MANAGEMENT OF INDUSTRIAL AIR POLUTION IN INDUSTRIAL AREA OF THE NAIROBI COUNTY

BY

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DECLARATION

This research project is my original work and has never been presented in this way or any other to any university for examination or award

....

Sitati M . Benjamin Date

Reg. No: N36/2795/2010

This Research Project has been submitted for examination with my approval as a University supervisor.

....

Mr. Dekow S. Mohamed Date

DEDICATION

This research project is dedicated to my parents Ernest Barasa Sitati and Concepta Nekesa Sitati for their love for excellence and scholarly achievements.

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ABSTRACT

The effects of improper management of industrial air pollution are being dramatically demonstrated in most development countries and Kenya has not been left out. Quality of air within industrial areas is daily deteriorating and its effect are becoming evident daily, some gradual, some sudden. This is threatening human livelihood and the environment as a whole. The ever increasing effect on industrial air pollution calls for management strategies and decisions to be made after comprehensive analysis of all relevant factors.

Though considerable efforts in management of industrial air pollution have been made, it is still palpable that centralized, progressive and segmental approaches are characterized by several Achilles' heels/ flaws and gaps thus are substantially insufficient in addressing industrial air pollution. The episode of such is because there's no proper management strategy, insufficient stakeholder participation to handle the issue at hand and lack of profound understanding of the problem. The study analyses the strategies espoused earlier, while determining their successes and failure. This has thus provided a basis for a proper management plan.

The study proposes a number of strategies that can be implemented under the new county administration and the national government. Some of the strategies include improved safe technology among industries, improved health and safety preventive measures, implementation of proper laws and legislation and air quality standards among others.

TABLE OF CONTENTS

Page

CHAPTER 2

CHAPTER 3

CHAPTER 4

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

LIST OF ACRONYMNS

TSP	Total Suspended Particulates
APINA	Air Pollution Information Network for Africa
NGOs	Non-governmental Organizations
GHG	Green House Gases
WHO	World Health Organization
UNEP	United Nations Environment Programme
AQI	Air Quality Index
NCC	Nairobi City County
OR	Odds Ratio
CBD	Central Business District
GDP	Gross Domestic Product
KICC	Kenyatta International Conference Centre
NSE	Nairobi securities Exchange
OECD	Organization for Economic Co-operation and Development
EEC	European Economic Community
REDD	Reducing emissions from deforestation and forest degradation

CHAPTER 1

INTRODUCTION

1.1 Problem background

Concerns on air pollution caused by industries have been rising over time due to increased industrialization and the effects on the environment. Data from "Air pollution in Europe" (EEA, 1997) shows figures describing the respective production of pollutants by each sector of manufacturing. The EEA study indicated that air pollution is the presence of substances in the air in sufficient concentration and for sufficient time, so as to be, or threaten to be injurious to human, plant or animal life, or property, or which reasonably interferes with the comfortable enjoyment of life and property. According to Shakeel (2011) in the Journal of Public Administration and Policy Research, air pollution kills 15000 Bangladeshis each year. He also states that Young children are mostly exposed to cadmium (Cd) through inhalation of smokes and contaminated soils and dust from industrial emissions. Available data shows that the air quality in most major cities of the World has deteriorated to levels that make air quality management strategies necessary.

Challenges of air pollution in Africa led to the development of Air Pollution Information Network for Africa (APINA), which is a network of African policy makers, scientists, Non-governmental organizations (NGOs), industries and other stakeholders interested in air pollution issues. Its main role is to fill gaps in knowledge on air pollution issues in Africa and ensure that currently available information and concerns are articulated to policy makers and the regional policy process is promoted. They found out that air pollution is becoming a policy driver in the region, its effects particularly seen on health getting worse. They know that although Africa has low GHG emissions, it's susceptible to some of the worst effects of climate change.

Kenya has faced dire challenges from air pollution from industries. Years of protests by residents in Mombasa led to the installation of dust arrestors by the Bamburi cement factory. Nairobi is the largest town in Kenya with a population of over 2.1 million people and has the greatest concentration of industrial air pollutant sources. Research shows that in developing nations

especially those in Africa, capabilities of air quality management are either absent or only rudimentary; the situation in Kenya given as an example.

1.2 Statement of the problem

Increasing number of industries in urban environments has led to an increase in the rates of air pollution. Air pollution introduces chemicals, particulates or biological materials which cause discomfort, disease or death to humans and damage to both the living organisms (such as food crops) and the built environment. According to the World Health Organization (WHO), *asbestosis, lung cancer* and *Peritonial Mesothelioma* are sicknesses associated with exposure to materials such as asbestos in the air emitted by industries. About 2.4 million people die each year from causes directly attributed to air pollution. The worst short term civilian pollution crisis in India was the 1984 Bhopal Disaster. Leaked industrial vapours from the Union Carbide, Inc., U.S.A., killed more than 25,000 people outright and injured 150,000 to 600,000 people. Less effort has been put both nationally and internationally to deal with this problem. The purpose of this study therefore wass to come up with various other measures to curtail the negative effects of air pollution from industries and place limitations and restrictions on rates of release of exhaust by industries and consequent penalties on exceeding such.

1.3 Research questions

The study attempted to seek answers to the following research questions:

a) What industries are major causes of air pollution? – This helped the researcher evaluate the extent to which certain industries alone have contributed to air pollution and the rate of pollution.
b) What are the major diseases or injuries that pollution inflicts in living and non-living environment?
c) What policies and legislation are in place to govern industrial air pollution?
d) What mitigation measures are in place to minimize industrial air pollution? –Suggested strategies to minimize effects and impacts of air pollution.

1.4 Research objectives

a) The main goal of the study was to investigate which industries in particular in the urban environment are involved and examine its causes and effects on the environment. The purpose of

conducting this study was to provide valuable information to the development of alternative ways to control air pollution from industries.

b) To determine major diseases or physical injuries the pollution inflicts on living and non-living environment. The study was to help bring out the broader aspect of air pollution and its impacts on the environment.

c) To evaluate how the policies and legislations address the issue of air pollution by industries

d) This research was aimed at determining the mitigation measures in place to minimize air pollution. This helped the researcher come up with some of the measures to counter this pollution, and also knew some of the measures put before and the challenges encountered in implementing them and came up with recommendations.

e) This research was also meant to suggest strategies to minimize effects and impacts of industrial air pollution. This involved coming up with alternative ways of controlling or reducing the effects of air pollution by industries on the environment.

1.5 Research premises

The main purpose of the research premises was to find tentative answers i.e if the public or residents were familiar with. They should be clear.

Although several studies and much available literature has addressed the problem of industrial pollution, implementing a comprehensive and most of all robust industrial pollution management system capable of operating in ambient environments, is by no means a trivial task. As part of the applied project "Management of Industrial Air Pollution in Nairobi County" the study will be guided by the premises;

1. One the underlying causes of unchecked continuous air pollution by industries is inexistence of a comprehensive implemented policy to govern industrial pollution
2. The continuous air pollution by industries will have direct effects to the environment and the local communities within the industrial area; including health effects.
3. Policies and legislations addressing the issue of air pollution by industries.
4. The problem of air pollution by industries is complex and existing strategies are not well structured to address it.
5. An appropriate plan of action is required to address the effects of air pollution by industries.

1.6 Justification of study

It's an open truth that the growing number of industries in urban environments has led to an increase in the rates of air pollution. The alarming rate of impacts of air pollution on the environment has influenced my research on this. Air pollution introduces chemicals, particulates or biological materials which cause discomfort, disease or death to humans, damage other living organisms such as food crops, or damage the natural or built environment. According to the World Health Organization (WHO), *asbestosis, lung cancer* and *Peritonial Mesothelioma* are sicknesses associated with exposure e.g. to asbestos from air pollution by industries. The organization also states that 2.4 million people die each year from causes directly attributed to air pollution. The worst short term civilian pollution crisis in India was the 1984 Bhopal Disaster. Leaked industrial vapours from the Union Carbide, Inc., U.S.A., killed more than 25,000 people outright and injured anywhere from 150,000 to 600,000.

Nairobi is the largest town in Kenya and also the country's capital city. It covers an area of approximately 696 km^2 and currently has a population of over 3 million people according to the 2009 census; nationally it has the greatest concentration of industrial air pollutant sources. Nairobi is reputed to be the fastest growing city in the World after Guadaloupe, Mexico City (Mexico) and Maputo (Mozambique). Nairobi does not have any regular air quality management system yet, and any measurements of air pollution have been done on an ad hoc basis; indeed out of 20 mainly developing country cities sampled for a UN study on air quality management capability, Nairobi's capacity was rated as the worst (UNEP/WHO, 1996). Although in general, the current quality of air in Nairobi does not present a critical health or environmental problem, available data indicates that air quality has been rapidly deteriorating (Ngugi, 1983; Karue, 1991). The situation can only get worse with the increasing population, growing industrial area, and deforestation on the city's fringes, increased construction works to pave way for industrial development.

This research will therefore help in coming up with various other measures to curtail the negative effects of air pollution from industries and place limitations and restrictions on rates of release of exhaust by industries and consequent penalties on exceeding such.

1.7 Significance of study

A number of individuals and groups are going to benefit from this project, the greatest beneficiaries being the local community/residents within Nairobi County. Other beneficiaries include: businesses and property owners within the region, wildlife and livestock within Nairobi. The research will contribute to:

a. Policy making. It will enable policy makers to review the existing policies on management of industrial air pollution and come up with realistic and applicable strategies/measures to enhance environmental sustainability on air pollution matters.
b. The research will enhance/increase the local community's awareness on the effects of industrial air pollution and bring commitment among the society to address such issues.
c. It will contribute to knowledge enhancement through identifying gaps in the existing literature on the strategies for management of industrial air pollution.
d. It will also act as baseline data/secondary information for future studies in areas of similar characteristics/challenges.

1.8 Scope and delimitation of study

The main purpose of the study was majorly to determine how industries are a major source of air pollution in Nairobi County and come up with recommendations aimed at reducing the air pollution effect on the environment. The research majorly dwelt on Nairobi County being the capital city of the country and the city with major industrial activities and majorly the industrial area of Nairobi. The study captured Industrial Area (major concentration of industries in Nairobi) and Roysambu area (no major industries around).

1.9 Operational terms

Some of the few key terms that I will define in my area of study/research are as follows:

- **Air Pollution** - Air pollution is any atmospheric condition in which certain substances are present in such concentrations and duration that they may produce harmful effects on man and his environment. Common air pollutants include; carbon monoxide, nitrogen oxide, sulphur dioxide, lead and Total Suspended Particulates (TSP), the latter being the most widespread and the most serious for human health.

- **Air Quality** – this term means the state of the air around us. Good air quality refers to clean, clear, unpolluted air. Clear air is essential to maintaining the delicate balance of life on the earth, not just for humans, but wildlife, vegetation, water and soil. Poor air quality occurs when pollutants reach high enough concentrations to endanger human health and/or the environment.
- **Sustainable Management** - defined as the application of sustainable practices in the categories of businesses, agriculture, society, environment, and personal life by managing them in a way that will benefit current generations and future generations.
- **Air Quality Index -** The standard system that state and local air pollution control programs use to notify the public about levels of air pollution. The AQI tracks levels of two pollutants - ozone (smog) and particle pollution (tiny particles from ash, vehicle exhaust, soil dust, pollen, and other pollution).
- **Abatement -** The reduction or elimination of pollution.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Concerns on air pollution caused by industries have been rising over time due to increased industrialization and the effects on the environment. Data from "Air pollution in Europe" (EEA, 1997) shows figures describing the respective production of pollutants by each sector of manufacturing. Chapter 2 of *Air Pollution, Sources and Characteristics* states that air pollution is the presence of substances in the air in sufficient concentration and for sufficient time, so as to be, or threaten to be injurious to human, plant or animal life, or property, or which reasonably interferes with the comfortable enjoyment of life and property. Shakeel Ahmed Ibne Mahmood (2011) in his Journal of Public Administration and Policy Research Vol.3 (4), states that Air pollution kills 15000 Bangladeshis each year. He also states that Young children are mostly exposed to cadmium (Cd) through inhalation of smokes and contaminated soils and dust from industrial emissions.

