA	HECA Defa	Arrival	########	26	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A		05R
RUNWAY2	Embraer EMB120 Brasilia	PW118	NONE				HECA	HECA Defa	Arrival	########	208	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A		05R
RUNWAY3	Boeing 737-100 Series	1PW006	NONE				HECA	HECA Defa	Arrival	########	26	1	Fixed Wing	STANDARD	ANP	DEFAULT_05L_A		05L
RUNWAY3	Embraer EMB120 Brasilia	PW118	NONE				HECA	HECA Defa	Arrival	########	208	1	Fixed Wing	STANDARD	ANP	DEFAULT_05L_A		05L

Appendix 4 International flights

User ID	Airframe	Engine	Engine Mo	Equipment	Departure	Departure	Arrival Airp	Arrival Lay	Operation	Operation	Operation	Stage Leng	Aircraft Ty	Profile	Profile Typ	Track	Departure	Arrival Runway
23C	Ilyushin 76	1AA005	NONE				HECA	HECA Defa	Arrival	########	3	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Boeing 707	1CM003	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	NOISEMAP	ANP	DEFAULT_23C_A		23C
23C	Boeing 737	1CM007	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Boeing 737	1PW004	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Boeing 737	1PW007	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Boeing 737	1PW007	NOR-LW				HECA	HECA Defa	Arrival	########	48	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Airbus A31	1PW032	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Boeing 777	1PW041	NONE				HECA	HECA Defa	Arrival	########	4	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Airbus A33	1PW049	NONE				HECA	HECA Defa	Arrival	########	3	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Boeing 767	1RR011	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Antonov 1	1ZM001	NONE				HECA	HECA Defa	Arrival	########	21	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Airbus A32	2CM012	NONE				HECA	HECA Defa	Arrival	########	15	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Airbus A32	2CM012	NONE				HECA	HECA Defa	Arrival	########	15	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Airbus A32	2CM018	NONE				HECA	HECA Defa	Arrival	########	63	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Airbus A30	2GE039	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Boeing 777	2PW061	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Boeing 777	3GE064	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Airbus A30	3GE076	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Airbus A33	4GE080	NONE				HECA	HECA Defa	Arrival	########	13	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Boeing 777	6GE089	NONE				HECA	HECA Defa	Arrival	########	10	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Boeing 777	6GE090	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Boeing 777	7GE097	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Airbus A31	7PW083	NONE				HECA	HECA Defa	Arrival	########	5	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Boeing 777	9GE120	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Airbus A33	CF680C	NONE				HECA	HECA Defa	Arrival	########	13	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Eclipse 500	PW610F-A	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Antonov 3	T56-1	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23C	Boeing 707	TF3310	TF33-PW-100A				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	NOISEMAP	ANP	DEFAULT_23C_A		23C
23C	Lockheed	TF3440	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	NOISEMAP	ANP	DEFAULT_23C_A		23C
23C	BAE Jetstre	TP10UK	NONE				HECA	HECA Defa	Arrival	########	7	1	Fixed Wing	STANDARD	ANP	DEFAULT_23C_A		23C
23L	Ilyushin 76	1AA005	NONE				HECA	HECA Defa	Arrival	########	3	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L	Boeing 707	1CM003	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	NOISEMAP	ANP	DEFAULT_23L_A		23L
23L	Boeing 737	1CM007	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L	Boeing 737	1PW004	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L	Boeing 737	1PW006	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L	Boeing 737	1PW007	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L	Boeing 737	1PW007	NOR-LW				HECA	HECA Defa	Arrival	########	48	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L	Airbus A31	1PW032	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L	Boeing 777	1PW041	NONE				HECA	HECA Defa	Arrival	########	4	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L	Airbus A33	1PW049	NONE				HECA	HECA Defa	Arrival	########	3	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L	Boeing 767	1RR011	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L	Antonov 1	1ZM001	NONE				HECA	HECA Defa	Arrival	########	21	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L	Airbus A32	2CM012	NONE				HECA	HECA Defa	Arrival	########	15	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L	Airbus A32	2CM018	NONE				HECA	HECA Defa	Arrival	########	63	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L	Airbus A30	2GE039	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L	Boeing 777	2PW061	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L	Boeing 777	3GE064	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L	Airbus A30	3GE076	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L	Airbus A33	4GE080	NONE				HECA	HECA Defa	Arrival	########	13	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L	Boeing 777	6GE089	NONE				HECA	HECA Defa	Arrival	########	10	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L	Boeing 777	6GE090	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L
23L	Boeing 777	7GE097	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A		23L

23L	Airbus A31	7PW083	NONE				HECA	HECA Defa	Arrival	########	5	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A	23L
23L	Boeing 777	9GE120	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A	23L
23L	Airbus A33	CF680C	NONE				HECA	HECA Defa	Arrival	########	13	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A	23L
23L	Eclipse 500	PW610F-A	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A	23L
23L	Antonov 3	T56-1	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A	23L
23L	Boeing 707	TF3310	TF33-PW-100A				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	NOISEMAP	ANP	DEFAULT_23L_A	23L
23L	Lockheed S	TF3440	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	NOISEMAP	ANP	DEFAULT_23L_A	23L
23L	BAE Jetstre	TP10UK	NONE				HECA	HECA Defa	Arrival	########	7	1	Fixed Wing	STANDARD	ANP	DEFAULT_23L_A	23L
23R	Ilyushin 76	1AA005	NONE				HECA	HECA Defa	Arrival	########	3	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Boeing 707	1CM003	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	NOISEMAP	ANP	DEFAULT_23R_A	23R
23R	Boeing 737	1CM007	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Boeing 737	1PW004	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Boeing 737	1PW006	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Boeing 737	1PW007	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Boeing 737	1PW007	NOR-LW				HECA	HECA Defa	Arrival	########	48	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Airbus A31	1PW032	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Boeing 777	1PW041	NONE				HECA	HECA Defa	Arrival	########	4	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Airbus A33	1PW049	NONE				HECA	HECA Defa	Arrival	########	3	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Boeing 767	1RR011	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Antonov 1	1ZM001	NONE				HECA	HECA Defa	Arrival	########	21	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Airbus A32	2CM012	NONE				HECA	HECA Defa	Arrival	########	15	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Airbus A32	2CM018	NONE				HECA	HECA Defa	Arrival	########	63	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Airbus A30	2GE039	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Boeing 777	2PW061	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Boeing 777	3GE064	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Airbus A30	3GE076	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Airbus A33	4GE080	NONE				HECA	HECA Defa	Arrival	########	13	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Boeing 777	6GE089	NONE				HECA	HECA Defa	Arrival	########	10	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Boeing 777	6GE090	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Boeing 777	7GE097	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Airbus A31	7PW083	NONE				HECA	HECA Defa	Arrival	########	5	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Boeing 777	9GE120	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Airbus A33	CF680C	NONE				HECA	HECA Defa	Arrival	########	13	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Eclipse 500	PW610F-A	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Antonov 3	T56-1	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
23R	Boeing 707	TF3310	TF33-PW-100A				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	NOISEMAP	ANP	DEFAULT_23R_A	23R
23R	Lockheed S	TF3440	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	NOISEMAP	ANP	DEFAULT_23R_A	23R
23R	BAE Jetstre	TP10UK	NONE				HECA	HECA Defa	Arrival	########	7	1	Fixed Wing	STANDARD	ANP	DEFAULT_23R_A	23R
c	Airbus A30	2GE039	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_05C_A	05C
c	Boeing 777	2PW061	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_05C_A	05C
c	Boeing 777	9GE120	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_05C_A	05C
c	Lockheed S	TF3440	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	NOISEMAP	ANP	DEFAULT_05C_A	05C
C	Ilyushin 76	1AA005	NONE				HECA	HECA Defa	Arrival	########	3	1	Fixed Wing	STANDARD	ANP	DEFAULT_05C_A	05C
C	Boeing 707	1CM003	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	NOISEMAP	ANP	DEFAULT_05C_A	05C
C	Boeing 737	1CM007	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_05C_A	05C
C	Boeing 737	1PW004	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_05C_A	05C
C	Boeing 737	1PW006	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_05C_A	05C
C	Boeing 737	1PW007	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_05C_A	05C
C	Boeing 737	1PW007	NOR-LW				HECA	HECA Defa	Arrival	########	48	1	Fixed Wing	STANDARD	ANP	DEFAULT_05C_A	05C
C	Airbus A31	1PW032	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_05C_A	05C
C	Boeing 777	1PW041	NONE				HECA	HECA Defa	Arrival	########	4	1	Fixed Wing	STANDARD	ANP	DEFAULT_05C_A	05C
C	Airbus A33	1PW049	NONE				HECA	HECA Defa	Arrival	########	3	1	Fixed Wing	STANDARD	ANP	DEFAULT_05C_A	05C
C	Boeing 767	1RR011	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_05C_A	05C

C	Antonov 1	1ZM001	NONE				HECA	HECA Defa	Arrival	########	21	1	Fixed Win	STANDARD	ANP	DEFAULT_05C_A	05C
C	Airbus A32	2CM012	NONE				HECA	HECA Defa	Arrival	########	15	1	Fixed Win	STANDARD	ANP	DEFAULT_05C_A	05C
C	Airbus A32	2CM018	NONE				HECA	HECA Defa	Arrival	########	63	1	Fixed Win	STANDARD	ANP	DEFAULT_05C_A	05C
C	Boeing 777	3GE064	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	STANDARD	ANP	DEFAULT_05C_A	05C
C	Airbus A30	3GE076	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Win	STANDARD	ANP	DEFAULT_05C_A	05C
C	Airbus A33	4GE080	NONE				HECA	HECA Defa	Arrival	########	13	1	Fixed Win	STANDARD	ANP	DEFAULT_05C_A	05C
C	Boeing 777	6GE089	NONE				HECA	HECA Defa	Arrival	########	10	1	Fixed Win	STANDARD	ANP	DEFAULT_05C_A	05C
C	Boeing 777	6GE090	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	STANDARD	ANP	DEFAULT_05C_A	05C
C	Boeing 777	7GE097	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	STANDARD	ANP	DEFAULT_05C_A	05C
C	Airbus A31	7PW083	NONE				HECA	HECA Defa	Arrival	########	5	1	Fixed Win	STANDARD	ANP	DEFAULT_05C_A	05C
C	Airbus A33	CF680C	NONE				HECA	HECA Defa	Arrival	########	13	1	Fixed Win	STANDARD	ANP	DEFAULT_05C_A	05C
C	Eclipse 500	PW610F-A	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	STANDARD	ANP	DEFAULT_05C_A	05C
C	Antonov 3	T56-1	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Win	STANDARD	ANP	DEFAULT_05C_A	05C
C	Boeing 707	TF3310	TF33-PW-100A				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	NOISEMAP	ANP	DEFAULT_05C_A	05C
C	BAE Jetstre	TP10UK	NONE				HECA	HECA Defa	Arrival	########	7	1	Fixed Win	STANDARD	ANP	DEFAULT_05C_A	05C
L	Ilyushin 76	1AA005	NONE				HECA	HECA Defa	Arrival	########	3	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Boeing 707	1CM003	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	NOISEMAP	ANP	DEFAULT_05L_A	05L
L	Boeing 737	1CM007	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Boeing 737	1PW004	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Boeing 737	1PW006	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Boeing 737	1PW007	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Boeing 737	1PW007	NOR-LW				HECA	HECA Defa	Arrival	########	48	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Airbus A31	1PW032	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Boeing 777	1PW041	NONE				HECA	HECA Defa	Arrival	########	4	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Airbus A33	1PW049	NONE				HECA	HECA Defa	Arrival	########	3	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Boeing 767	1RR011	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Antonov 1	1ZM001	NONE				HECA	HECA Defa	Arrival	########	21	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Airbus A32	2CM012	NONE				HECA	HECA Defa	Arrival	########	15	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Airbus A32	2CM018	NONE				HECA	HECA Defa	Arrival	########	63	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Airbus A30	2GE039	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Boeing 777	2PW061	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Boeing 777	3GE064	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Airbus A30	3GE076	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Airbus A33	4GE080	NONE				HECA	HECA Defa	Arrival	########	13	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Boeing 777	6GE089	NONE				HECA	HECA Defa	Arrival	########	10	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Boeing 777	6GE090	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Boeing 777	7GE097	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Airbus A31	7PW083	NONE				HECA	HECA Defa	Arrival	########	5	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Boeing 777	9GE120	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Airbus A33	CF680C	NONE				HECA	HECA Defa	Arrival	########	13	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Eclipse 500	PW610F-A	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Antonov 3	T56-1	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
L	Boeing 707	TF3310	TF33-PW-100A				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	NOISEMAP	ANP	DEFAULT_05L_A	05L
L	Lockheed S	TF3440	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Win	NOISEMAP	ANP	DEFAULT_05L_A	05L
L	BAE Jetstre	TP10UK	NONE				HECA	HECA Defa	Arrival	########	7	1	Fixed Win	STANDARD	ANP	DEFAULT_05L_A	05L
R	Ilyushin 76	1AA005	NONE				HECA	HECA Defa	Arrival	########	3	1	Fixed Win	STANDARD	ANP	DEFAULT_05R_A	05R
R	Boeing 707	1CM003	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	NOISEMAP	ANP	DEFAULT_05R_A	05R
R	Boeing 737	1CM007	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	STANDARD	ANP	DEFAULT_05R_A	05R
R	Boeing 737	1PW004	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	STANDARD	ANP	DEFAULT_05R_A	05R
R	Boeing 737	1PW006	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	STANDARD	ANP	DEFAULT_05R_A	05R
R	Boeing 737	1PW007	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	STANDARD	ANP	DEFAULT_05R_A	05R
R	Boeing 737	1PW007	NOR-LW				HECA	HECA Defa	Arrival	########	48	1	Fixed Win	STANDARD	ANP	DEFAULT_05R_A	05R
R	Airbus A31	1PW032	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Win	STANDARD	ANP	DEFAULT_05R_A	05R