R Edwards, T Pless-Mulloli, D Howel, T Chadwick, R Bhopal, R Harrison, and H Gribbin in their article, *"Does living near heavy industry cause lung cancer in women? A case-control study using life grid interviews"* found out that; the incidence of lung cancer among women is high in the highly industrialized area of Teesside in north-east England. Previous research has implicated industrial pollution as a possible cause. A study was undertaken to investigate whether prolonged residence close to heavy industry is associated with lung cancer among women in Teesside.

As a method; two hundred and four women aged <80 years with incident primary lung cancer and 339 age matched community controls were recruited to a population based case-control study. Life course residential, occupational, and active and passive smoking histories were obtained using an interviewer administered questionnaire.

The results showed that; the age adjusted odds ratio (OR) for lung cancer among people living >25 years *v* 0 years near (within 0–5 km) heavy industry in Teesside was 2.13 (95% CI 1.34 to 3.38). After adjustment for confounding factors the OR was 1.83 (95% CI 0.82 to 4.08) for >25 years or 1.10 (95% CI 0.96 to 1.26) for an additional 10 years living near industry. ORs were similar after residence near heavy industry outside Teesside was also included, and when latency was allowed for by disregarding residential exposures within the last 20 years. Adjustment for active smoking had the greatest effect on the OR.

It was concluded that this population based study using life grid interviews for life course exposure assessment had addressed many deficiencies in the design of previous studies. The findings support those in most of the international literature of a modestly raised risk of lung cancer with prolonged residence close to heavy industry, although the confidence intervals were wide. The effect of air pollution on the incidence of lung cancer merits continued study.

Previous studies have shown that in general, where there is air pollution, TSP represent the most serious immediate threat to human health amongst air pollutants as shown in the table below.

Table 2-1: Urban air pollution in megacities of the World, 1992

CITY	Sulphur dioxide	TSP	Airbone Lead
Bangkok	Low	High	Low
Beijing	High	High	Low
Bombay	Low	High	Low
Calcutta	Low	High	Low
Cairo	No data	High	High
London	Low	Low	Low
Los Angeles	Low	Medium	Low
Mexico City	High	High	Medium

Rio De Jeneiro	Medium	Medium	Low
Sao Paulo	Low	Medium	Low

LOW-conforms to WHO guidelines

MEDIUM-WHO guideline exceeded by up to a factor of 2

HIGH – WHO guideline exceeded by more than a factor of 2

Source: After UNEP/WHO, 1992

Industrial areas are characterized by a high density of industries, sharing common infrastructures, such as transport networks, waste water treatment plants, and waste incineration plants. These areas cluster at-risk activities and pollution sources. They have historically attracted, and may still attract, hundreds of employees who have settled in the vicinity of the industrial plants. With extensive urbanization, industrial areas have been embedded in the urban landscape, increasing the nuisances and the exposure of the population. For instance, in the South of France, the industrial area of l'etang de Berre hosts 430 industries classified for the protection of the environment and more than 60% of the Seveso II (referring to the European directive 96/82/CE) plants of the region. About 16 towns representing more than 300,000 inhabitants are exposed to the plumes produced by these plants.

On man, air pollution is now associated with respiratory and eye diseases such as asthma, lung cancer and conjunctivitis, especially in the young and elderly (UNEP/WHO, 1992; Patel, 1994). Lead as a pollutant is particularly serious for children, since relatively low concentrations of lead in the blood may have a damaging and permanent effect on their mental development (Needleman et al, 1991). On the environment, air pollution is a major contributor to effects such as acid rain, which has been responsible for much damage to soil, fish resources and vegetation, often very far away from the source of the pollutant (Acid Rain 2000, 2001). Air pollution is also responsible for the effect of smog, which is a reduction in visibility due to scattering of light by airborne particles. It may also cause offensive odours in addition to soiling buildings and monuments. Kamau E.C (2010) in his case study says that Pan Paper has been accused of polluting activities since it was founded. Back in the year 2000, the area councillors took an initiative to urge the company management to check pollution caused by effluent from the factory. The chairman of the Webuye Environment Commission and the legislators claimed that the factory was producing corrosive emissions and dumping liquid and solid waste in the open

environment as a result of which iron sheet roofing on houses in the town were rusting and animals and crops were dying. Recently, a number of health symptoms in humans attributed to pollution from the industry were confirmed, including irritation of the eyes and nose, cough, breathlessness, nausea, headaches and mental illness and depression. A medical technician confirmed this report while lamenting, "(…) Babies are being born with chest and breathing problems. Our children will have no future if they are born sick into this world." Apart from these tangible effects, there had been no measurements to show the level of pollution until a team of local environmental and human rights investigators from Resource Conflict Institute (RECONCILE) and their local community partners, Centre for Development and Education Program (CDEP), received assistance from Global Community Monitor (GCM). The latter trained and equipped them with special buckets for taking samples.

"Since 1974, a pulp mill in Western Kenya has been polluting the air and water in the town of Webuye. Visitors report that the air smells like rotten cabbage and "snowstorms" of foam droplets from the mill's waste ponds cloud the sky and burn the skin and nose." (www.elaw.org - Winning clean air for Kenya).

However, by far, the most serious long-term environmental effect of air pollution is global warming, which, it is now recognized, may soon threaten the very existence of human life, especially in the coastal and highland regions. Concern about global warming led to the famous Kyoto Protocol of 1997, through which over 100 countries undertook to reduce their emissions of certain pollutant gases significantly (NRP, 2001; Brasseur and Pszenny, 2001).

Considering its effects and potential effects on man and his environment, air pollution is clearly one of the greatest threats to sustainable development today.

2.2 Causes of Air Pollution

Some air pollutants may be introduced through natural occurrences such as volcanic eruptions, wind soil erosion, forest fires, sand storms, dispersion of plant pollen, etc.; however, pollutants are mainly introduced through man-made activities, particularly industrial manufacturing plants engaged in the manufacture of chemicals or allied products whose processes depend on the chemical reaction of two (2) or more elements or compounds and includes plants producing acids, fertilizer materials, dyestuff, synthetic fibers and industrial gases and motor vehicle operation. These activities are mainly concentrated in cities and other urban areas, which today

are expected to be holding nearly half the World's population (UNCHS, 1996). Cities and urban areas therefore contain the bulk of people that are most vulnerable to the immediate effects of air pollution. This fact received international recognition when in 1992, the United Nations Conference on Environment and Development (UNCTED) made specific recommendations in its Agenda 21 (UN,1992) with regards to addressing air pollution in cities. One key recommendation was, "… the establishment of appropriate air quality management capabilities in large cities and the establishment of adequate environmental monitoring capabilities or surveillance of environmental quality and the health status of populations".

2.3 Policies and legislation on industrial air pollution

This section looks at the international, regional and national, protocols, conventions, agreements, policies and legislation on industrial air pollution.

2.3.1 International

2.3.1.1 The United Nations Framework Convention on Climate Change

The United Nations Framework Convention on Climate Change entered into force on 21st March 1994, after being ratified by 50 states. The Convention's general objective is the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (Article 3). To achieve this the Convention elaborates legally binding commitments in three categories: (1) those to be undertaken by all Parties; (2) those that apply to OECD countries, except Mexico, the EEC and eleven countries that are undergoing transition to a market economy; and (3) those to be undertaken by OECD countries except Mexico and the EEC. One commitment that applies to all parties is; preparation and communication to the Conference of Parties (COP) of national inventories of greenhouse gas emissions caused by human activity using comparable methodologies.

2.3.1.2 The Kyoto Protocol on Climate Change

The Conference of the Parties (COP) of the United Nations Framework Convention on Climate Change held a conference in Kyoto, Japan on December 1-11, 1997 and agreed on a plan to reduce greenhouse gas emissions which was resultant of this protocol. The developed countries are required to reduce these emissions by five per cent in the 2008-2012 periods relative to 1990 which is used as the base year. The Protocol offers the Annex I parties three market-based

mechanisms for achieving these targets: emissions trading; clean development mechanism (CDM) and joint implementation. Increasingly, other programs such as REDD+ (which are rooted in Articles 2 and 3 of the Protocol), and wetland conservation and restoration are seeking to reduce GHG emissions.

2.3.1.3 The Convention on the Transboundary Effects of Industrial Accidents

Is a United Nations Economic Commission for Europe (ECE) convention signed in Helsinki, Finland, on 17 March 1992 that entered into force on 19 April 2000. The Convention is designed to protect people and the environment against industrial accidents. The Convention aims to prevent accidents from occurring, or reducing their frequency and severity and mitigating their effects if required. The Convention promotes active international cooperation between countries, before, during and after an industrial accident.

The Convention helps its Parties (that is States or certain regional organizations that have agreed to be bound by the Convention) to prevent industrial accidents that can have transboundary effects and to prepare for, and respond to accidents if they occur. The Convention also encourages its parties to help each other in the event of an accident, to cooperate on research and development, and to share information and technology.

2.3.2 Regional Level

2.3.2.1 East African Community

The East African treaty of 1999 established the East African Community to focus on various areas of cooperation including environment and natural resources management. One of the key objectives of the treaty is the commitment to promote sustainable utilization of natural resources. Sustainable utilization of natural resources aims at minimizing industrial air pollution for safer air quality.

2.3.3 National Level

2.3.3.1 The Constitution of Kenya 2010

The Constitution is the supreme law of the land that lays the fundamental principles for the governance of the country. All the provisions dealing with the conservation of the environment

and natural resources are to be found in the laws enacted under the Constitution. The constitution provides that every citizen is entitled to a clean and healthy environment and therefore is against any form of pollution in this case industrial air pollution that will pollute the environment and cause discomfort to the public either health wise or otherwise.

2.3.3.2 Physical Planning Act

This Act provides for the preparation and implementation of physical development plans and establishes the responsibility for the physical planning at various levels of Government in order to remove uncertainty regarding the responsibility of urban planning. It provides hierarchy of plans in which guidelines are laid down for future physical development of areas referred to in the specific plan. The Physical Planning Act also promotes public participation in the preparation of plans and requires that in preparation of plans proper consideration be given to the potential for economic and social development. In planning for industries according to the Act, strong controls must be exercised in establishing industries if surrounding areas are not to suffer or deteriorate. It is suggested that a public authority retains the title to the land and leases it to private firms. In this way there would be stronger controls than town planning regulations alone. Buffers could be created between these estates and homes such as major internal roads, shopping and commercial centres, community buildings and school etc. this grouping of facilities would be mutually beneficial.

2.3.3.2 The Environmental Management and Coordination Act, 1999 (EMCA)

It's a promising attempt to create a stable and efficient system of regulation. It was established in Kenya in 1999, and entered into force in January 14, 2000. It aimed at establishing an appropriate legal and institutional framework for the management of the environment and other matters connected therewith and incidental thereto (Preamble). It asserts the paramount right of every individual to a clean and healthy environment and gives every Kenyan a right to bring an action to stop environmental damage. It is mandated to supervise and coordinate all matters relating to the environment and implement all policies relating thereto and to make an assessment of changes in the environment and other possible impacts, and, the operation of any industry, project or activity, to determine its immediate and long term effects on the environment.