R	Boeing 777	1PW041	NONE				HECA	HECA Defa	Arrival	########	4	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A	05R
R	Airbus A33	1PW049	NONE				HECA	HECA Defa	Arrival	########	3	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A	05R
R	Boeing 767	1RR011	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A	05R
R	Antonov 14	1ZM001	NONE				HECA	HECA Defa	Arrival	########	21	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A	05R
R	Airbus A32	2CM012	NONE				HECA	HECA Defa	Arrival	########	15	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A	05R
R	Airbus A32	2CM018	NONE				HECA	HECA Defa	Arrival	########	63	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A	05R
R	Airbus A30	2GE039	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A	05R
R	Boeing 777	2PW061	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A	05R
R	Boeing 777	3GE064	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A	05R
R	Airbus A30	3GE076	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A	05R
R	Airbus A33	4GE080	NONE				HECA	HECA Defa	Arrival	########	13	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A	05R
R	Boeing 777	6GE089	NONE				HECA	HECA Defa	Arrival	########	10	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A	05R
R	Boeing 777	6GE090	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A	05R
R	Boeing 777	7GE097	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A	05R
R	Airbus A31	7PW083	NONE				HECA	HECA Defa	Arrival	########	5	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A	05R
R	Boeing 777	9GE120	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A	05R
R	Airbus A33	CF680C	NONE				HECA	HECA Defa	Arrival	########	13	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A	05R
R	Eclipse 500	PW610F-A	NONE				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A	05R
R	Antonov 32	T56-1	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A	05R
R	Boeing 707	TF3310	TF33-PW-100A				HECA	HECA Defa	Arrival	########	1	1	Fixed Wing	NOISEMAP	ANP	DEFAULT_05R_A	05R
R	Lockheed S	TF3440	NONE				HECA	HECA Defa	Arrival	########	2	1	Fixed Wing	NOISEMAP	ANP	DEFAULT_05R_A	05R
R	BAE Jetstre	TP10UK	NONE				HECA	HECA Defa	Arrival	########	7	1	Fixed Wing	STANDARD	ANP	DEFAULT_05R_A	05R

Appendix 5 device setting

Measurement conditions

weather conditions

- Measurements were not being carried out during wind of velocity of 5 or more ,or during rain.

- Daily weather conditions during the measurement period (temperature, humidity, wind direction and wind velocity) were recorded.

Microphone locations

- Measurements were taken at an elevation of 1.5 meter above the ground.

- During the measurement, the Sound Level Meter was mounted on a tripod and the operator was at a proper distance in order to minimize the interferences with the noise field.
- The microphone (free-field type) was oriented towards the main noise source. For the measure carried out at boundary fence, the microphone was oriented towards the Plant forming a right angle with the boundary fence.

- A microphone windshield was used for all measurements to ensure that the effects of any wind turbulence are minimized.

- The microphone was always placed so that it is protected from air currents, vibrations, electric or magnetic fields, and other influences that might affect the noise Level reading.

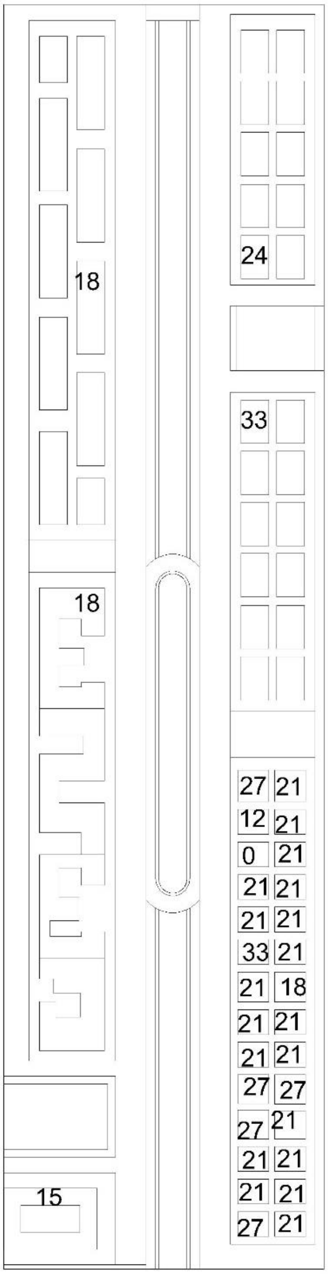
Measurement locations

- Measurements were carried out in different location within the four selected zone.
- All measurement locations were clearly marked on a map with GIS coordinates at this report

Measurement *duration*

- Day and night measurement in one point in each location for 5 min
- Event measurement during aircraft for 2 min

Appendix 6 Detailed height map



Appendix 7 noise guidelines required by EEAA

Zone type	Permissible limit	
	Day from (7 AM to 10 PM)	At night (from 10 pm to 7 am)
An area with sensitivity to noise (such as hospitals, schools, libraries and parks).	50 dB	40 dB
Residential suburbs with little traffic and limited service activities.	55 dB	45 dB
Residential areas in the city with commercial activities.	60 dB	50 dB
Residential areas located on roads of less than 12 meters, with some workshops, commercial activities, administrative activities, recreational activities, or amusement parks.	65 dB	55 dB
Areas located on roads 12 meters or more wide, or industrial areas with light industries and some other activities.	70 dB	60 dB
An industrial zone with heavy industries.	70 dB	70 dB

Appendix 8 Day measurement

Table 1 Day Measurements location GPS,Source:Author

Measurement	Latitude	Longitude
M01	30° 4' 45.012" N	31° 22' 24.168" E
M02	30° 4' 3.324" N	31° 21' 37.692" E
M03	30° 8' 21.192" N	31° 23' 50.856" E
M04	30° 6' 17.028" N	31° 22' 12.864" E
M05	30° 4' 43.032" N	31° 22' 21.972" E
M06	30° 4' 42.924" N	31° 22' 21.864" E

POINT (1)

Measurement Data			
Date: 29/5/2021	Time: 7:28:25 PM	Duration: 00:05:00	Leq: 77.42 dB (A)

Weather Condition				
Wind: 3.5 m/s	Direction: NE	Temp: 30 ^{o}C	Humidity: 58 %	Precipitation: 0

Measurement Apparatus		
Sound Level Meter B&K 2245	Serial number: 100418	Certificate of calibration n^{o} **121/2020**
Microphone	Serial number: 3236964	
Calibrator B&K 4321	Serial number: 1839253	Certificate of calibration n^{o} **122/220**

Coord. GPS

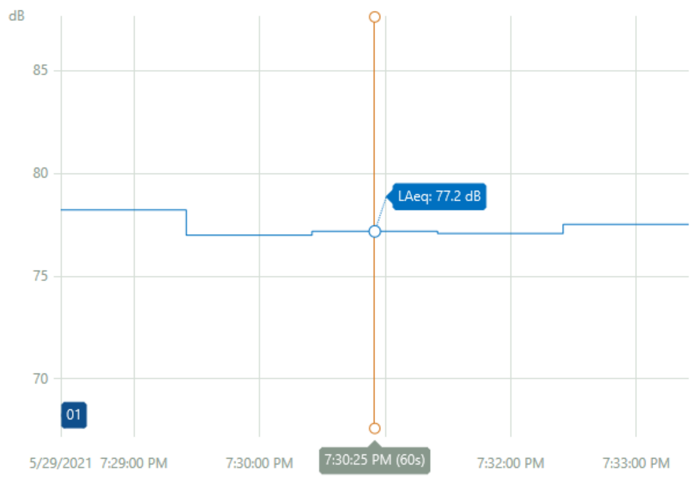
Latitude	Longitude
30° 4' 45.012" N	31° 22' 24.168" E

Leq dB (A)	L10 dB (A)	L50 dB (A)	L90 dB (A)
77.42	79.21	76.93	74.8

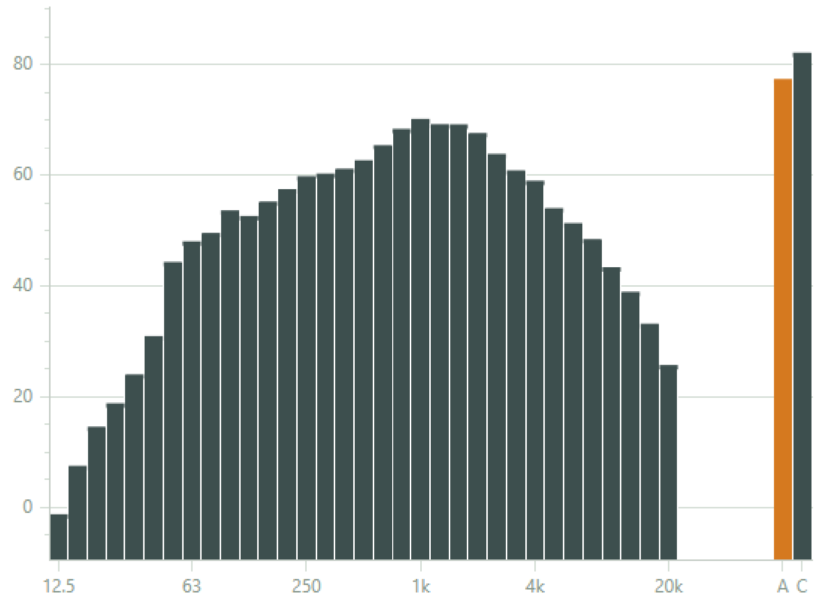
Google earth location

Photo of measurement point

Time History of Leq (A)



Leq(A) Spectrum 1/3 Octave Bands



Notes:

.
- Electricity hospital on suez road which is considered an area with sensitivity to noise (such as hospitals, schools, libraries and parks) so sound level required is 50 dB   375 car /5min   3 buses   5 mini bus   - Cars speed 60/70 km/hour   - Noise limit is above required

POINT (2)

Measurement Data			
Date: 29/5/2021	Time: 7:54:28 PM	Duration: 00:05:00	Leq: 73.81 dB (A)