2.4 Measures on industrial air pollution

Only spatially and temporally concentrated pollution can be retracted effectively by anthropogenic efforts, and such methods are already in use in such projects as the U.S. Superfund, a program implemented by the U.S. Environmental Protection Agency (EPA) to contain hazardous pollution and restore polluted sites. Any dissolute pollution (pollution present in low concentrations in aquatic systems) cannot be removed efficiently by human efforts since such large areas are affected and must therefore be removed through natural biodegradation. The only way to restore biodiversity to areas affected by dissolute pollution is to remove the sources of pollution, make sure that toxic buildups can be naturally removed through chemical, physical and biological processes (Alexander, 2000) and ensure that pollution-intolerant organisms have access to recolonize the area. The process, especially of the last two steps, is very time-consuming; it may take 10 to 50 years to increase biodiversity in the system and rebuild ecosystem services (Langford et al., 2010), as evidenced from cleanup efforts in the U.S. and the U.K. To evaluate solutions to pollution, it may be helpful to distinguish between different kinds of industrial pollution. A first and common distinction is between sources of pollution: point sources, which are spatially and temporally defined such as a factory, and non-point sources, which are impossible to locate or confine such as household emissions (Auty, 1997). Only point sources can be effectively reduced by treatment of waste due to the possibility of regulation, whereas lessening the overall consumption will affect both point and non-point sources. Another distinction may be chosen between the uses of the pollutant: agrochemicals, industrial organic and inorganic waste, and household emissions of chemicals.

Organic and inorganic wastes are releases of large amounts of the most Eco toxic materials such as heavy metals, ammonia, cyanide, volatile organic compounds, halogenated organic compounds and arenes (U.S. EPA, 2011). Release of these chemicals into the environment is not intentional; that is, the release of these chemicals is not required in order for any process to work. Because agrochemicals are intentionally released into the environment, prohibiting their usage would probably not be politically or economically feasible. This kind of regulation would significantly raise food prices and incur food shortages and famines because pests would destroy a significant amount of the crop yield. A feasible solution should include both reduction of use and shifts to less chronically toxic products. As such a solution may lead to a reduction of crop yield and will definitely require farmers in industrialized countries to change their habits; it can

only be implemented through enforced government regulations. To make decisions about how to regulate agrochemicals, governments will need objective data on the damage pollutants pose to environments.

2.5 Gap Identification

From the literature review it is clear that industries pose a major challenge to air pollution both to the environment and communities around. New partnerships among all relevant stakeholders should be formed and specifically the industries to undertake joint planning and accelerate projects to mitigate challenges affecting them all. The main challenge here is coming up with means to mitigate air pollution from industries. This study aimed at helping in; moving from rhetoric to actual air pollution management plans on the ground and incorporating the local community in the planning project right from conceptualization to implementation.

2.6 Theoretical Framework

From the review of literature, major factors contributing to industrial air pollution include; unchecked/uncontrolled emissions by industries, insufficient technology to come up with ways to mitigate industrial air pollution, poor implementation of policies governing industrial pollution. Inadequate involvement of the local communities in the planning process has also been a major challenge.

2.7 Conceptual Framework

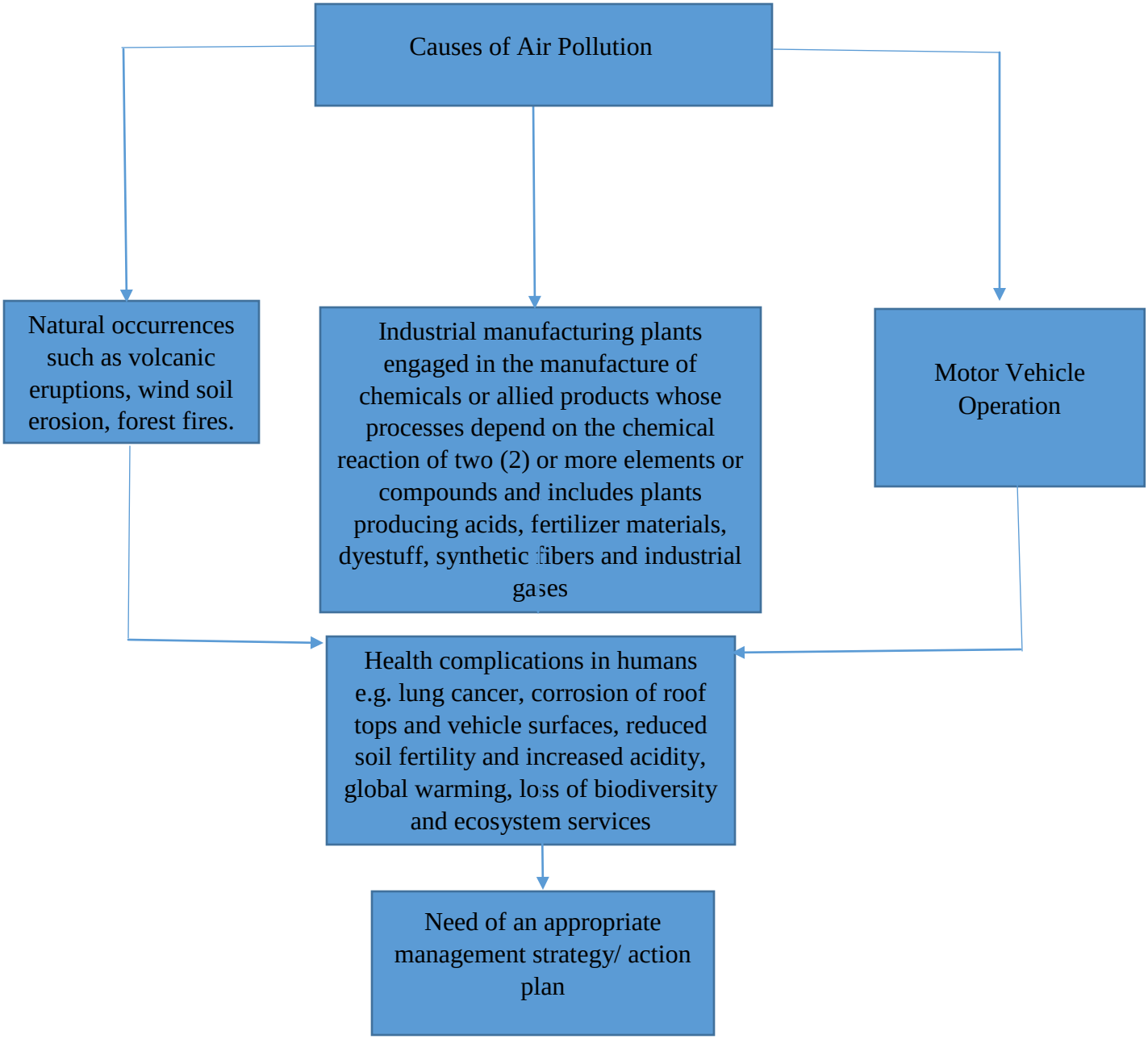
Continuous industrial air pollution comes about as a result of various factors which are either directly or indirectly linked to the issue of study. It can lead impairment of water quality in interest areas, health complications by individuals within the local areas, and affecting soils fertility and acidity in an area. When these occur, there's an outcry action to be taken thus calling for an appropriate management plan.

To achieve sustainability in this area of study, it calls for more attention from government officials and other relevant stakeholders to restore the quality of air. For results to be achieved, the interest community must be involved fully.

According to fig 2-1 below, air pollution is caused by: natural occurrences including volcanic eruptions, forest fires; industries engaged in manufacture of chemicals/allied productions whose

processes depend on the chemical reaction of two or more chemicals; motor vehicle operations. The main focus of this study is however on air pollution from industrial processes. This has consequent harmful impacts on livelihood, soil fertility, biodiversity, and global warming. This therefore calls for the need of an appropriate management strategy/plan.

Fig. 2-1 Conceptual Model for Management of Industrial Air Pollution



Source: derived by researcher

CHAPTER 3

AREA OF STUDY

3.1 Introduction

Nairobi city is popularly ‘referred to as the green city in the sun’ and the CBD is the heartbeat of the city. It has grown from humble beginnings since the late 1890’s; Nairobi city has grown from a simple railroad depot on the railway linking Mombasa to Uganda, to become the fourth largest city in Africa, in terms of infrastructure development and size. The CBD skyline is usually compared to cities in America and Asia. This is due to a construction boom after independence and another construction boom after independence, and another construction boom in the late 1990s and early 2000s. It has evolved from a rustic village to an important economic hub for the East African region.

3.2 Physical Set-up

Figure 3-1: Location Map of Nairobi. Source: www.midnightwatcher.wordpress.com

The city is situated 1^{o} 17'S 36^{o} 49^{o} E / 1.283^{o} S 36.817^{o} E and occupies 696 km^{2}. It's situated between the cities of Kampala and Mombasa. It's adjacent to the eastern edge of the Rift Valley. The Ngong Hills located to the west of the city are the most prominent geographical feature of the Nairobi area. Mt. Kenya is situated north of Nairobi, and Mt. Kilimanjaro is towards the south-east. The Nairobi River and its tributaries traverse through the Nairobi County. It is partially surrounded by The Great Rift Valley Mountain Ranges thus emissions are prone to be trapped since mountain range plays as a barrier. No strong winds blowing therefore no quick dispersion of pollutant. The pollutants stay longer inside the region thus prone to occur is thermal inversions.

3.3 Ecological Set-up

Under the Köppen climate classification, Nairobi has a subtropical highland climate. At 1,795 metres (5,889 ft) above sea level, evenings may be cool, especially in the June/July season, when the temperature can drop to 10 °C (50 °F). The sunniest and warmest part of the year is from December to March, when temperatures average the mid-twenties during the day. The mean maximum temperature for this period is 24 °C (75 °F). There are two rainy seasons, but rainfall can be moderate. The cloudiest part of the year is just after the first rainy season, when, until September, conditions are usually overcast with drizzle. As Nairobi is situated close to the equator, the differences between the seasons are minimal. The seasons are referred to as the wet season and dry season. The timing of sunrise and sunset varies little throughout the year for the same reason.

Table 3-1: Climate for Nairobi

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average high °C (°F)	25.5 (77.9)	26.7 (80.1)	26.8 (80.2)	25 (77)	23.6 (74.5)	22.5 (72.5)	22 (72)	22.7 (72.9)	25 (77)	25.7 (78.3)	24 (75)	24.4 (75.9)	24.49 (76.11)
Daily mean °C (°F)	18 (64)	18.8 (65.8)	19.4 (66.9)	19.2 (66.6)	17.8 (64)	16.3 (61.3)	15.6 (60.1)	15.9 (60.6)	17.3 (63.1)	18.5 (65.3)	18.4 (65.1)	18.1 (64.6)	17.77 (63.95)

Average low °C (°F)	10.5 (50.9)	10.9 (51.6)	12.1 (53.8)	13.4 (56.1)	12.1 (53.8)	10 (50)	9.2 (48.6)	9.1 (48.4)	9.7 (49.5)	11.3 (52.3)	12.7 (54.9)	11.7 (53.1)	11.06 (51.92)
Rainfall mm (inches)	58.3 (2.295)	49.8 (1.961)	92.2 (3.63)	242.3 (9.539)	189.5 (7.461)	38.6 (1.52)	17.6 (0.693)	24 (0.94)	31.2 (1.228)	60.8 (2.394)	149.6 (5.89)	107.6 (4.236)	1,061.5 (41.787)
Avg. rainy days (≥ 1 mm)	4	4	8	16	13	5	3	4	4	7	14	9	91
Mean monthly sunshine hours	288.3	268.4	266.6	204	189.1	159	130.2	127.1	180	226.3	198	257.3	2,494.3

Source : Hong Kong Observatory *(1961-1990) and* World Meteorological Organization

3.4 Economic Set-up

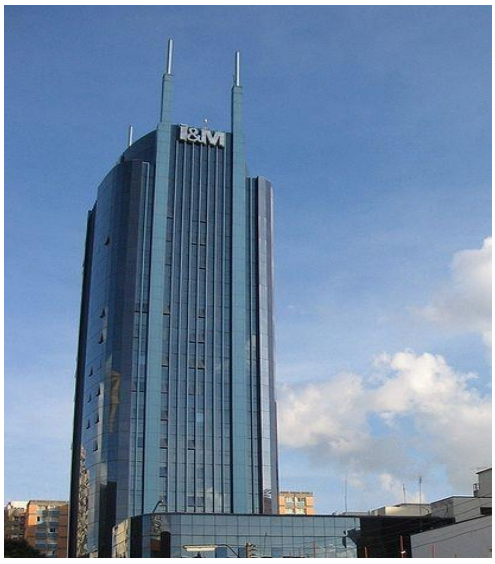


Plate 3-1: I&M Bank headquarters in Nairobi

Nairobi plays an important role in the global, regional, national and local economy. It is a centre of international diplomacy, finance, banking and commerce, because of its facilities and its strategic position in the African continent. The city is a hub of road, rail and air transport networks, connecting eastern, central and southern African countries, and the potential for development is huge. Nairobi employs 25% of Kenyans and 43% of urban workers in the country, generating over 45% of national GDP (UN-Habitat).