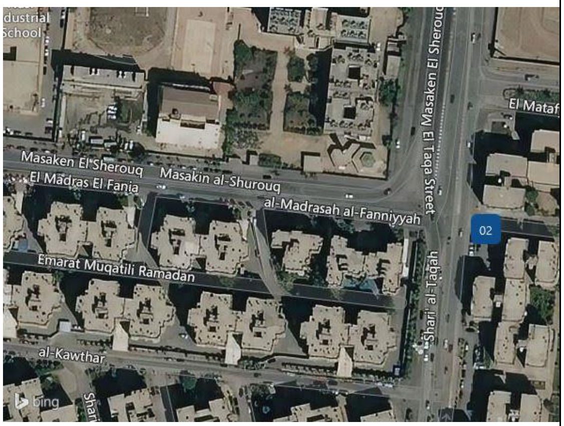
Weather Condition				
Wind: 3.5 m/s	Direction: NE	Temp: 30 ^{o}C	Humidity: 58 %	Precipitation: 0

Measurement Apparatus		
Sound Level Meter B&K 2245	Serial number: 100418	Certificate of calibration nº **121/2020**
Microphone	Serial number: 3236964	
Calibrator B&K 4321	Serial number: 1839253	Certificate of calibration nº **122/220**

Coord. GPS

Latitude	Longitude
30° 4' 3.324" N	31° 21' 37.692" E

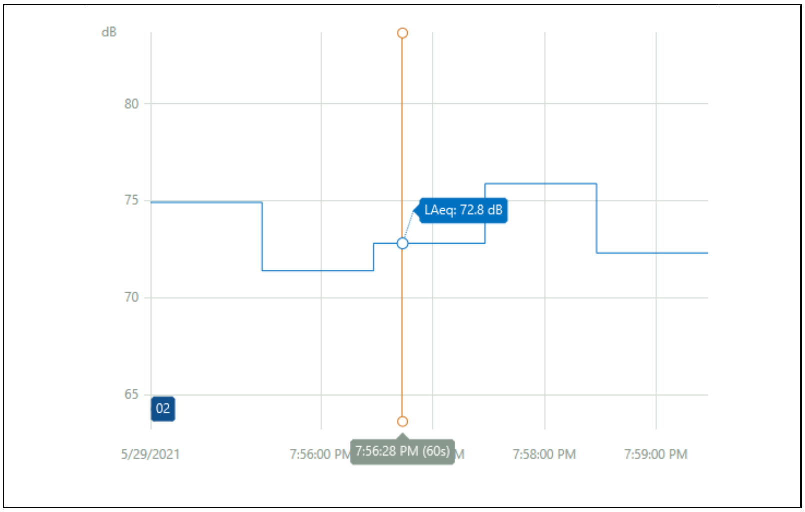
Leq dB (A)	L10 dB (A)	L50 dB (A)	L90 dB (A)
73.81	75.51	70.56	66.22



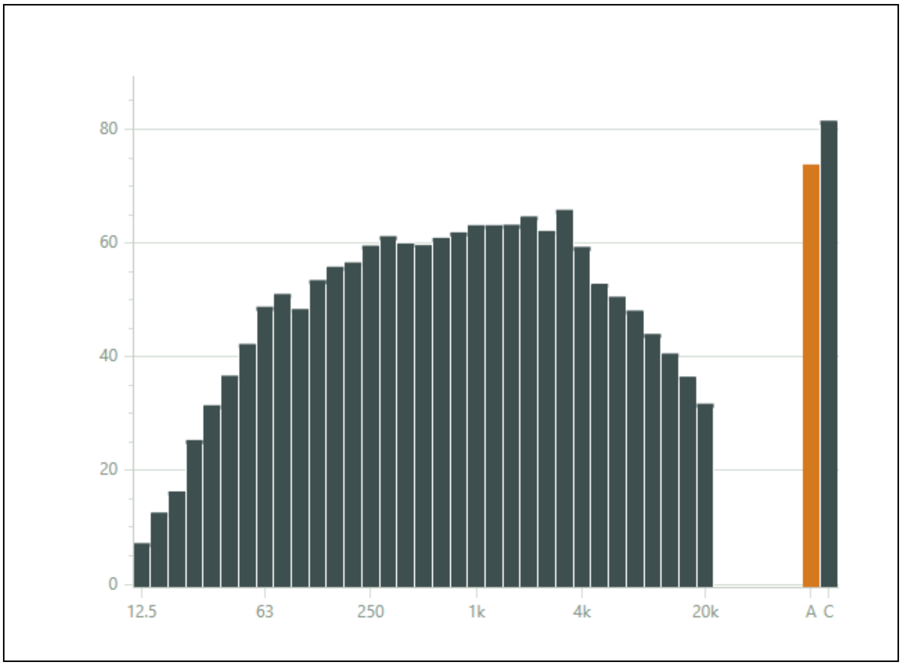
Google earth location

photo of measurement point

Time History of Leq (A)



Leq(A) Spectrum 1/3 Octave Bands



Notes:

.
- Residential area near Al AHLY club which is Residential areas in the city with commercial activities so sound level required is 60 dB   120 car /5min   - Cars speed 55/60 km/hour   - Noise limit is above required

POINT (3)

Measurement Data			
Date: 29/5/2021	Time: 8:18:55 PM	Duration: 00:05:00	Leq: 77.55 dB (A)

Weather Condition				
Wind: 3.5 m/s	Direction: NE	Temp: 30 ^{o}C	Humidity: 58 %	Precipitation: 0

Measurement Apparatus		
Sound Level Meter B&K 2245	Serial number: 100418	Certificate of calibration nº **121/2020**
Microphone	Serial number: 3236964	
Calibrator B&K 4321	Serial number: 1839253	Certificate of calibration nº **122/220**

Coord. GPS

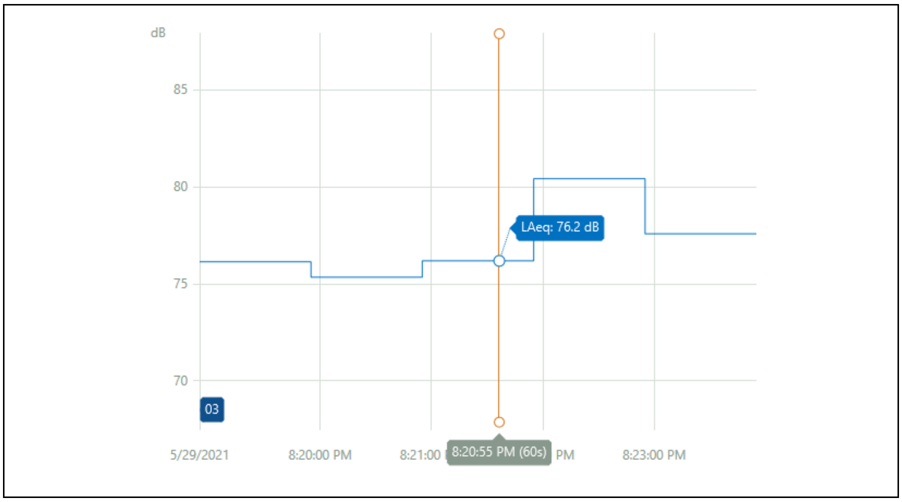
Latitude	Longitude
30° 8' 21.192" N	31° 23' 50.856" E

Leq dB (A)	L10 dB (A)	L50 dB (A)	L90 dB (A)
77.55	78.67	75.69	73.17

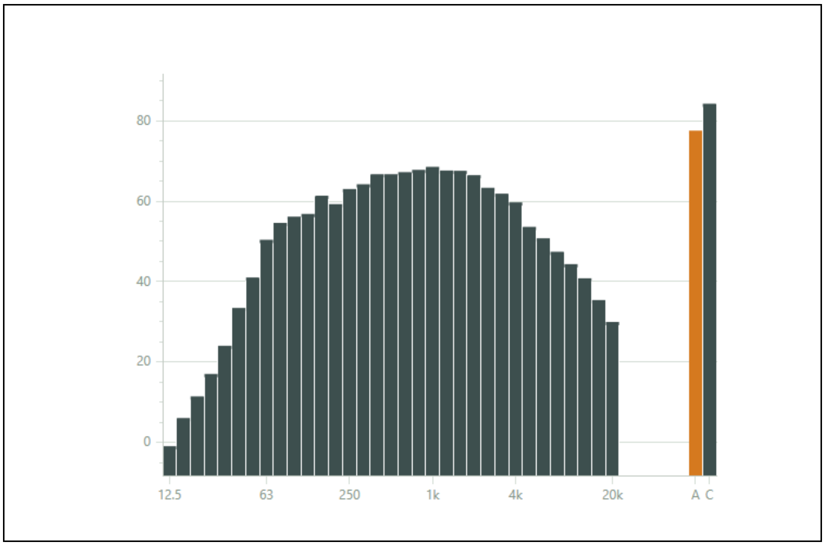
Google earth location

Photo of measurement point

Time History of Leq (A)



Leq(A) Spectrum 1/3 Octave Bands



Notes:

.
- Workshops area on Ismailia road which is Areas located on roads 12 meters or more wide, or industrial areas with light industries and some other activities so sound level required is 70 dB   319 car /5min   - Cars speed 65/70 km/hour   - Noise limit is above required

POINT (4)

Measurement Data			
Date: 29/5/2021	Time: 8:34:08 PM	Duration: 00:05:00	Leq: 69.06 dB (A)

Weather Condition				
Wind: 3.5 m/s	Direction: NE	Temp: 30 ^{o}C	Humidity: 58 %	Precipitation: 0

Measurement Apparatus		
Sound Level Meter B&K 2245	Serial number: 100418	Certificate of calibration n^{o} **121/2020**
Microphone	Serial number: 3236964	
Calibrator B&K 4321	Serial number: 1839253	Certificate of calibration n^{o} **122/220**

Coord. GPS

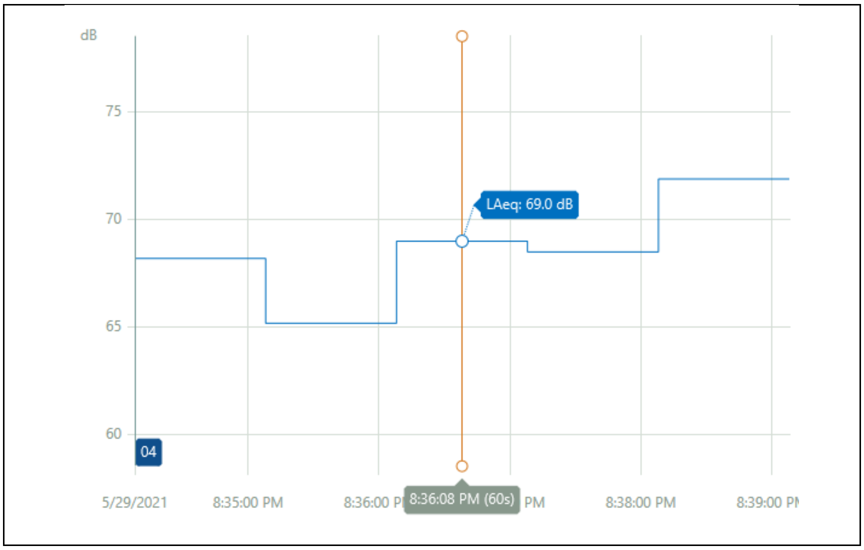
Latitude	Longitude
30° 6' 17.028" N	31° 22' 12.864" E

Leq dB (A)	L10 dB (A)	L50 dB (A)	L90 dB (A)
69.06	71.63	65.6	58.94

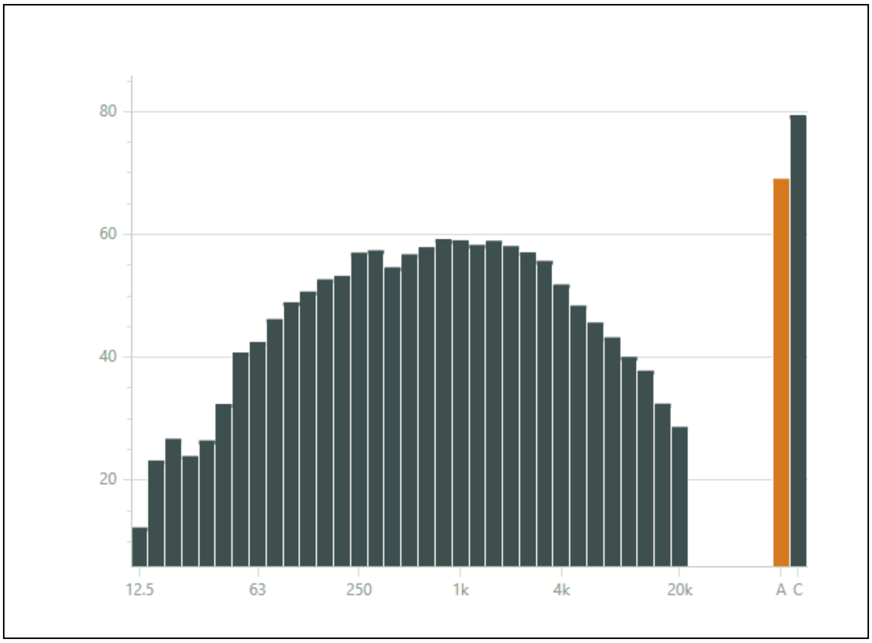
Google earth location

Photo of measurement point

Time History of Leq (A)



Leq(A) Spectrum 1/3 Octave Bands



Notes:

.
- Residential area in Sheraton Heliopolis which is Residential areas with little traffic and limited service activities so sound level required is 55 dB   90 car /5min   1 Bus   - Cars speed 50/55 km/hour   - Noise limit is above required

POINT (5)

Measurement Data			
Date: 29/5/2021	Time: 9:02:32 PM	Duration: 00:02:00	Leq: 80.01 dB (A)

Weather Condition				
Wind: 3.5 m/s	Direction: NE	Temp: 30 ^{o}C	Humidity: 58 %	Precipitation: 0

Measurement Apparatus		
Sound Level Meter B&K 2245	Serial number: 100418	Certificate of calibration n^{o} **121/2020**
Microphone	Serial number: 3236964	
Calibrator B&K 4321	Serial number: 1839253	Certificate of calibration n^{o} **122/220**

Coord. GPS

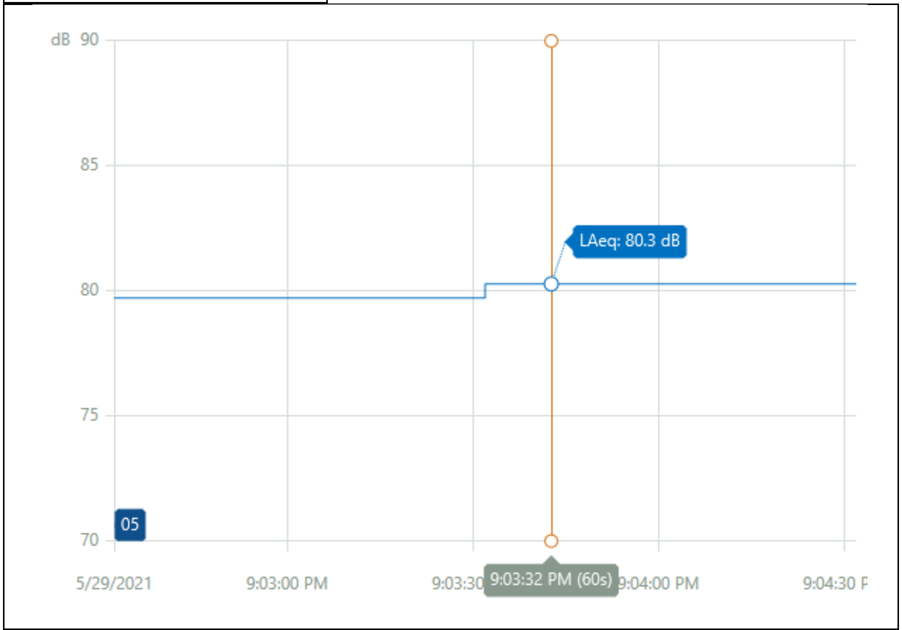
Latitude	Longitude
30° 4' 43.032" N	31° 22' 21.972" E

Leq dB (A)	L10 dB (A)	L50 dB (A)	L90 dB (A)
80.01	81.65	77.59	75.33

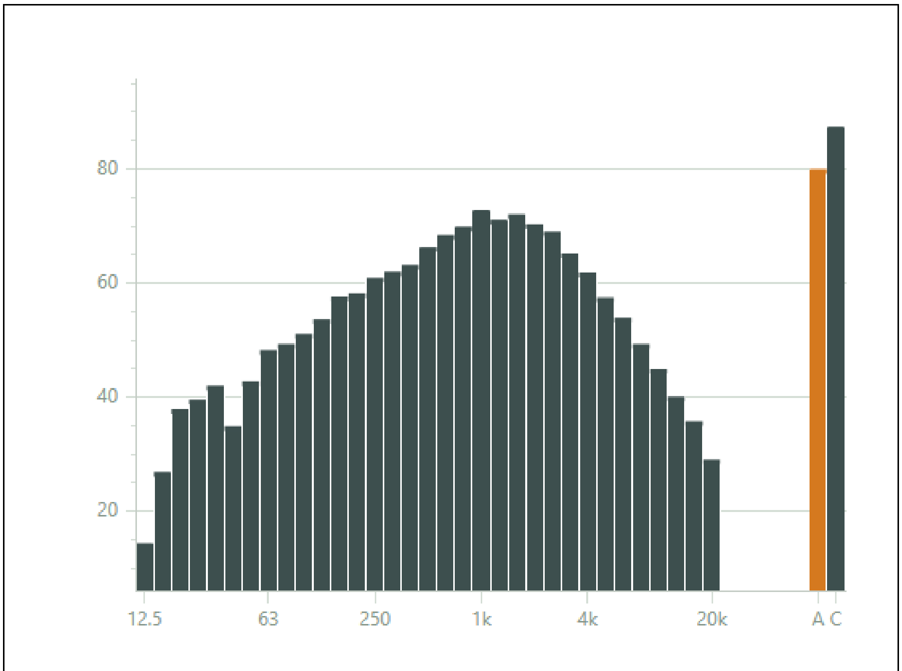
Google earth location

Photo of measurement point

Time History of Leq (A)



Leq(A) Spectrum 1/3 Octave Bands



Notes:

.
- Workshops area on Ismailia road which is Areas located on roads 12 meters or more wide, or industrial areas with light industries and some other activities so sound level required is 70 dB   - Aircraft was passing during measurements.   - Noise limit is above required

POINT (6)

Measurement Data			
Date: 29/5/2021	Time: 9:04:50 PM	Duration: 00:02:00	Leq: 79.43dB (A)

Weather Condition				
Wind: 3.5 m/s	Direction: NE	Temp: 30 ^{o}C	Humidity: 58 %	Precipitation: 0

Measurement Apparatus		
Sound Level Meter B&K 2245	Serial number: 100418	Certificate of calibration nº **121/2020**
Microphone	Serial number: 3236964	
Calibrator B&K 4321	Serial number: 1839253	Certificate of calibration nº **122/220**

Coord. GPS

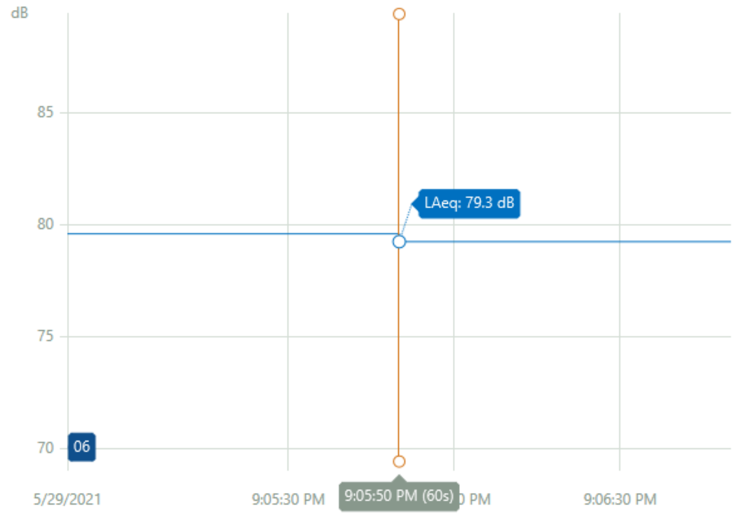
Latitude	Longitude
30° 4' 42.924" N	31° 22' 21.864" E

Leq dB (A)	L10 dB (A)	L50 dB (A)	L90 dB (A)
79.43	81.18	77.97	76.04

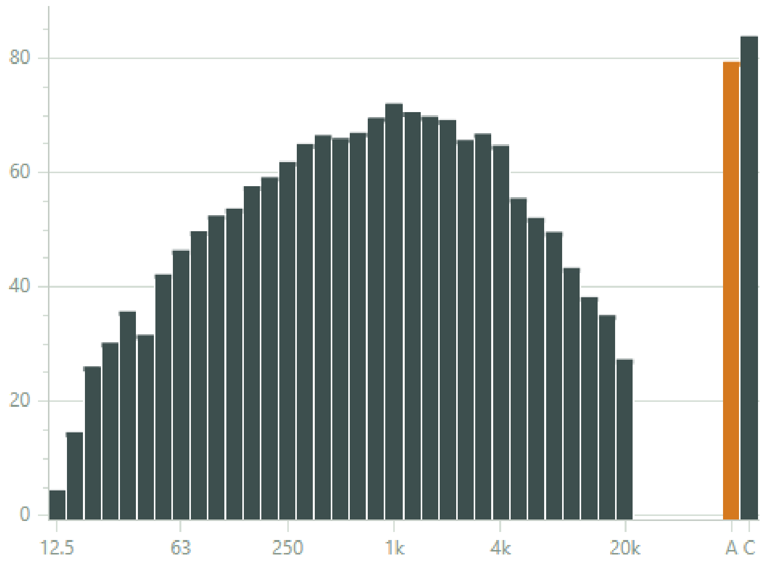
Google earth location

Photo of measurement point

Time History of Leq (A)



Leq(A) Spectrum 1/3 Octave Bands



Notes:

.
- Workshops area on Ismailia road which is Areas located on roads 12 meters or more wide, or industrial areas with light industries and some other activities so sound level required is 70 dB   - Aircraft was passing during measurements.   - Noise limit is above required

Appendix 9 Night measurement

Table 2 Night Measurements location GPS, source: Author

Measurement	Latitude	Longitude
M01	30° 8' 17.5266" N	31° 23' 42.9612"E
M02	30° 6' 16.9596"N	31° 22' 12.7158"E
M03	30° 4' 0.876" N	31° 21' 37.227"E
M04	30° 4' 44.7384"N	31° 22' 23.7642"E

POINT (1)

Measurement Data			
Date: 1/6/2021	Time: 10:00:51 PM	Duration: 00:05:00	Leq: 80.44 dB (A)

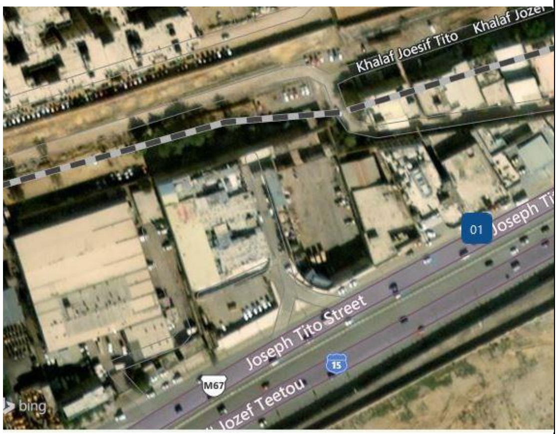
Weather Condition				
Wind: 4 m/s	Direction: NE	Temp: 25 ^{o}C	Humidity: 56 %	Precipitation: 0

Measurement Apparatus		
Sound Level Meter B&K 2245	Serial number: 100418	Certificate of calibration n^{o} **121/2020**
Microphone	Serial number: 3236964	
Calibrator B&K 4321	Serial number: 1839253	Certificate of calibration n^{o} **122/220**