Nairobi is home to the Nairobi Securities Exchange (NSE), one of the largest in Africa. It was officially recognized as an overseas stock exchange by the London Stock Exchange in 1953. Its Africa's largest in terms of trading volumes and 5th largest in terms of Market Capitalization as a percentage GDP.

Nairobi is the regional headquarters of several international companies and organizations. In 2007, General Electric, Young &Rubicam, Google, Coca-Cola, Airtel, and Cisco Systems relocated their African headquarters to the city. The UN office at Nairobi hosts UNEP and UN-Habitat headquarters. Several Africa's largest companies are headquartered in Nairobi. Goods manufactured in Nairobi include clothing, textiles, building materials, processed foods, beverages, and cigarettes. Several foreign companies have factories based in and around the city i.e. Goodyear, General Motors, Toyota Motors, and Coca-Cola.

Nairobi has a large tourist industry, being both a tourist destination and a transport hub. It's one of the few cities with a National Park within its boundaries making it a prime tourist destination as well with several other tourist attractions. The Nairobi National Park is unique in being the only game-reserve of this nature to border a capital city, or any major city, with animals including lions, giraffes, buffaloes and black rhinos and a home of over 400 bird species. Nairobi is also a home to several museums, sites and monuments e.g. Nairobi National Museum. It's nicknamed the *Safari Capital of the world,* and has many spectacular hotels to cater for safari-bound tourists. It's also home to the largest ice rink in Africa: the Solar Ice Rink at the Panari Hotel's Sky Centre. Other places of interest include: Uhuru gardens, Giraffe Centre, Bomas of Kenya, and Karen Blixen Museum among others.

3.5 Social Set-up

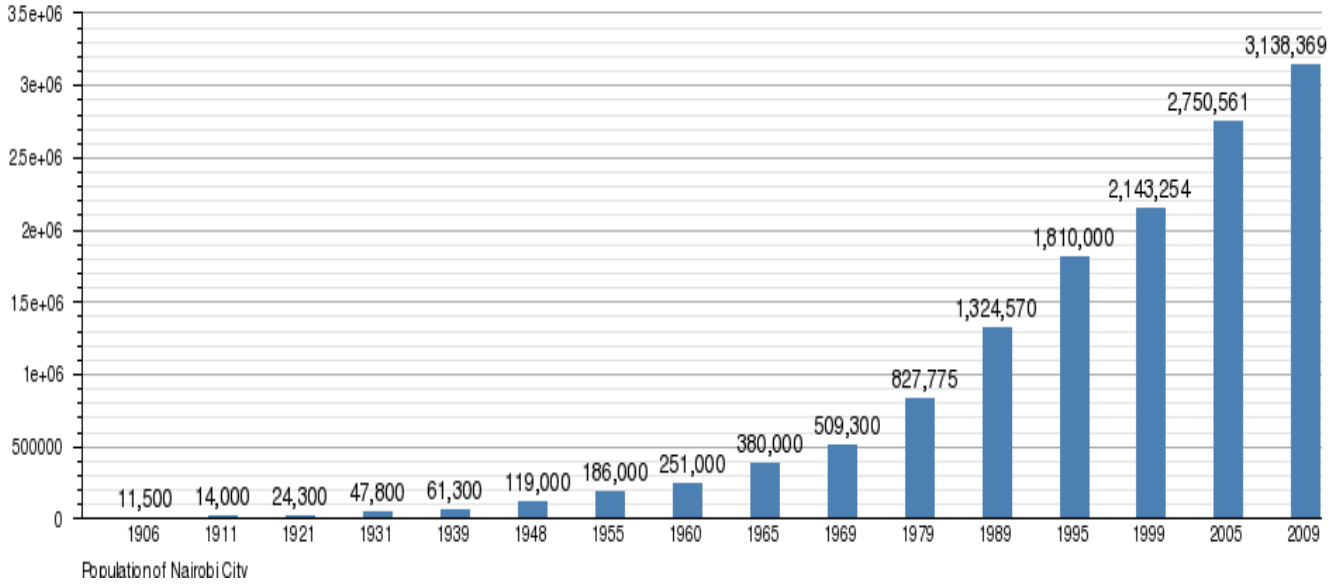


Figure 3-2: Population of Nairobi between 1906 and 2009

Nairobi has experienced one of the highest growth rates of any cities in Africa. Since its foundation in 1899, Nairobi has grown to become the largest city in East Africa, despite being the youngest city in the region. The growth rate of Nairobi is currently 4.1%. It is estimated that Nairobi's population will reach 5 million in 2025.

These data fit remarkably closely (r^2 = 0.9994) to a logistic curve with t(0) = 1900, P(0)=8500, r = 0.059 and K = 8,000,000. This suggests a current (2011) growth rate of 3.5% (the CIA estimate of 4.5% cited above would have been true in 2005). According to this curve, the population of the city will be below 4 million in 2015, and will reach 5 million in 2025, (Kenya Central Bureau of Statistics. Retrieved 2009).

Nairobi has the highest growth rates per annum compared to the other growth rates in Africa. 75% of the urban population growth is absorbed by informal settlements. The number of urban population living in slums will double in the next 15 years. Informal settlements cover only 5% of the total residential land area of the city, but they are inhabited by at least half of the city's population. (Intra-City Differential Study of Nairobi, 2004).

CHAPTER 4

RESEARCH DESIGN AND METHODOLOGY

4.1 Introduction

This chapter describes mainly the research design and methodology of my study, which focuses on population description, sampling frame, methods of sampling, nature and sources of data, data collection methods, methods of data analysis and presentation and constraints of data collection.

4.2 Research Design

This is majorly a systematic plan to study the scientific problem or issue of concern. Defines the type (descriptive, correlational, semi-experimental, experimental, review, meta-analytic) and sub-type i.e. (descriptive longitudinal case study), research question, hypotheses, independent and dependent variables, experimental design and data collection methods and a statistical analysis plan.

This involved use of Case Studies- which are usually used as a precursor to more rigorous methods and avoid the problem of the experiment environment affecting the behaviour of organisms tested. It's Experimental- i.e. involving standard practice of manipulating quantitative, variables, to generate statistically analysed data. This involved quantitative data, data collection and testing of hypotheses.

4.3 Nature and Sources of data

The study aimed at assessing the impact of industry on pollution of the air in Nairobi region majorly within the industrial area, and proposing an action plan to mitigate the impact of industries on air to achieve sustainability. The majority of the data was in form of administered questionnaires as for the local community, interviews with factory workers and self-administered questionnaires on the officials. Further observations on the conditions in the study were done and recorded using observation guides and photographs for visual aid to depict the conditions of the

area. Existing maps were also a major source of data showing the extent/margin of air pollution done by industries.

The data collected for the study involved primary data collected directly from the field and secondary data, which was abstracted from the documented literature on the subject study, and tertiary data which were general references such as Wikipedia, dictionaries, Encyclopedia Britannica among others.

4.3.1 Primary data

This is a type of data that is collected directly from the first hand sources by means of surveys, experimentation, research or observation. It's raw data that has not been previously published and is derived from a new or original research study and collected as the source. White (1977) states that its advantage is that, the exact information required is obtained for as long as terms are spelt out carefully to avoid misunderstanding. For the purpose of the study primary data was collected through questionnaire administration at the Industrial area, interviews with factory workers and interviews with resource persons in relevant institutions, observation and photography.

4.3.2 Secondary Data

This is data collected for purpose of other than the completion of a research project and is used to gain initial insight into the research problem, and enables the researcher to have a view of what is to be found in the field. It's classified in terms of its source i.e. internal or external. It is recorded information inform of relevant literature. It's cheaper since it doesn't require a researcher to get to the field first. For the purpose of this study, secondary data was collected from documented information/literature (textbooks, journals, dissertations, and review of relevant development plans and information on industrial air pollution) to topographical maps and satellite imagery.

4.3.3 Tertiary Data

A tertiary source is an index and/or textual condensation of primary and secondary sources. It usually gives general explanations condensed from 'common knowledge' on the topic intended for a broad public audience, and aren't usually credited to a particular author, but intended only to provide a superficial overview of what the topic includes; its basic terminology, basic

definitions and often references for further reading (usually secondary sources). This included: bibliographies, dictionaries, encyclopedias, and almanacs, guide books, survey articles, timelines, user guides and Wikipedia.

4.4 Population Description

The study concentrated on several interest groups of people, including; the local community i.e. constituting households within the industrial area of Nairobi, the Nairobi City County, land owners and other business sectors and industry workers and consequent areas within Kasarani and Roysambu that don't have industries around.

4.5 Sampling frame

Sampling frame refers to a statistical sub-population from which to take the sample that locates individuals within the population, and usually collected from a true population. Sampling frame is the statistical population from which to take the sample, M.C Cullagah (1978). It's the list from which the potential respondents are drawn.

4.6 Methods of Sampling

The study employed the following sampling methods to administer household questionnaires and interview factory/ industry workers: random sampling, cluster sampling and multi-stage sampling.

4.6.1 Random Sampling

This is a sampling method where every of a given population have an equal chance/probability of being included in the sample and every possible sample an equal chance of being drawn. This method was preferred since the area was relatively large. Respondents were drawn from households and factory workers. This type of sampling technique was easier and was applicable in areas where houses were not constructed in order (scattered), in areas around SOUTH B, MARIAKANI, MAKONGENI and KALOLENI within industrial area and subsequent areas around KASARANI and ROYSAMBU that have no industries around.

4.6.2 Cluster Sampling

It's an example of a 'two-stage sampling' where the population of study is divided into distinct clusters. It's necessary because population distribution is rarely even. A sample area is usually chosen then sample respondents within the area are selected. The population is divided into clusters of homogenous units, usually based on geographical contiguity. Sampling units are groups rather than individuals

4.6.3 Multi-stage Sampling

This technique is an advantageous and crucial one too since it reduces the study area to a manageable size. It's a complex form of cluster sampling in which two or more levels of units are embedded one in the other. This technique is essentially the process of taking random samples of preceding random samples.

4.7 Methods of Data collection

The study combined various social science instruments of data collection including: inter alia observation/pilot study, questionnaire schedules and interviews.

4.7.1 Questionnaire Administration

A questionnaire is usually a research instrument consisting of a series of questions and other prompts asked/given to individuals to respond to in order to obtain statistically useful information about a given topic. The questionnaires were made up of both semi-structured questions. The semi-structured questions allowed respondents to give their genuine thoughts beyond the simple one word answers and also gave allowance for opinions and discussions. Some of the questions also needed a simple 'yes' or 'no' answer.

4.7.2 Observation

An observation sheet was an important tool in this data collection. The sheet was used to obtain primary data on: the extent of air pollution by industries in the area e.g. by observing roof tops of buildings, strategies in place by industries to manage the air pollution, other factors contributing to air pollution including exhaust from vehicles.

4.7.3 Interviews

Interviews are a systematic way of talking and listening to people (http://www.who.int) and are another way to collect data from individuals through conversations. The researcher or the

interviewer often uses open questions. Data is collected from the interviewee. The researcher needs to remember the interviewer's views about the topic are not of importance. The interviewee or respondent is the primary data for the study. Interviewing is a way to collect data as well as to gain knowledge from individuals. Kvale (1996, p. 14) regarded interviews as " … an interchange of views between two or more people on a topic of mutual interest, sees the centrality of human interaction for knowledge production, and emphasizes the social situatedness of research data." Cohen, Manion and Morrison (2000, p. 267) explain "… the interview is not simply concerned with collecting data about life: it is part of life itself, its human embeddedness is inescapable."

Primary was collected using interview schedules with resource fellows from the Nairobi City County- City planning Department, Environment Department, and Managers/supervisors in various industries.

4.7.4 Photography

Photography usually leaves an opportunity for collaboration around the data material with research colleagues or participants in the study which is an opportunity for challenging imageries and biases. It's usually used as reference/ a reminder to support what one is saying, showing evidence of visit. Photos speak much since we don't have a mind that can capture everything. They usually depict the real ground situation without alterations. While field notes are often regarded as personal and private documents which are rarely shared with others (HAMMERSLEY & ATKINSON 1995), visual data is easy to share and can be used for collaborative research. In this study photos were taken to depict the current air pollution situation within industrial area, for instance, fumes released in the atmosphere, corrosion on roof tops.

4.8 Data Analysis and Presentation

Concept analysis is the process of analysing verbal or written communications in a systematic way to measure variables. After collection, data was organised and analysed based of study guidelines. Qualitative and quantitative methods were incorporated to analyze information gathered from the respondents through calculation of means, percentages and mode. Analysis targeted respondents' expressions, perceptions, events, questionnaires, behavioural observation, photographs, maps and records. The responses and suggestions were discussed according to the

original objectives of the study. In addition, data was analyzed using descriptive statistics representing frequency tables, pie diagrams and bar graphs. Evidently, successful analysis of data entailed

- **Sorting data:** organizing both coded and random data into categories that best serve the purpose of the study. It also entailed prioritizing information based on relevancy and reliability.
- **Quality control check**: this is a control strategy in research that ensures all data collected is important and relevant. In many circumstances, research without quality control systems has flaws that subject them to many questions.

The data was analyzed by used of Microsoft excel.

4.8.1 Constraints of Data Collection

The following were the field constraints:

a) Some respondents, mainly in the household were hesitant in giving information either due to suspicion or ignorance.
b) Time constraints. There was insufficient time to collect the amount of data needed due to time inadequacy in the timeline given.
c) There was poor accessibility of some areas due to poor road connectivity.
d) Lack of facilities and advanced knowledge on complex data analysis techniques, also limited the analysis and presentation of data.
e) Absenteeism of some household respondents for questioning.

4.9 Summary

In summation the research methodology was successful in complimenting and availing necessary information as per the study objectives. Concurrently, the methodology succeeded in bridging research weaknesses and gaps by bringing on board ethical considerations. It is also noteworthy to mention that, the methodology achieved connection of survey to various research components with regards to the topic. Therefore the methodology has accomplished all its desired efforts aimed at collecting data and finding all the research requirements.

CHAPTER 5

DATA ANALYSIS AND DISCUSSIONS

5.1 Introduction

This chapter presents the analysis of data collected from a research conducted around Industrial area of Nairobi region and consequent areas within Kasarani and Roysambu. The main purpose of the study was to investigate which industries in particular in the urban environment are involved and examine its effects on the environment. This will help provide valuable information to the development of alternative ways to control air pollution from industries. It was further aimed at determining major diseases or injuries the pollution inflicts on living and non-living environment. It was also meant to evaluate how the policies and legislations address the issue of air pollution by industries. The study aimed at bringing out the broader aspect of air pollution, its causes and its impacts on the environment. It also aimed at determining the mitigation measures in place to minimize air pollution to help me come up with some of the measures to counter this pollution, and also know some of the measures put before and the challenges encountered in implementing them and coming up with recommendations. Lastly it was meant to suggest strategies to minimize effects and impacts of industrial air pollution. This involved coming up with alternative ways of controlling or reducing the effects of air pollution by industries on the environment.

The study equally involved administration of questionnaires in Nairobi majorly the Industrial area (South B, Mariakani, Makongeni, Kaloleni) and consequent areas within Kasarani and Roysambu.

In the same vein, questionnaires were administered to 20 respondents of which 75% were male and 25% were female.

a) Housing occupancy

According to field data 2014, the different housing occupancy types in the area of study are as shown below:

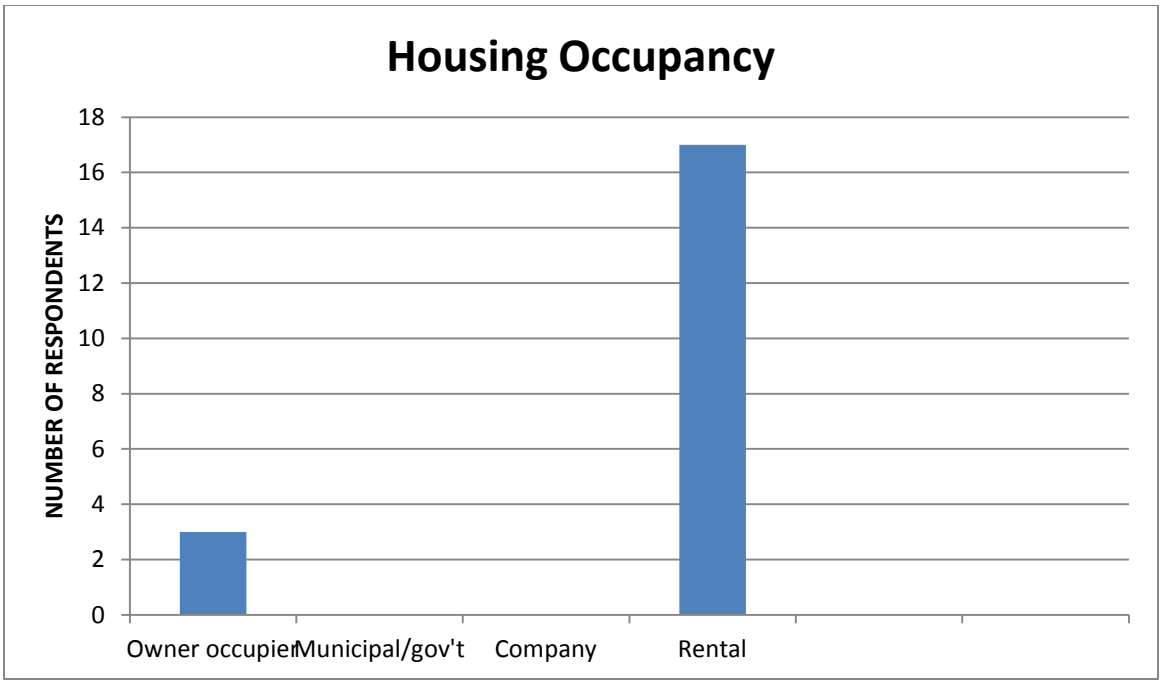


Figure 5-1: Housing Occupancy

Rental housing accounts for the highest percentage of housing occupancy in the study area. 70% of the respondents live in houses with corrugated iron sheet roof tops while 30% live in tiled rooftops. 10% confirmed to live in houses with corrugated iron sheets as walls while the remaining 90% lived in mostly concrete walled houses. The 70% are majorly lower middle and low income earners who have limited purchasing power and are thus the most vulnerable and most affected by the pollution. Their conditions of living are quite demanding as shown in plate 5-1 below.

Plate 5-1: poor housing conditions; made of corrugated iron sheets

The iron sheets are preferred since they're cheaper and easily available. However they pose health hazards to livelihood since they aren't safe for fetching rain water for instance due to contamination of both acid rain and corroded roof tops thus increased health complications including waterborne diseases. The iron sheets are not safe since they weaken easily with time due to corrosion thus can easily collapse or be carried away in case of strong winds or heavy rain pour. They also lack enough capacity to withstand fires as a result. In cases of heavy out poor and roof leaks, the droplets can find their way into food thus contaminating it in the process and affecting people's health. Plate 5-5 also shows further corroding of rooftops in industrial area.

Plate 5-2: polluted water flowing besides the road in Mariakani area

Such loosely flowing water in plate 5-2 in a drainage may find itself in a leaking water pipe and end up in households while contaminated thus affecting them health wise.

b) Duration of stay in the area

Most of the respondents within the area had lived there long enough to feel the effects of air pollution by industries.

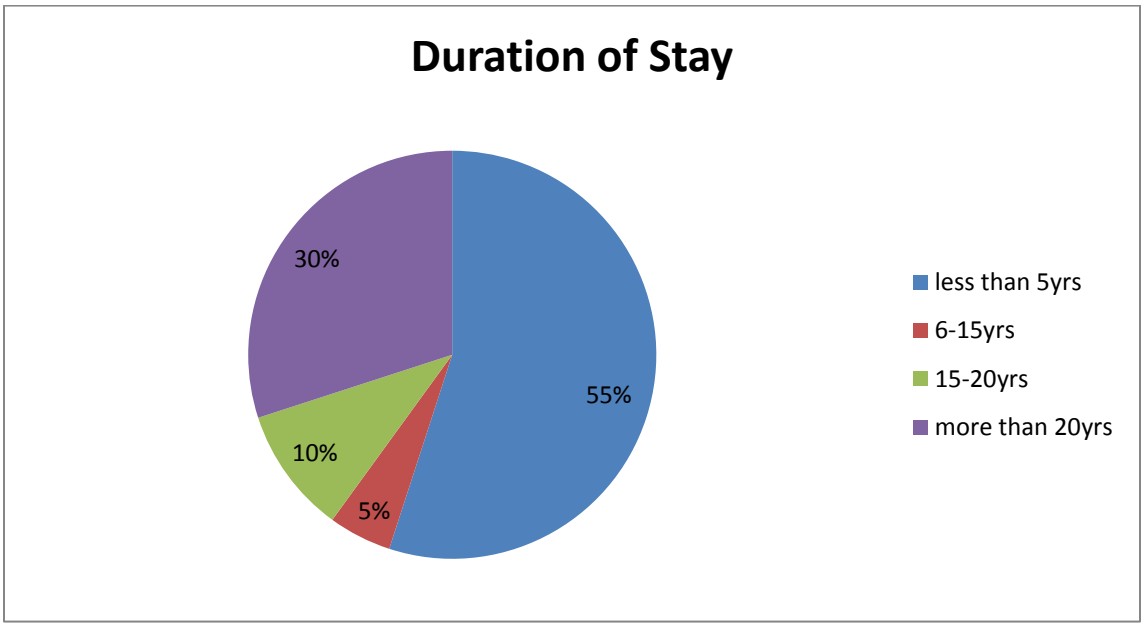


Fig 5-2: Duration of stay in the area of study

c) Educational levels

The levels of education among the households are indicated in the table 5-1 below. According to the table all respondents were past primary level. 45% were of secondary level while 55% of post-secondary level. With education one has basic reading and writing skills and are aware of current issues of concern thus were in better position to comprehend the issue at hand.

Table 5-1: Educational levels of respondents

Level of Education	Frequency	Percentage (%)
None	0	0
Primary	0	0
Secondary	9	45
Post-secondary	11	55

Total	20	100

5.2 Industrial involvement in air pollution

This was the first objective of the study and data was collected through administration of questionnaires, interviews, observation and photos. Field questionnaires were analyzed using excel and the information presented in form of graphs and tables as indicated below. Interviews, observations and photos were analyzed using content study technique.