Coord. GPS

Latitude	Longitude
30° 8' 17.5266" N	31° 23' 42.9612"E

Leq dB (A)	L10 dB (A)	L50 dB (A)	L90 dB (A)
80.44	82.15	78.04	74.14



Google earth location

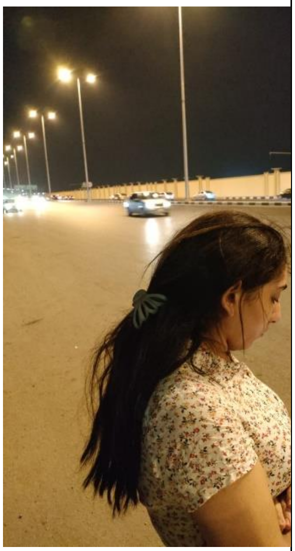
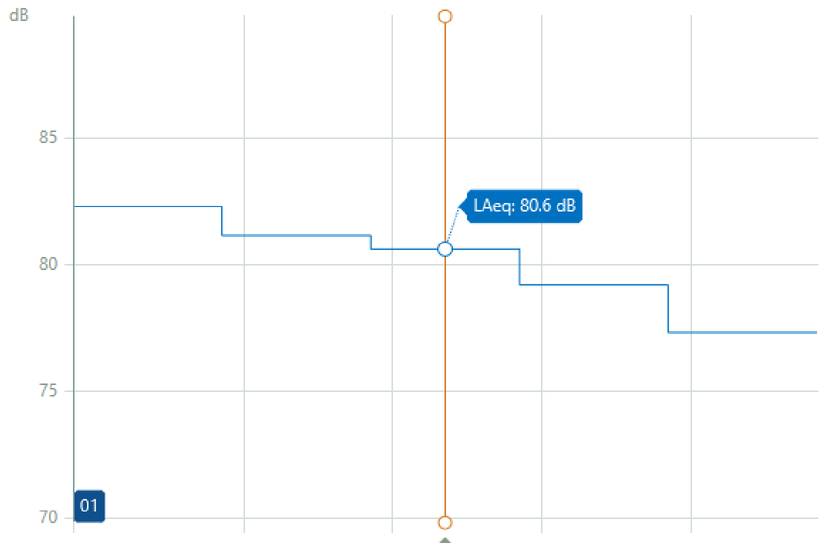
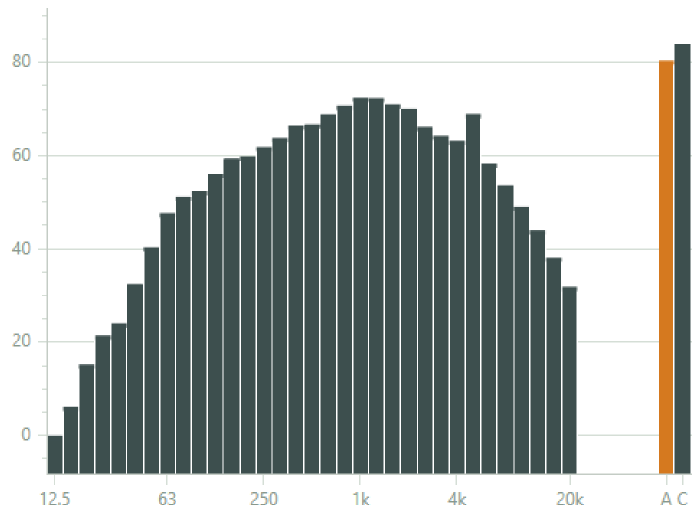


Photo of measurement point

Time History of Leq (A)



Leq(A) Spectrum 1/3 Octave Bands



Notes:

.
• Workshops area on Ismailia road which is Areas located on roads 12 meters or more wide, or industrial areas with light industries and some other activities so sound level required is 60 dB • 230 car /5min • 5 buses • 4 mini buses • Cars speed 65/70 km/hour • Noise limit is above required

POINT (2)

Measurement Data			
Date: 1/6/2021	Time: 10:19:27 PM	Duration: 00:05:00	Leq: 68.82 dB (A)

Weather Condition				
Wind: 4 m/s	Direction: NE	Temp: 25 ºC	Humidity: 56 %	Precipitation: 0

Measurement Apparatus		
Sound Level Meter B&K 2245	Serial number: 100418	Certificate of calibration nº **121/2020**
Microphone	Serial number: 3236964	
Calibrator B&K 4321	Serial number: 1839253	Certificate of calibration nº **122/220**

Coord. GPS

Latitude	Longitude
30° 6' 16.9596"N	31° 22' 12.7158"E

Leq dB (A)	L10 dB (A)	L50 dB (A)	L90 dB (A)
68.82	70.85	64.73	60.15

Google earth location

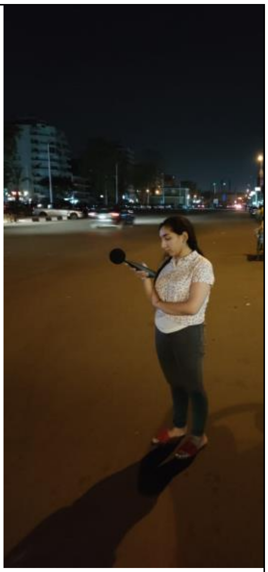
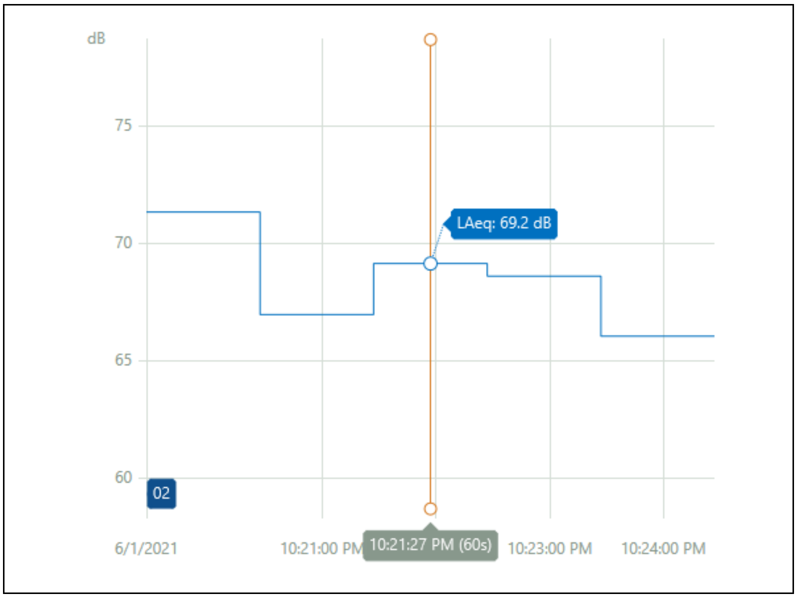
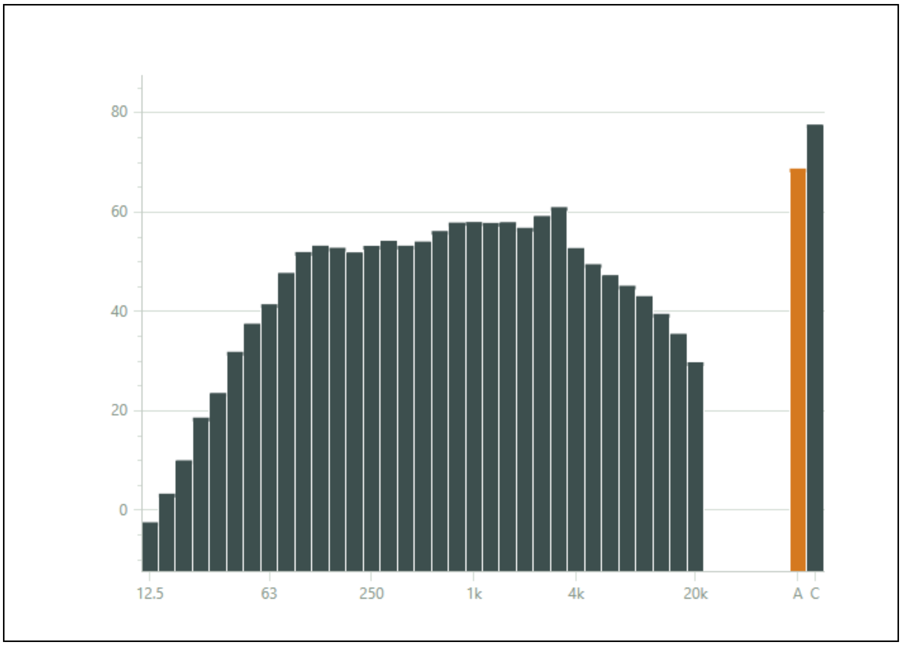


Photo of measurement point

Time History of Leq (A)



Leq(A) Spectrum 1/3 Octave Bands



Notes:

.
- Residential area in Sheraton Heliopolis which is Residential areas with little traffic and limited service activities so sound level required is 45 dB   70 car /5min   8 motorcycle   - Cars speed 50/55 km/hour   - Noise limit is above required

POINT (3)

Measurement Data			
Date: 1/6/2021	Time: 10:46:08 PM	Duration: 00:05:00	Leq: 75.45 dB (A)

Weather Condition				
Wind: 4 m/s	Direction: NE	Temp: 25 ^{o}C	Humidity: 56 %	Precipitation: 0

Measurement Apparatus		
Sound Level Meter B&K 2245	Serial number: 100418	Certificate of calibration n^{o} **121/2020**
Microphone	Serial number: 3236964	
Calibrator B&K 4321	Serial number: 1839253	Certificate of calibration n^{o} **122/220**

Coord. GPS

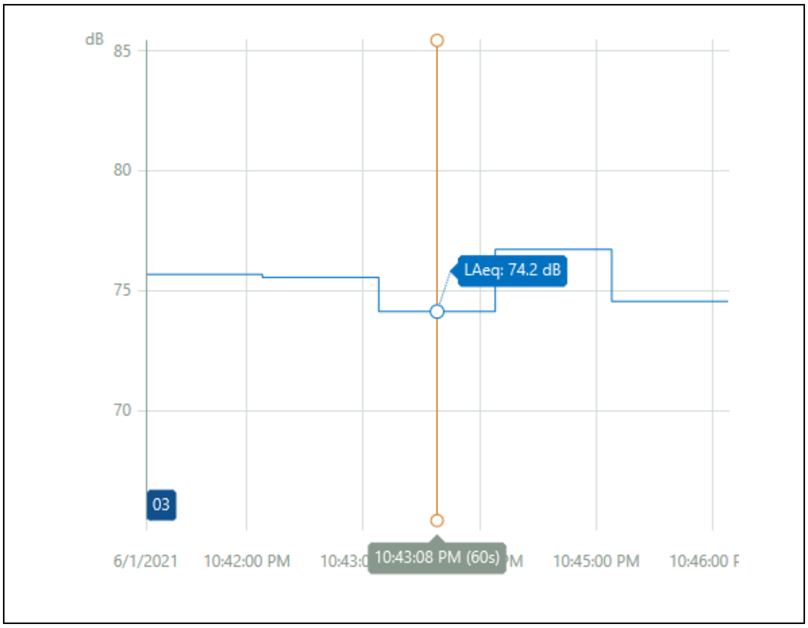
Latitude	Longitude
30° 4' 0.876" N	31° 21' 37.227"E