Data collected from the field shows that industries are contributing a great deal to air pollution and majorly manufacturing and processing industries.

a) Condition of air

100% of the respondents within the industrial area said they were fully aware of pollution by industries majorly within the area. 90% of them said the condition of air within the area was poor and 10% said it was satisfactory while none of them said it was good. From comparative data collected from areas without concentration of industries, 60% did not have an idea of air pollution within the area of study while 40% said they did. On the condition of air within the area, 60% said it was good, 20% said it was satisfactory while the other 20% said it was poor. This openly showed the difference in air quality in the two areas of study in that air quality in areas away from the industries was relatively cleaner than that of areas within industrial area.

b) Contributing industries

The major contributors to air pollution from the research are mainly manufacturing and processing industries including: chemical processing industries, wood, paint, cereal processing, vehicle assembling, plastic manufacturing, food and beverage processing, metal /iron processing industries among others. These industries use high content toxic materials such as heavy metals, ammonia, cyanide, volatile organic compounds, halogenated organic compounds, Sulphur dioxide among others which are harmful to humans, animals and plants and the general surrounding.

Plate 5-3: heavy chemical and manufacturing industries in industrial area

One respondent identified the British American Tobacco industry that releases heavy fumes into the air that affect the environment. Timsales industry that is involved in wood processing was also cited by a respondent as to releases dust from timber that mostly affects the workers who frequently inhale it.

Plate 5-4: emission of harmful smoke in the atmosphere in industrial area

Plate 5-5: release of fumes in the air in industrial area

c) Causes and effects of industrial air pollution on the environment

As one walks through industrial area all the way past the Railways foot bridge behind the Technical University of Kenya, the smell of polluted air strikes you coming from chemical processes in the industries around all the way down Enterprise road to General Motors Company. Besides inhaling polluted air, one respondent complained of corroded roof tops as a result of chemical fumes from the industries that have weakened overtime thus leak during rainy seasons, and also complained that the industries have grown so close to residential areas unlike before where they were slightly away from residential areas. They also corrode rooftops of vehicles.

Plate 5-6: corroded roof tops in sections of industrial area

The causes of industrial pollution include:

1. Lack of Policies to Control Pollution: Lack of effective policies and poor enforcement drive have allowed many industries to bypass laws made by pollution control boards which has resulted in mass scale pollution that has affected lives of many people.

2. Unplanned Industrial Growth: In most industrial townships just like Nairobi, unplanned growth has taken place wherein those companies have flouted rules and norms and polluted the air.

3. Use of Outdated Technologies: Most industries in industrial are still rely on old technologies to produce products that generate large amount of waste. To avoid high cost and expenditure, many of these companies still make use of traditional technologies to produce high end products.

4. Presence of Large Number of Small Scale Industries: Many small scale industries and factories in the area don't have enough capital and rely on government grants to run their day-to-day business thus often escape environment regulations and release large amount of toxic gases in the atmosphere.

5.3 Major diseases and injuries on livelihood

On asked whether they can breathe easily in rushing chokes of industry fumes during their working hours, 100% of the respondents said no. effects of this is coughing and health complications on livelihoods. Some of the major diseases and health complications mentioned by respondents included: lung cancer, whooping cough, nausea, colds, heart complications and breathing difficulties. Another complication is irritation of the eyes and nose, and burning of the skin due to contact with the chemical fumes from the industries. These diseases have affected both humans and animals within the area. With such complications one is not able to work efficiently thus reducing manpower in areas of production. Further complications have led to increased deaths mostly amongst infants increasing the infant mortality rate. Much is being spent in hospitals treating such complications. The chemicals and fumes in the long run end up in water bodies thus affecting the quality of water being consumed by households. Part of it falls as rain water. Respondents complained of some leaking water pipes thus some of the chemicals fall directly into water being piped to households. One of the respondents raised an alarm on the

water quality since a number of residents have been complaining of taking contaminated water in the past few months. The mentioned cholera and typhoid being major diseases being experienced.

Plate 5-7: Contaminated water from industries in a drainage

When asked to respond on the safety of the water they take, 40% said the water was very safe, 30% said it was fairly safe, while the other 30% said it was unsafe.

According to statistic done in line with the Integrated Master Plan of Nairobi, respiratory related illnesses contribute to the highest number of mortality rates in Nairobi as shown in table 5-2 below.

Table 5-2: Top ten major causes of mortality (%) in Nairobi (1998- 2000)

	1998	**1999**	**2000**
Respiratory symptoms	37.0	27.0	35.5
Malaria	23.1	18.8	14.7
Accidents	-	14.2	10.0
Skin diseases	14.4	6.6	7.7
Diarrhoea	9.3	8.3	9.5
Urinary tract disease	4.6	Not indicated	6.0
Intestinal worms	4.1	Not indicated	Not indicated
Disease of puerperium and childbirth	3.9	7.3	Not indicated

Eye infections	3.2	7.9	6.7
Ear infections	-	9.4	0.8

Source: City of Nairobi outlook; Nairobi Integrated Master Plan

Most respiratory illnesses are linked to poor air quality and with this effect, industrial air pollution. It's therefore proper to say that industrial air pollution is highly contributing to deaths in Nairobi.

5.4 Policies and legislation

Data collected from various respondents shows that there are various legal policies and institution frameworks that guide the management of industrial air pollution, such include:

1. Constitution of Kenya 2010
2. EMCA 1999
3. Physical Planning Act
4. Regulatory standards from NEMA for release of fumes from industries
5. Environmental conservation by laws 2008

Air pollution in Kenya is mainly controlled through the Public Health Act and the Factories Act under the statutory law. However, it has not been efficient enough in dealing with problems of air pollution at the national level. Its main failure lies in lack of clean air act.

According to the data collected on the level of policy awareness, the Constitution of Kenya 2010 is the popular legislation. However most of the respondents were not aware of any legal provisions on air pollution.

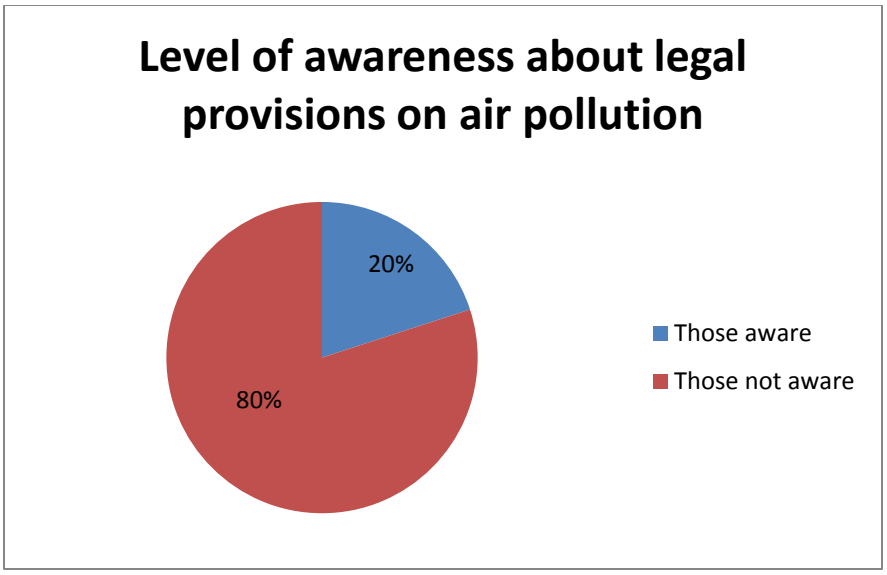


Fig.5-3: Level of awareness about legal provisions on air pollution

The figure shows that only 20% of the respondents were aware of legal provisions on air pollution while 80% were not.

70% of the respondents cited ineffectiveness in the coordination of the existing policies and legislation in the management of air pollution by industries, 10% were satisfied while 20% termed it as fair. Challenges faced in implementing such policies as stated by the respondents included: negligence (from both the policy implementers and the industries), corruption, lack of infrastructure/adequate technology, poor planning by the policy makers, lack of political goodwill, and poor coordination between relevant stakeholders.

On the other hand, the institutions interviewed listed non-compliance and lack of awareness and information on existing policies as a challenge to implementation of policy and legislation. It was also noted that the relevant institutions do not provide community awareness on air pollution, and lack of air quality standards, laws and policies was cited as a major challenge in providing such awareness. One of the institutions interviewed (maize manufacturing factory) cited harassment from the city council askaris who sometimes ask for bribes.

The community around and factory staff acknowledged the existence of policies and legislative frameworks. According to the data collected on community response, the policies and legislative framework is considered as good because legislative frameworks have provisions for ensuring clean air thus preventing industrial air pollution.

Suggestions brought forth to address the inadequacies of the policies and legislative frameworks include: creation of awareness; impose punitive measures for polluters (policies that will state actual cost for various forms of pollution); formulation of relevant policies, regulations and air quality standards; setting up of monitoring and evaluation units at the county; recruitment of additional technical staff; enhance community participation in policy formulation and effective enforcement/implementation of relevant laws and policies.

Further, data obtained from institutions show that they face challenges in policy implementation. These include inter alia: Lack of capacity (qualitative and quantitative), shortage of technical staff and non-compliance from developers. Causes of these problems were cited as: poor enforcement mainly by NEMA, through EIA and Audit; the county is yet to develop relevant tools, policies and regulations to tackle air pollution by industries. Other challenges included: Lack of generally applicable criteria and standards; overlap of tasks of the different legislations, and hence of the different organs; and lack of enforcement powers, lack of precedents; the onerous burden (of proof) imposed on would-be litigants;17 lack of criteria and standards; lack of cases testing existing remedies, except injunction; the lack of clarity as to who bears the cost of litigation for public rights; the low level of public environmental consciousness; and until recently, the standing requirements (direct personal interest in the subject of the suit).

5.5 Mitigation measures to minimize air pollution

Due to increased air pollution by industries, the following were the suggested mitigation measures:

1. Enforcement of bylaws that regulate industrial air pollution e.g. testing of chemical content in fumes before being released to ensure they meet the international threshold allowed.
2. Application of self-regulation mechanisms by industries
3. Setting up of monitoring and evaluation units at the county level to ensure consistent check on the industries involved
4. Cleaner production dealing with air pollution at the source
5. Use of electric /solar powered generators/safer energy in production
6. Industries being located in their own designated areas away from residential areas
7. Emitted smoke/gases should be screened before being let out in the air

8. Giving a green light to industry owners around without harassing them
9. Community/stakeholder partnerships to ensure comprehensive management and implementation of laws put in place.
10. New technology/innovation that limits release of fumes/chemicals in the air
11. Closure of industries that release excessive fumes into the atmosphere
12. Protective gear including gloves, aprons, masks and goggles to workers in such industries to reduce health implications
13. Provision of milk to workers mostly in the wood processing industries that produce much dust

5.6 Strategies to minimize effects of industrial air pollution

1. Use of dust collectors/vapour recovery systems for industries that release much dust and contaminated vapour to reduce its effect o humans
2. Carrying out of frequent air pollution checks by the industries involved
3. Use of scrubbers that remove some particulates/gases from industrial exhaust streams e.g. carbon dioxide, hydrochloric acid and ammonia
4. Use of electrostatic precipitators/air cleaners by industries that release contaminated fumes into the air
5. Use of shades in parking lots to minimize corrosion of vehicle rooftops

Plate 5-8: Parking with an improved shade to avoid corrosion of vehicle surfaces

Apart from industries, other sources of air pollution noted from the respondents included: automobiles, waste burning and dust from vehicles and other machinery.

Plate 5-9: Waste burning on the side of the road with vehicle traffic

These pose such a great risk to people living in such areas. In plate 5-8 above, people walking besides the road are inhale both exhaust fumes from vehicles, waste being burnt.

CHAPTER 6

RECCOMENDATIONS

6.1 Introduction

It is clear management of industrial air pollution should be taken a notch higher to reduce the effects of air pollution in the atmosphere. This should be done with an open participatory approach involving both the industries involved and the community with specialist input at all stages of the planning process. As noted earlier, the existing strategies have not comprehensively dealt with the challenge of air pollution by industries. Such strategies are usually characterized with by limited participation by the interested and affected parties and entrenched organizational cultures thus have not solved the issue at hand.

This management strategy with the recommendations is aimed at developing of coordinated or linked arrangement for decision making with the aim of reducing conflicts and resolving them where possible. It calls for harmonizing values and input of a broad range of agencies when formulating, designing and implementing programmes in order to achieve a common goal. It involves skillful improvement of existing systems, laws and policies that are globally acceptable to ensure proper management of the air to ensure sustainability of the environment. It's also focused on ensuring proper implementation and actualization of policies set in place to govern air pollution by industries.

6.2 Diseases and physical injuries from industrial air pollution

1. Lung cancer
2. Whooping cough
3. Nausea
4. Colds, wheezing and asthma attacks mostly in children
5. Heart complications and breathing difficulties
6. Irritation of the eyes and nose

7. Burning of the skin due to contact with the chemical fumes from the industries

Recommendations:

1. Setting of industries away from residential areas
2. Providing protective working gear for factory workers to avoid direct contact with chemicals
3. Screening of emissions before being released into the air
4. Proper equipping of hospitals to handle such complication in case of their occurrence
5. Neighbouring residents to carryout proper basic health and safety measures

6.3 Policies and legislative framework

The challenges faced in the implementation of policies and legislative frameworks in the management of air pollution by industries include:

1. Conflicting policies and legislation
2. Non-compliance by developers
3. Lack of quantitative and qualitative capacity
4. Poor coordination amongst the stakeholders involved
5. Corruption among policy enforcers
6. Inadequate funds
7. Lack of adequate air quality standards
8. Lack of political good will
9. Lack of infrastructure/adequate technology
10. Conflict of interest between stakeholders

Recommendations:

1. Harmonization of the policies and mandate of various institutions
2. Proper and strict enforcement of relevant laws and policies with stern penalties for non-compliance
3. Setting up of monitoring and evaluation units/watchdogs at the county level

4. Prioritize active multi stakeholder participation by sensitization on the need for stakeholder participation.
5. Promote the values of integrity among public officials in line with Chapter 6 of the Constitution of Kenya
6. Budgetary re-allocation should prioritize on environmental management through enhancing systems that promote better financial management within policy enforcing organizations.
7. Improved infrastructure and technology for implementing bodies to easily follow up on industries
8. Formation of relevant policies, regulations and air quality standards
9. Involvement of politicians in the implementation of policies
10. Clear definition of roles of various institutions

6.4 Impacts of industrial air pollution on the environment

Impacts of industrial air pollution can be grouped into the following:

6.4.1 Human health impacts

1. Fine particulate matter ($PM_{2.5}$) and ground-level ozone (O_3) can affect human respiratory and cardiovascular systems. The young, the elderly and those with acute illnesses are at greater risk of such effects. $PM_{2.5}$ and ground-level O_3 have been associated with hospitalizations, increased respiratory and cardiovascular mortality, asthma exacerbation, decreased lung function, lung inflammation and changes in heart rate variability. Sulphur oxides also contribute to the incidence of respiratory diseases.
2. Impacts range from minor breathing problems to premature death. The more common effects include changes in breathing and lung function, lung inflammation, and irritation and aggravation of existing heart and lung conditions (e.g. asthma, emphysema and heart disease). There is no safe level for $P_{M2.5}$ and $_{O3}$ that does not pose risks to human health.
3. Negative health effects increase as the concentrations of pollutants in the air increases. Even modest increases in concentration (e.g. $PM_{2.5}$ and O_3) can cause small but

measurable increases in emergency room visits, hospital admissions, skin cancer, cataracts and premature death.

6.4.2 Environmental Impacts

1. Ground-level ozone damages vegetation, including crops, flowers, shrubs and forests, by interfering with plants' ability to produce and store food. This damage makes them more susceptible to disease, pests and environmental stresses.
2. Nitrogen oxides (NO_x) and sulphur dioxide (SO_2) can become acidic gases or particulates, and cause or accelerate the corrosion and soiling of materials. Together with ammonia, they are also the main precursors of acid rain. Acid rain affects soils and water bodies, and stresses both vegetation and animals. Acidic rain can also contaminate drinking water and vegetation, damage aquatic life, and erode buildings.
3. It also causes natural rhythms and patterns to fail, meaning that the wildlife is affected in a severe manner. Habitats are being lost, species are becoming extinct and it is harder for the environment to recover from each natural disaster.
4. With the rise in industrial pollution, global warming has been increasing at a steady pace. Smoke and greenhouse gases are released by the factories into the air, which causes an increase in the greenhouse effect and increase in global warming. Melting of glaciers, extinction of polar bears, floods, tsunamis, hurricanes are few of the effects of global warming.

6.4.3 Economic impacts

1. The health effects from $PM_{2.5}$ and ground-level ozone can reduce work attendance and overall participation in the labour force. In terms of increased health care costs, missed days of work, and reduced worker productivity.
2. Increased ozone levels also reduce the growth of crops, plants and trees, leading to economic losses in agriculture and forestry.

Recommendations:

1. **Controlling Airborne Particulate Matters –** Airborne particulate matters (PM) emissions can be minimized by pollution prevention and emission control measures. Prevention, which is frequently more cost-effective than control, should be emphasized. Special attention should be given to mitigate the effects, where toxics associated with particulate emissions may pose a significant environmental risk. Measures such as improved process design, operation, maintenance, housekeeping, and other management practices can reduce emissions. By improving combustion efficiency in Diesel engines, generation of particulate matters can be significantly reduced. Proper fuel-firing practices and combustion zone configuration, along with an adequate amount of excess air, can achieve lower products of incomplete combustion (PIC). Few following steps should be adhered to control PM:

   a. Choosing cleaner fuels – Natural gas used as fuel emits negligible amounts of particulate matter.

   b. Low-ash fossil fuels contain less noncombustible, ash-forming mineral matter and thus generate lower levels of particulate emissions.

   c. Reduction of ash by coal cleaning reduces the generation of ash and Particulate Matter (PM) emissions.

   d. The use of more efficient technologies or process changes can reduce products of incomplete combustion (PIC) emissions.

   e. Advanced coal combustion technologies such as coal gasification and fluidized-bed combustion are examples of cleaner processes that may lower PICs.

   f. A variety of particulate removal technologies, are available – these are: Inertial or impingement separators, Electrostatic precipitators (ESPs), Filters and dust collectors (bag houses), Wet scrubbers that rely on a liquid spray to remove dust particles from a gas stream.

2. **Use of air pollution control devices / equipments for industries, in general –** The commonly used equipments / process for control of dust in various industries are: Mechanical dust collectors in the form of dust cyclones; Electrostatic precipitators – both dry and wet system; particulate scrubbers; Water sprayer at dust generation points; proper ventilation system and various monitoring devices to know the concentration of dust in general body of air.

   The common equipments / process used for control of toxic / flue gases are: the process of desulphurization; process of denitrification; Gas conditioning and various monitoring devices to know the efficacy of the systems used.

3. **Health and Safety Preventive Measures –** The most successful tool of prevention of respiratory diseases from industrial dust/fumes is to minimize exposure. However, this is not an efficient practical approach from the perspective of industries such as mining, construction/demolition, refining/manufacturing/processing, where industrial dust/fumes are an unavoidable byproduct. In such cases, industries must implement a stringent safety protocol that effectively curtails exposure to potentially hazardous dust/fume sources. The following precautionary measures are recommended to reduce exposure to a variety of industrial dust types:

a) Recognize when industrial dust/fumes may be generated and plan ahead to eliminate or control the emission at the source. Awareness and planning are keys to prevention of silicosis.
b) Avoiding use of silica sand or other substances containing a high percentage of crystalline silica as abrasive blasting materials, sulphur oxides and ammonia. These should be substituted with less hazardous materials.
c) Use of engineering controls and containment methods such as blast-cleaning machines and cabinets, wet drilling, or wet sawing of silica-containing materials to control the hazard and protect adjacent workers from exposure.
d) Routinely maintain emission control systems to keep them in good working order.
e) Practice good personal hygiene to avoid unnecessary exposure to other worksite contaminants such as lead.

f) Wear disposable or washable protective clothes at the worksite.
g) Shower (if possible) and change into clean clothes before leaving the worksite to prevent contamination of cars, homes, and other work areas.
h) Conduct air monitoring to measure worker exposures and ensure that controls are providing adequate protection for workers.
i) Use adequate respiratory protection when source controls cannot keep chemical exposures below the designated limit.
j) Provide periodic medical examinations for all workers who may be exposed to respirable chemicals.
k) Post warning signs to mark the boundaries of work areas contaminated with respirable harmful chemicals.
l) Provide workers and the neighboring residents with training that includes information about health effects, work practices, and protective equipment for harmful effects from exposure to such emissions.
m) Report all cases of illnesses or injury due to exposure to such emissions to any private / State health departments.

4. **Role of government** – The government of Kenya plays a very important role in prevention of air pollution. It is through government regulations that industries are forced to reduce their air pollution and new developments in technology are created to help everyone do their part in the prevention of air pollution. The government should continuously make regulations stricter and enforce new regulations that help to combat any new found source of air pollution and develop more comprehensive emissions permit systems. The government should invest in scientific studies on the damaging effects on plants, animals and human life. The legislative body should write laws to control emissions. It should also invest more in education in schools and universities where trainers teach students, beginning at very young ages, about the effects of air pollution.

   It should also introduce Emission Charges (are prices established for the right to emit a unit of a pollutant) to ensure polluters pay for emissions released thus discourage illegal emissions from industries. Its advantage is that it directly internalizes a negative externality by pricing the use of the environment to emit fumes. The first step to solving

air pollution is assessment. Government researchers should investigate industrial air pollution and develop standards for measuring the type and amount of some serious air pollutants. It can also use incentives to encourage compliance. they should also determine how much exposure to such pollutants is harmful. Once exposure levels have been set, steps can be undertaken to reduce exposure to industrial air pollution. These can be accomplished by regulation of industrial air pollution through legislation.

5. **Planting of trees –** Trees reduce air pollution, and planting them is one of the most concrete, satisfying actions that can be taken to help the air quality in our regions. Trees produce oxygen and absorb carbon dioxide, which they turn into food. Researchers can find out what types of trees are best to plant in certain areas and take action.

6.5 Summary and Conclusion

The knowledge base for industrial air pollution is expanding fast but still with significant gaps in the management process. Industrial air pollution prevention efforts of companies have generally focused on both source and waste reduction, and on reuse and recycling. Preventing air pollution within a company's manufacturing processes remains the key approach. Cleaning and processing, switch to non-polluting technologies and materials, reduced generation of emissions, converting hazardous by-products to non-threatening forms, etc. have been attempted in this regard. The fragmentation of responsibilities for industrial air pollution is proving to be a great impediment to promoting sustainable management of the environment. This has brought about conflict of interest among various stakeholders. A proper management plan is therefore an important alternative for management of air pollution by industries not only in Kenya but other countries characterized with similar management problems. The success of such a management strategy is however cosseted in the basic principle of guaranteeing informed decision-making fastened with accountability which is pulled off using an open, participatory approach of public and specialist input during all stages of the management process, with due consideration of alternative and a genuine attempt to mitigate negative impacts and enhance positive aspects.

It should be noted that, only through the efforts of scientists, business leaders, legislators, and individuals can we reduce the amount of air pollution by industries on the planet. This challenge

must be met by all of us in order to assure that a healthy environment exist for ourselves and our children.

For an effective management strategy, implementation and coordination mechanisms are to be put in place. Existing management strategies are capable of achieving management of industrial air pollution, but need has arisen for new institutions based on the perspective of regional and local development committees. It should further be noted that although industrial air pollution is managed at various levels in the political and socio-economic systems, sustainable environmental management requires the development of relevant institutions in appropriate levels of management to govern air pollution by industries. Proper integration with other pollution related management systems should be put into account. Capacity building in the relevant institutions is an important constituent in the implementation of a management strategy.
In conclusion it is noted that a proper management plan/strategy for industrial pollution may result in sustainable management of the air quality. This would however end up in a deadlock in Kenya if there's no proper effective legislation and institutional framework.