	Leq dB (A)	L10 dB (A)	L50 dB (A)	L90 dB (A)
	75.45	78.39	72.2	65.12

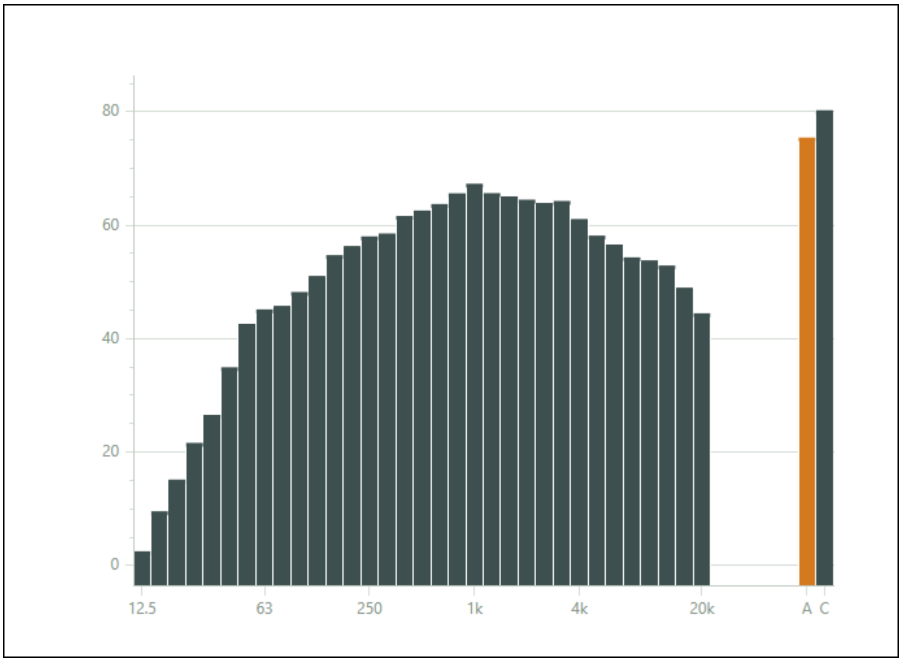
Google earth location

Photo of measurement point

Time History of Leq (A)



Leq(A) Spectrum 1/3 Octave Bands



Notes:

.
• Residential area near Al AHLY club which is Residential areas in the city with commercial activities so sound level required is 50 dB • 110 car /5min • Cars speed 55/60 km/hour • Noise limit is above required

POINT (4)

Measurement Data			
Date: 1/6/2021	Time: 10:53:54 PM	Duration: 00:05:00	Leq: 78.22 dB (A)

Weather Condition				
Wind: 4 m/s	Direction: NE	Temp: 25 ^{o}C	Humidity: 56 %	Precipitation: 0

Measurement Apparatus		
Sound Level Meter B&K 2245	Serial number: 100418	Certificate of calibration nº **121/2020**
Microphone	Serial number: 3236964	
Calibrator B&K 4321	Serial number: 1839253	Certificate of calibration nº **122/220**

Coord. GPS

Latitude	Longitude
30° 4' 44.7384"N	31° 22' 23.7642"E

Leq dB (A)	L10 dB (A)	L50 dB (A)	L90 dB (A)
78.22	80.62	76.72	74.17

Google earth location

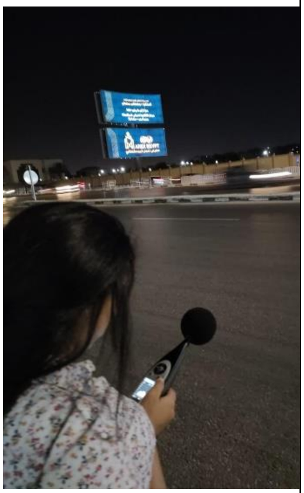
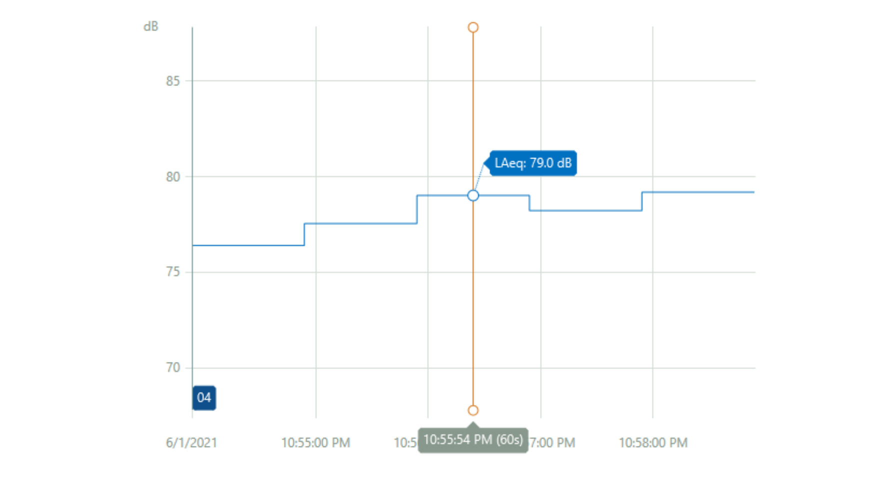
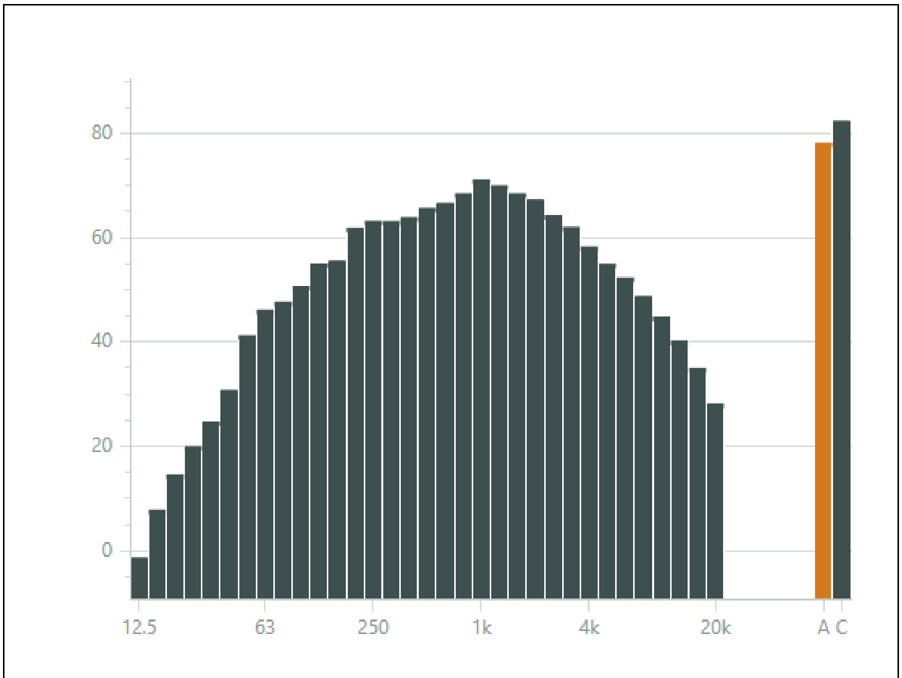


Photo of measurement point

Time History of Leq (A)



Leq(A) Spectrum 1/3 Octave Bands



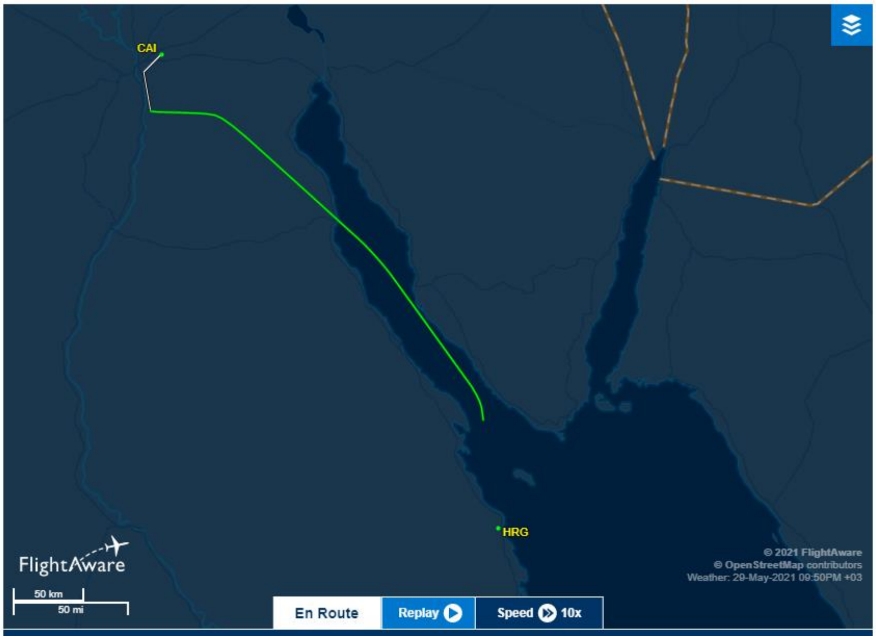
Notes:

.
- Electricity hospital on suez road which is considered an area with sensitivity to noise (such as hospitals, schools, libraries and parks) so sound level required is 40 dB   300 car /5min   - Cars speed 60/70 km/hour   - Military aircraft C 130 pass   - Noise limit is above required

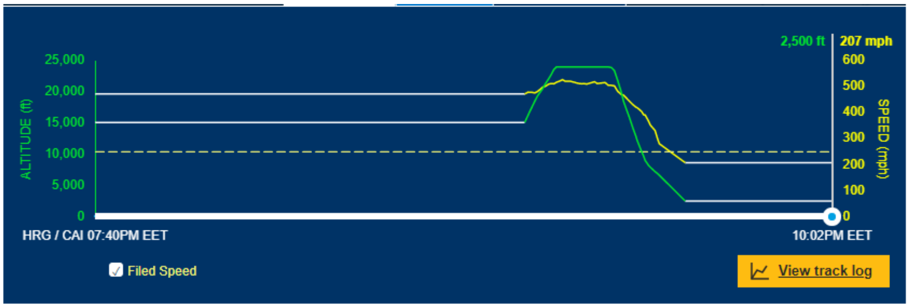
Appendix 10 Flight details of aircraft pass while measurements

Flight 1

Flight number: MS049
Direction: Hurgada to Cairo
Pass during Mo5 and M06 day measurements



AIRCRAFT INFORMATION		
Aircraft Type	Airbus A220-300 (twin-jet) (BCS3)	Photos
Registration	Upgrade account to see tail number	
AIRLINE INFORMATION		
Airline	Egypt Air "Egyptair"	all flights
FLIGHT DATA		
Speed	Filed: 251 mph	graph
Altitude	—	
Distance	Actual: 280 mi (Direct: 250 mi)	
Route	—	



Source: https://flightaware.com/live/flight/MSR49/history/20210529/1740Z/HEGN/HECA

Flight 2

Flight pass during night Mo4 measurement

Aircraft type C130

Aircraft	T/V		Local S/N	AF/Unit	Version	Date	St
73-1678	4572	Delivered:	B-678		C-130H	25 Apr 1975	
		Current:	1296/SU-BPJ		C-130H	13 Dec 2004	
73-1679	4587	Delivered:	B-679		C-130H	25 Apr 1975	
		Current:	1297/SU-BPK		C-130H	13 Dec 2004	
73-1680	4599	Delivered:	B-680		C-130H	18 Jul 1975	
		Current:	1298/SU-BPL	EAF 4 sqn	C-130H	Oct 2015	
76-1598	4707	Delivered:	1270/SU-BAA		C-130H	Dec 1976	
		Current:	1270/SU-BAA		C-130H	19 Feb 1978	
76-1599	4709	Delivered:	1271/SU-BAB		C-130H	Dec 1976	
		Current:	1271/SU-BAB	EAF 16 sqn	C-130H	Unknown	
76-1600	4714	Delivered:	1272/SU-BAC		C-130H	Jan 1977	
		Current:	1272/SU-BAC		C-130H	24 Feb 2009	
76-1601	4719	Delivered:	1273/SU-BAD		C-130H	Jan 1977	
		Current:	1273/SU-BAD	EAF 16 sqn	C-130H	Unknown	
76-1602	4721	Delivered:	1274/SU-BAE		C-130H	Mar 1977	
		Current:	1274/SU-BAE	EAF 16 sqn	C-130H	Unknown	
76-1603	4728	Delivered:	1275/SU-BAF		C-130H	Jan 1977	
		Current:	1275/SU-BAF		C-130H	Unknown	
78-0755	4792	Delivered:	1276/SU-BAH		C-130H	Oct 1978	
		Current:	1276/SU-BAH		C-130H	29 May 1981	
78-0756	4794	Delivered:	1277/SU-BAI		C-130H	Oct 1978	
		Current:	1277/SU-BAI		C-130H	Unknown	
78-0757	4795	Delivered:	1278/SU-BAJ		C-130H	Nov 1978	
		Current:	1278/SU-BAJ		C-130H	Unknown	
78-0758	4797	Delivered:	1279/SU-BAK		C-130H	Nov 1978	
		Current:	1279/SU-BAK		C-130H	Unknown	
78-0759	4802	Delivered:	1280/SU-BAL		C-130H	Jan 1979	
		Current:	1280/SU-BAL	EAF 16 sqn	C-130H	22 Nov 1979	
78-0760	4803	Delivered:	1281/SU-BAM		C-130H	Jan 1979	
		Current:	1281/SU-BAM	EAF 16 sqn	C-130H	Unknown	