6.6 Areas for further study

In the course of the research it was open that several issues have to be researched further. They include:

a) Ways to determine where and how often unhealthy peaks occur in industrial environments
b) International partnerships to promote worldwide reductions in global industrial pollutants.
c) Global campaigns against industrial air pollution and extend of their successes and failure

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7 APPENDICES

7.1 Appendix 1: Planning Matrix

Challenges/causes and effects	Recommendations	Actors	How to be achieved	Time frame (years)	Benefits
1. **Industrial involvement in air pollution**					
Lack of policies to control industrial air pollution	Formulation of relevant policies, legislations and air quality standards.	Government, County, NEMA, Parliament, ministry of Environment, Water and Natural Resources, NEMA	• Proper awareness • Stakeholder involvement/participation • Avoid forceful/harassing approaches	Continuous process	• Quality regulation standards • Improved compliance amongst industries • Improved air quality
Non-compliance/negligence amongst developers	Proper and strict enforcement of relevant laws and policies with stern penalties for non-compliance	County and local government, NEMA, Local administration	• Integrity among law enforcers • Developers complying to laws put in place • Awareness amongst	Continuous process	• Improved legislation • Proper management of industries • Promotion of integrity

			industries		
Unplanned industrial growth	• Setting up of monitoring and evaluation units at county level to ensure check on growing industries • Proper legislation on process of growth and designated areas for establishment	Ministry of Environment, Water and natural resources, County Government, Ministry of Industrialization & Enterprise Development	• Standard procedure for registration & establishment of industries • Follow up watchdog units on functioning of industries	Long term	• Controlled growth and development of industries • Reduced mushrooming of sub-standard industries
Use of outdated technology	New technology/ innovation that limits release of fumes	Industry Owners, NGOs, Ministry of Industrialization & Enterprise Development, KEBS, County and national governments	• Improved quality training of workers • Stakeholders participation	Continuous	• Quality technology with reduced harmful effects and pollution levels • Input from various fields of specialization

2. **To evaluate how the policies and legislations address the issue of industrial air pollution in Nairobi county's industrial area**

Conflicting policies and legislation	Harmonization of the policies and mandate of various institutions	Ministry of Environment, Water and Natural Resources, NEMA, County and National Governments	• Unifying policy that integrates conflicting policies and constitutions. • Single institution to deal with all the matters pertaining to industrial air pollution	Long-term	• Effective and efficient co-ordination • Easier management of industries on air pollution • Proper coordination among relevant institutions
Poor stakeholder co-ordination	Prioritize multi-stakeholder participation	County Government, Local community, Private sector, NGOs, industries	• Communication • Education • Awareness • Information sharing • Public participation	Continuous process	• Improve acceptance and recognition of the projects and programs • Utilization of indigenous knowledge • Pulling together of knowledge and experience • Enhances co-ordination within institutions, industries, departments and the government

Corruption among policy enforcers	Promote value and integrity among public officials in line with chapter six of the constitution	Ethics and Anti-corruption Commission, Community, Religious leaders, Local administration	• Preaching integrity • Community& industry watchdogs • Social and financial auditing • Information availability to everyone • Policy enforcement and compliance	Continuous process	• Accountability • Good financial management • Value for money • Economic development • Promotion of integrity within industries
Inadequate funds	• Prioritize on environmental management during budget allocation. • Establish systems that promote better financial management within institutions/organizations. • Access other sources of funds e.g. donors	NGOs, MPs, National Treasury, County Government, Controller of Budget	• Liaising with global financial institutions e.g. IMF • Utilization of local available resources e.g. labour to cut down funds • Members of the community and NGOs lobbying their representatives to allocate more funds	Continuous	• Effective implementation of policies and legislation. • Better financial management. • Taking opportunity of available resources. • Better investment opportunities

	and grants		for environmental management.		
Non-compliance by developers	Proper and strict enforcement of relevant laws and policies with stern penalties for non-compliance	County and local government, NEMA, Local administration	• Integrity among law enforcers • Developers complying to laws put in place • Awareness amongst industries	Continuous process	• Improved legislation • Proper management of industries • Promotion of integrity • Reduced conflict between industry owners and the government
Lack of adequate air quality standards	Establishment of proper relevant air quality standards	County and local government, NEMA, Ministry of Environment, Water and Natural resources, KEBS	• Equipping of counties with adequate tools and equipment • Counties training and stakeholder involvement	Continuous	• Improved air quality • Proper management of industrial emissions • Improved hands on skills by enforcers • Prevented air pollution damage on human and animal health
Lack of quantitative and qualitative capacity	Improved infrastructure and technology for implementing bodies	County and local government, Ministry of Industrialization and enterprise	• Training more skilled personnel • Recruitment of additional technical	Continuous	• Improved quality service provision •

		development	staff • Value addition mechanisms		
3. **Diseases and physical injuries**					
Increased mortality rates	• Improved health services	Ministry of Health, hospitals, county and national governments	• Improved training on air pollution related illnesses amongst medics	Continuous process	• Reduced mortality rates • Improved health standards
Reduced work attendance and overall participation in the labour force due to illnesses	• Practice good personal hygiene to avoid unnecessary exposure to other worksite contaminants • Wear disposable or washable protective clothes at the worksite • Improved workers	Ministry of Labour, Social Security and Services, County and National Governments, Ministry of Industrialization and Enterprise Development	• Provide periodic medical examinations for all workers who may be exposed to respirable chemicals • Post warning signs to mark the boundaries of work areas contaminated with respirable harmful	Continuous	• Improved work attendance and labour force

	healthcare • Avoiding contaminated working areas		chemicals.		
Increased health care costs, missed days of work, and reduced worker productivity	• Subsidized health costs on factory workers • Proper check up and follow up on factory workers	Private& State health departments, Ministry of Health, Ministry of Labour, Social Security and services, County and National governments	• Report all cases of illnesses or injury due to exposure to such emissions to any private / State health departments	Continuous process	• Improved worker productivity • Reduced healthcare costs

7.2 Appendix 2: Institutional Interview Questionnaire

KENYATTA UNIVERSITY

Department of Environmental Planning and Management

INSTITUTIONAL INTERVIEW QUESTIONNAIRE

INTRODUCTION

I am a Kenyatta University Undergraduate student pursuing a Bachelors Degree in Environmental Planning and Management. I am carrying out a research on the **Management of Industrial Air Pollution in Industrial area, Nairobi County.** I am kindly requesting for your time to answer some questions. Please kindly note that the information this study seeks to obtain shall solely be used for academic purposes only. Any information provided by the respondent will therefore be held with utmost confidentiality.

Institutional Questionnaire

1. **Institution Details**

Name of Institution _____

Respondents Name _____

Name of the Interviewer _____

Year of Establishment _____

1. What were the main purposes for establishing the institution? .....

.....

2. What role does the institution play in relation to industrial air pollution…….

3. To what extent have you achieved your objectives as far as industrial air pollution is concerned?.....

.....

4. What (if any) challenges do you face in your work? .....

.....

5. Can you briefly explain the causes of these problems?

……

……

6. What suggestions would you recommend to improve the situation?

.....

7. a.) How are the management of industrial air pollution strategies arranged?

……

……

b.) What causes delay in establishment if any

…….....

i) Local dispute […] ii) Administrative backlog […]

8. Do you seek technical expertise on management of industrial air pollution?

……..

9. Has the government been able to provide services where and when required?

……..

If no, what would you suggest is done?

……

……

……....

Sustainable air pollution management practices

a) What are the air pollution management practices encouraged by industries?

Practice	**Mark appropriately**
Legislation to regulate air pollution	
Dust collectors	
Vapour recovery systems	
Air pollution checks	
Scrubbers	
Waste water treatment	
Electrostatic precipitators/air cleaners	
Reduced use of harmful chemicals	

Others (specify)	

b) Do you provide awareness on air pollution to the community?

Yes ☐ No ☐ if yes, what kind of awareness?

……

…….....

c) What challenges do you face in giving such awareness?

7.3 Appendix 3: Household Interview Questionnaire

KENYATTA UNIVERSITY

Department of Environmental Planning and Management

HOUSEHOLD INTERVIEW QUESTIONNAIRE

INTRODUCTION

I am a Kenyatta University Undergraduate student pursuing a Bachelors Degree in Environmental Planning and Management. I am carrying out a research on the **Management of Industrial Air Pollution in Industrial area, Nairobi County.** I am kindly requesting for your time to answer some questions. Please kindly note that the information this study seeks to obtain shall solely be used for academic purposes only. Any information provided by the respondent will therefore be held with utmost confidentiality.

Household Questionnaire

Bio Data Information

Date of Interview _____

Name of the interviewer _____

Household Head Name _____

Respondent(s) Name _____

Relationship of respondent to Household Head _____

1. **Background Information**

a) Why did you decide to settle in this area?

……

……

……

b) How long have you lived in this area?

Less than 5 years ☐ 15-20 years ☐

☐ ☐

6-15 years More than 20 years

c) Level of Education None [ ] Primary [ ] Secondary [ ] Post-secondary [ ]

d) What is you occupation ……

e) Level of Income

Income Bracket	**Tick where appropriate**
Less than 5000	
5001 – 10000	
10001 – 15000	
15001 – 20000	
20001 – 30000	
30001 – 40000	
40000 and above	

2. Housing Details

a) Housing Occupancy (tick appropriately)

i) Owner Occupier [ ]

ii) Municipal/ government house [ ]

iii) Company house [ ]

iv) Rental house [ ]

v) Others (specify) …….

b) Housing Characteristics

TYPE	**DESCRIPTION (either iron sheets, tiles, paper, concrete, earth, bricks, plastic) specify**
Roof Type	
Floor Type	
Wall Type	

c) What housing problems do you encounter

……

……

……

d) How can these problems be solved in your opinion?

……

……

……

3. Details on industrial air pollution

a) Do you have an idea of air pollution by industries around? Yes [ ] No [ ]

b) What is the condition of air in this area? Poor [ ] Satisfactory [ ] Good [ ]

c) If poor, what type of health complications have you had due to poor quality of air

i) Respiratory diseases [ ] specify the disease …….

ii) Skin diseases [ ] specify the disease ……

iii) Other diseases [ ] specify the disease ……...

d) What are the major causes of air pollution in the area?

i) Automobiles [ ]

ii) Industries [ ]

iii) Waste burning [ ]

iv) Dust [ ]

e) Can you breathe easily in rushing chokes of industry fumes in their working hours?

Yes [ ] No [ ]

f) How can we control air pollution from industries in your area?

……

……....

.....

4. Existing Policies and legislation for management of pollution by industries

a) Are you conversant with the legal provisions on air pollution?

Yes ☐ No ☐

If yes, specify which ones.

……

……

……

b) In your opinion, is there any gap in the existing legislation?

Yes ☐ No ☐

c) What are the challenges faced in implementing such policies?

……

……

……

……

.....

d) How effective is the coordination of the existing policies and legislation in the management of air pollution by industries?

Good ☐ Fair ☐ Bad ☐

5. Water Supply

a) Water sources

Water Sources	**Uses**	**distribution**	**Amount/cost per month**	**Quality**	**Reliability**
Piped					
Public stands					
Water kiosks					
Water vendors					
River/stream					

b) How safe is the water you take?

Very safe ☐ fairly safe ☐ Unsafe ☐

If unsafe, what can be done to improve the quality?

7.4 Appendix 4: Observation Guide

KENYATTA UNIVERSITY

Department of Environmental Planning and Management

OBSERVATION GUIDE

a) Corrosion on roof and vehicle surfaces Yes [ ] No [ ]

b) Observable health effects on individuals

c) Strategies in place for managing air pollution from industries

   i) Existence [ ]

   ii) Not in existence [ ]

d) Chemical effects on plants within the vicinity

   i) Observed [ ]

   ii) Not observed [ ]

e) To what extent is the air pollution in the region? Large [ ] Average [ ] Less extent [ ]

f) Breathing difficulty around industries

   Yes [ ] No [ ]