Appendix 11Detailed measurements of case study

POINT (1)

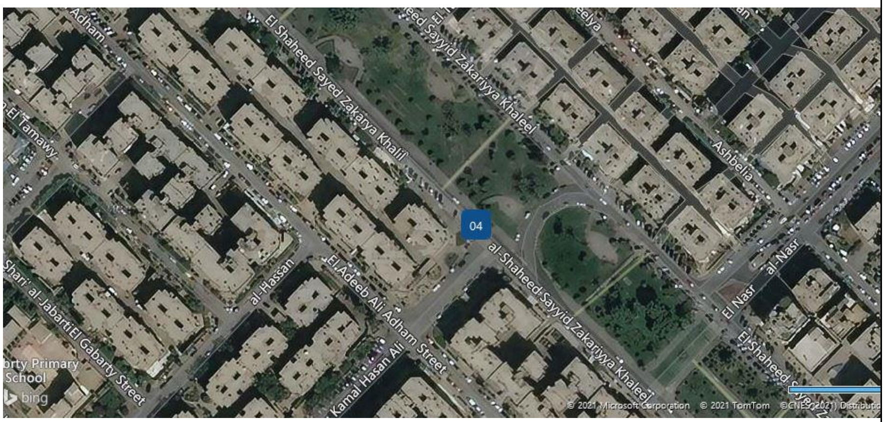
Measurement Data			
Date: 3/9/2022	Time: 10:14:50 AM	Duration: 2.10:27:06	Leq: 56.24 dB (A)

Measurement Apparatus		
Sound Level Meter B&K 2245	Serial number: 100418	Certificate of calibration nº **121/2020**
Microphone	Serial number: 3236964	
Calibrator B&K 4321	Serial number: 1839253	Certificate of calibration nº **122/220**

Coord. GPS

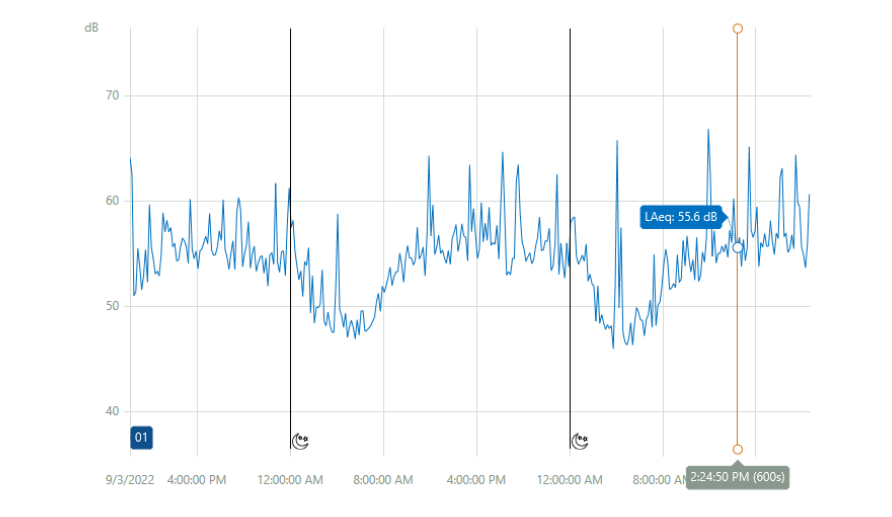
Latitude	Longitude
30° 6' 17.028" N	31° 22' 12.864" E

Leq dB (A)	L90 dB (A)	L50 dB (A)	L10 dB (A)
56.24	46.69	51.53	56.85

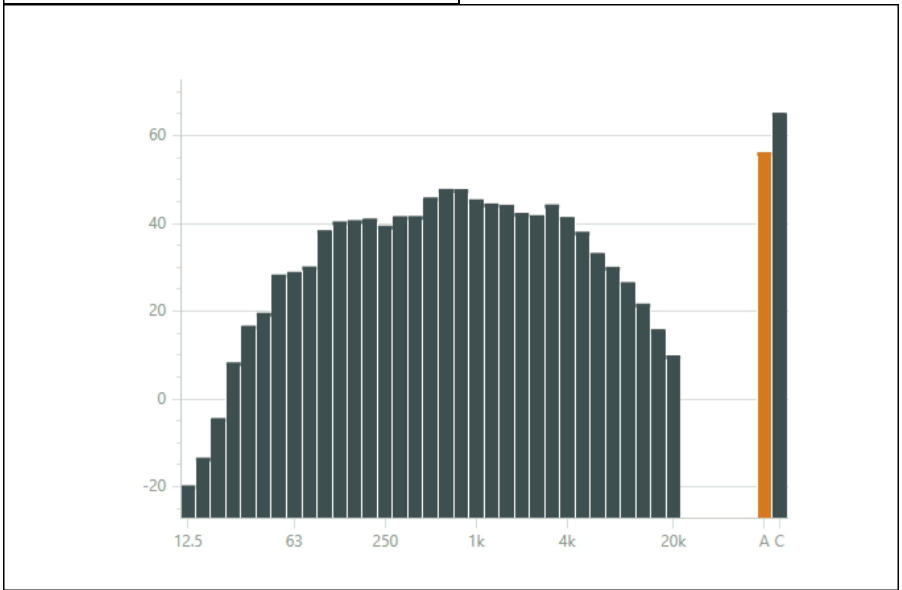


Google earth location

Time History of Leq (A)



Leq(A) Spectrum 1/3 Octave Bands



Notes:

.

- Residential area in Sheraton Heliopolis which is Residential areas in the city with commercial activities so sound level required is 55 dB during day and 50 during night

	Leq dB (A)	Limit dB (A)
Day 1	56.49	55
Day 2	56.80	55
Day 3	57.38	55
average day	56.91	55
L aeq max day	69.06	55
Night 1	53.62	45
Night2	54.79	45
Average night	54.24	45
L aeq max night	68.82	45

Appendix 12 Questionnaire

This online questionnaire is a part of academic research. the aim of these questions is to understand the awareness of the community towards visual and noise pollution. this survey will take 3-5 min. thanks for your participation.

1. Gender

☐ Male

☐ Female

2. Age

◯ Under 18

◯ 18-24

◯ 25-34

◯ 35-44

◯ 45-54

◯ 55-64

◯ 65+

3. Educational level

◯ high school

◯ Bachelor degree

◯ Master degree

◯ Doctor of Philosophy

◯ Other (please specify)

4. Please mention your current profession.

5. Do you think most projects in Cairo satisfy acoustical guidelines based on your experience?

- Very likely
- Likely
- Neither likely nor unlikely
- Unlikely
- Very unlikely

6. To what extent are you satisfied by the sound performance in Cairo, Egypt?

- Very satisfied
- Satisfied
- Neither satisfied nor dissatisfied
- Dissatisfied
- Very dissatisfied

7. From your knowledge, choose the suitable rank of Cairo, Egypt within the world concerning noise pollution.

0 100

8. Do you have any practical experience dealing with noise pollution?

- Extremely professional
- Very professional
- Somewhat professional
- Not so professional
- Not at all professional

9. Evaluate your capability to use various techniques to solve the noise pollution issue.

0 100

10. To what degree are you willing to play a role in reducing noise pollution.

- ◯ A great deal
- ◯ A lot
- ◯ A moderate amount
- ◯ A little
- ◯ None at all

11. Rate your openness to understand, monitor noise pollution in your context.

0 — 100

12. Is there anything else you'd like to add about noise pollution in Cairo, Egypt?

Appendix 13 Questionnaire responds

Noise pollution questionnaire

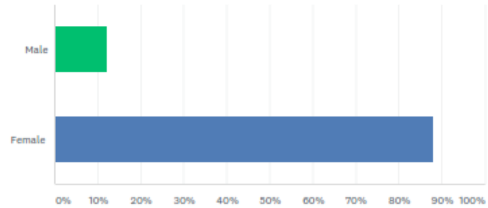
QUESTION SUMMARIES | DATA TRENDS | INDIVIDUAL RESPONSES

All Pages

Q1

Gender

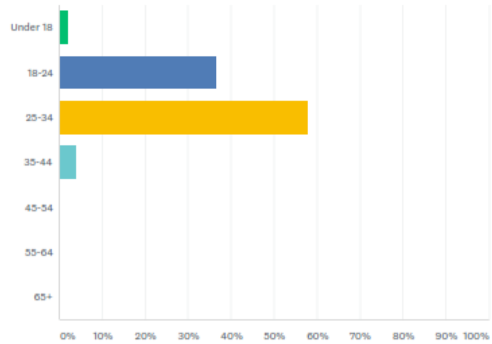
Answered: 109 Skipped: 0



ANSWER CHOICES	RESPONSES	
Male	11.93%	13

Age

Answered: 109 Skipped: 0



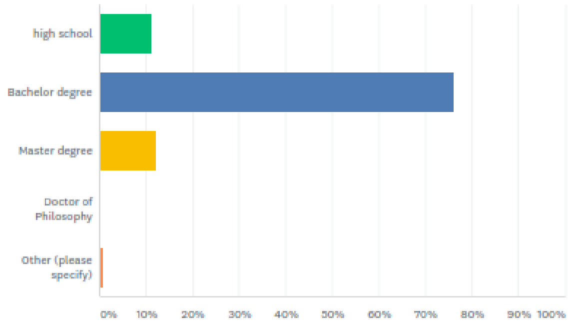
ANSWER CHOICES	RESPONSES	
		2
18-24	36.70%	40

25-34	57.80%	63
35-44	3.67%	4
45-54	0.00%	0
55-64	0.00%	0
65+	0.00%	0
TOTAL		**109**

Q3

Educational level

Answered: 109 Skipped: 0



ANSWER CHOICES	RESPONSES	
high school	11.01%	12
Bachelor degree	76.15%	83
Master degree	11.93%	13

Please mention your current profession.

Answered: 105 Skipped: 4

Architect

6/15/2021 3:45 PM

Running my own project

6/15/2021 12:08 PM

Business intelligence developer

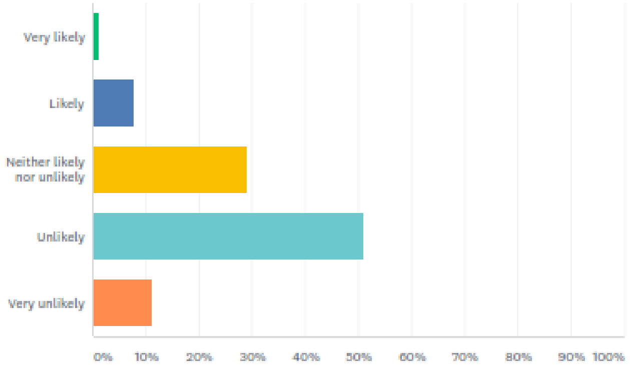
6/13/2021 12:38 PM

Teaching assistant

Q5

Do you think most projects in Cairo satisfy acoustical guidelines based on your experience?

Answered: 90 Skipped: 19

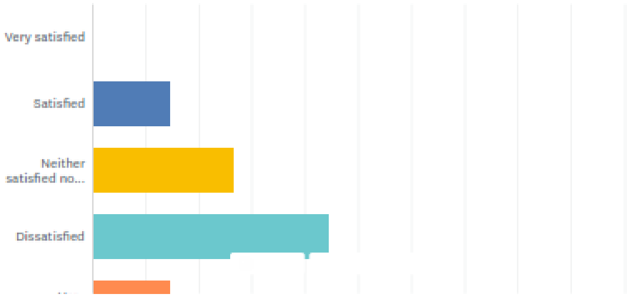


ANSWER CHOICES	RESPONSES	
Very likely	1.11%	1
Likely	7.78%	7
Neither likely nor unlikely	28.89%	26
Unlikely	51.11%	46
Very unlikely	11.11%	10
TOTAL		90

Q6

To what extent are you satisfied by the sound performance in Cairo, Egypt?

Answered: 90 Skipped: 19

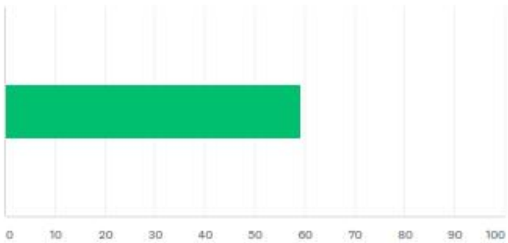


ANSWER CHOICES	RESPONSES	
Very satisfied	0.00%	0
Satisfied	14.44%	13
Neither satisfied nor dissatisfied	26.67%	24
Dissatisfied	44.44%	40
Very dissatisfied	14.44%	13
TOTAL		90

Q7

From your knowledge, choose the suitable rank of Cairo, Egypt within the world concerning noise pollution.

Answered: 89 Skipped: 20



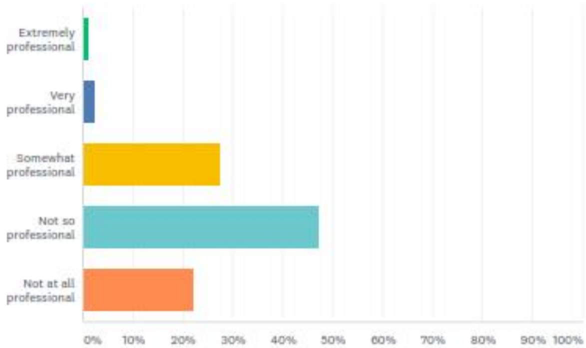
ANSWER CHOICES	AVERAGE NUMBER	TOTAL NUMBER	RESPONSES
Responses	59	5,271	89

Total Respondents: 89

Q8

Do you have any practical experience dealing with noise pollution?

Answered: 91 Skipped: 18

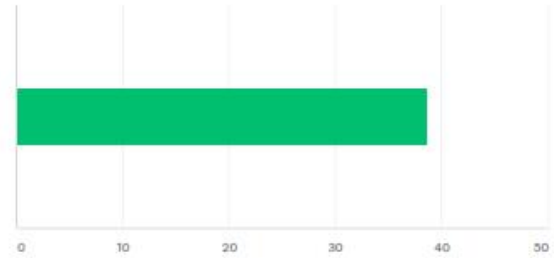


ANSWER CHOICES	RESPONSES	
Extremely professional	1.10%	1
Very professional	2.20%	2
Somewhat professional	27.47%	25
Not so professional	47.25%	43
Not at all professional	21.98%	20
TOTAL		91

Q9

Evaluate your capability to use various techniques to solve the noise pollution issue.

Answered: 89 Skipped: 20



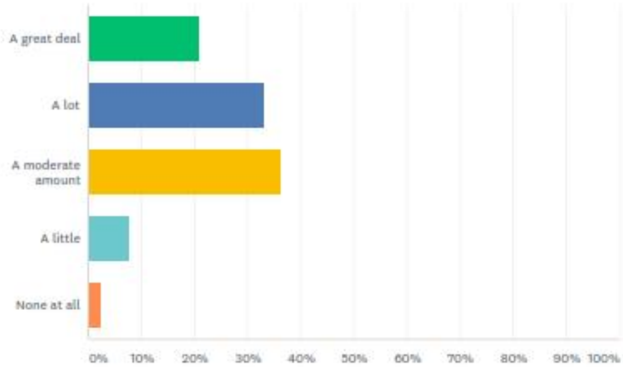
ANSWER CHOICES	AVERAGE NUMBER	TOTAL NUMBER	RESPONSES
Responses	39	3,447	89

Total Respondents: 89

Q10

To what degree are you willing to play a role in reducing noise pollution.

Answered: 91 Skipped: 18



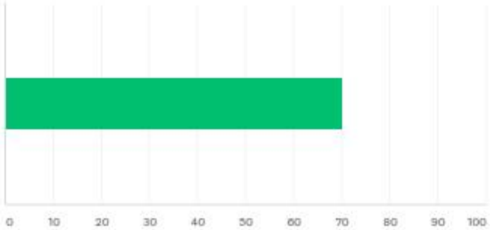
ANSWER CHOICES	RESPONSES	
A great deal	20.88%	19
A lot	32.97%	30

A moderate amount	36.26%	33
A little	7.69%	7
None at all	2.20%	2
TOTAL		91

Q11

Rate your openness to understand, monitor noise pollution in your context.

Answered: 90 Skipped: 19



ANSWER CHOICES	AVERAGE NUMBER	TOTAL NUMBER	RESPONSES
Responses	70	6,304	90
Total Respondents: 90			

Q12

Is there anything else you'd like to add about noise pollution in Cairo, Egypt?

Answered: 62 Skipped: 47

No

6/15/2021 3:47 PM

No

6/15/2021 12:09 PM

No

6/13/2021 12:39 PM

no

6/12/2021 5:12 PM

شكر

لم يكن هذا العمل ليرى النور بدون بئر الله وبركات عائلتي وأصدقائي الأعزاء .طوال هذا البحث ، حصلت على دعم العديد من الأشخاص الذين لن تتمكن الكلمات من التعبير عن تقديري وامتناني تجاههم .أنا بموجب هذا أعطي الفضل لعائلتي. أود أن أشكرك بعمق على كل ما صنعته من أجلي. شكرا للبقاء دائما بجانبي خلال العملية برمتها. شكرا لإيمانك بي ودعم اختياراتي. شكرا لصلواتكم. شكرا منصور البرديسي ، نادية الديواني ، هديل البرديسي ، وسام البرديسي ، جوانا محمد ، محمد لطفي .أود أن أعرب عن عميق تقديري للمشرفين علي. الأستاذة عبير الشاطر لدعمها المستمر وصبرها ومعرفتها الهائلة وملاحظاتها البناءة التي ساعدتني خلال عملية الدكتوراه. أود أن أعرب عن عميق تقديري أيضا للدكتور سامي عفيفي على الحماس المستمر والتشجيع والصبر والتوجيه والتعليقات المفيدة التي ساعدتني في عملية البحث. أشكر بامتنان للدكتور عبد المنعم الفقي على تعليقاته المفيدة ونصائحه ودعمه.

الملخص

يركز هذا البحث على الوعي البيئي للضوضاء لدى الأفراد والإجهاد البيئي الناجم عن التلوث الضوضائي . تأثير البعد الاجتماعي المورفولوجي على تخفيف الضوضاء في الأماكن العامة ، حيث يوضح البعد الاجتماعي المورفولوجي مورفولوجيا المدينة فيما يتعلق بنمطها المادي وثقافتها و الجوانب الاجتماعية . من منظور عالمي ، تعترف العديد من المجموعات البحثية بفوائد إغلاق كوفيد على البيئة .قام باحثون آخرون بتوثيق التأثير السلبي للاستخدام البشري على الطبيعة ، على مر السنين ، تظهر الدراسات أننا بحاجة إلى 1.6 أرض للتعامل مع الطلب البشري .بالإضافة إلى ذلك ، زادت البصمة البيئية وتغير يوم تجاوز الأرض والإجهاد البيئي .كل ذلك يعكس العلاقة بين التأثير القوي للوعي البيئي والضغوطات البيئية وحماية البيئة .نتيجة لمراجعة الأدبيات العالمية ذات الصلة التي تشير إلى أن الإفراط في استخدام الأرض يمثل تحديا والكثير من الضغوطات البيئية التي تؤثر على الوعي الفردي البشري، بالإضافة إلى ذلك ، تعد القاهرة ، مصر ثاني أكثر المدن ضوضاء في العالم .لذلك ، يحلل البحث بعمق الضوضاء في دراسة حالة محددة في مصر بناء على معايير ومحاكاة معينة ، بالتوازي مع فحص الوعي البيئي حول التلوث الضوضائي في ذلك السياق .تحليل الوعي البيئي والضوضاء باستخدام الاستبيانات عبر الإنترنت والملاحظة ومقياس مستوى الصوت وبرامج الكمبيوتر وأدوات رسم الخرائط . أكدت نتائجنا الفجوة بين الحالة المرغوبة والحالية للتلوث الضوضائي في مواقع معينة والوعي البيئي للأفراد له عيوب .ينتهي البحث بخطة عمل للتخفيف من الضوضاء والوعي البيئي تقسم المسؤوليات إلى مستويات متنوعة .تشمل خطط العمل استراتيجيات تخفيف الضوضاء أثناء عملية التصميم ، ومجموعة أدوات لتخفيف الضوضاء ، ودليل لجهاز شئون البيئة المصري .(EEAA) علاوة على ذلك ، فإن تعزيز الوعي البيئي حول الضوضاء يشمل المعرفة والمهارة وتعزيز التحفيز .أيضا ، الخطوات الموصي بها لتنفيذ خطة العمل في حالة وجود أي ضغوط بيئية أخرى والعواقب المستقبلية لخطة العمل هذه.

كلمات المفتاح:

يوم تجاوز الأرض ، البصمة البيئية ، السياق المصري ، الوعي البيئي ، التثقيف البيئي ، حماية البيئة ، علم النفس البيئي ، الضغوطات البيئية ، الوعي الفردي ، التلوث الضوضائي

تعريف بمقدم الرسالة

الاسم	**ناردين منصور محمد منصور البرديسى**
تاريخ الميلاد	**01 يناير 1994**
محل الميلاد	**القاهرة**
اخر درجة جامعية	**ماجستير علوم**
الجهة المانحة	**العمران المتكامل و التصميم المستدام**
تاريخ المنح	**2019,2021**
الوظيفه الحالية	**مهندسه معماريه حرة**

كلية الهندسة

قسم التصميم و التخطيط العمرانى

رسالة الدكتوراة:

اسم الطالب :ناردين منصور محمد منصور البرديسى

عنوان الرسالة :**تأثيرات الأبعاد الاجتماعية المورفولوجية على تخفيف الضوضاء في الأماكن العامة**

اسم الدرجة : دكتوراه الفلسفة فى الهندسة

لجنة الاشراف:

أ.د/ عبير الشاطر..

د/ سامى عفيفى

د/ عبد المنعم الفقى

تاريخ البحث : ..../............./.............

الدراسات العليا:

ختم الإجازة: اجيزت الرسالة بتاريخ : ..../............./.............

موافقة مجلس الكلية : ..../............./...........

موافقة مجلس الجامعة : ..../............./...........

القاهرة (2024)

الموافقة على المنح

كلية الهندسة

قسم التصميم التخطيط العمرانى

تأثيرات الأبعاد الاجتماعية المورفولوجية على تخفيف الضوضاء في الأماكن العامة

إعداد

ناردين منصور محمد منصور البرديسى

لجنة الحكم

الاسم	التوقيع
أ.د/ ايمن حسان	....
أ.د/ احمد سامى	....
أ.د/ عبير الشاطر	....
د/ سامى عفيفى	....
د/ عبد المنعم الفقى	....

.........../.........../.........

كلية الهندسة

قسم التصميم و التخطيط العمرانى

تأثيرات الأبعاد الاجتماعية المورفولوجية على تخفيف الضوضاء في الأماكن العامة

رسالة مقدمة للحصول على درجة دكتوراه الفلسفة

فى الهندسة المعمارية

(قسم التصميم و التخطيط العمرانى)

اعداد

ناردين منصور محمد منصور البرديسى

حاصل على ماجستير العلوم

فى العمران المتكامل و التصميم المستدام

جامعة ستوتجارت, شتوتجارت, المانيا, سنة 2019

جامعة عين شمس , القاهرة , مصر , سنة 2021

المشرفون

أ.د/ عبير الشاطر

د/ سامى عفيفى

د/ عبد المنعم الفقى

القاهرة (2024)