Soot Pollution in Port Harcourt Nigeria: A Grand Societal Challenge

Faith Ayomikun Omisakin

Leadership and Organization
Degree of Master of Arts (120 ECTS) with a major in Leadership and Organization
Master thesis with a focus on Leadership and Organization: Societal Challenges and Organizational Changes (OL675E), 30 ECTS.
Spring semester 2022
Supervisor: Filippa Säwe

Soot Pollution in Port Harcourt, Nigeria: A Grand Societal Challenge

Faith Ayomikun Omisakin

Leadership and Organization
Degree of Master of Arts (120 ECTS) with a major in Leadership and Organization
Master thesis with a focus on Leadership and Organization: Societal Challenges and Organizational Changes (OL675E), 30 ECTS.
Spring semester 2022
Supervisor: Filippa Säwe

Abstracts

Omisakin, F. A. (2022). *Soot pollution in Port Harcourt, Nigeria: A grand societal challenge.* Malmö, Sweden: Malmö University, Faculty of Culture and Society, Department of Urban Studies.

Soot pollution is a form of air pollution that can severely damage public health and the environment. The Residents of Port Harcourt, Rivers State, Nigeria, and its environs have been suffering from the negative environmental effects of particle (soot) pollution since the fourth quarter of 2016. The emergence this pollution has been drawing the interest of academics, international and local civil society organizations, and the government. The study analyzes soot pollution as a grand societal challenge in Port Harcourt, Nigeria, and critically understand the role of environmental governance (different stakeholders) and leadership concerning soot pollution in Port Harcourt, Nigeria. Given the interest of this research, the author decided to view the research problem from a social constructive perspective. Qualitative method (interview) was adopted in collecting data from eight (8) different stakeholders; two representatives from government, oil companies, civil society, and the community members respectively. The content and thematic analysis technique was used to analyze key informant interviews. Empirical findings shows that soot pollution in Port Harcourt Nigeria is a complex problem and poses several threats to the public health, politically, economically and the social environment. Further results also indicated governance as one of the most important factors in ensuring a sustainable environment.

Keywords*: Soot pollution, Air pollution, Grand societal challenges, Environmental Governance, Illegal bunkering.*

Contents

List of Tables

Figures of Tables

Abbreviations

BC Black Carbon

CBN Central Bank of Nigeria's Statistical Bulletin

CO_2 Carbon Dioxide

COPD Chronic Obstructive Pulmonary Disease

CVD Cardiovascular Disease

EPA Environmental Protection Agency, United States

GHG Greenhouse Gases

GSCs Grand Societal Challenges

IOCs international Oil Companies

NESREA National Environmental Standards and Regulations Enforcement Agency

NOSDRA National oil spills detection and response agency

OPEC Organization of Petroleum Exporting Countries

PM Particulate Matter

WHO World Health Organization

Introduction

Soot pollution is a form of air pollution that can severely damage public health and the environment. Air pollution introduces large quantities of particulate or gaseous contaminants into the atmosphere to induce unfavorable environmental impacts (Ewubare et al., 2021). It is characterized by an increase in the oxidizing capacity of the atmosphere, decreased atmospheric visibility, and deterioration of air quality in a given region. (Ewubare et al., 2021; Wang et al., 2014). In addition, it significantly impacts the climate, living environment, and human health (Ewubare et al., 2021; Ilten & Akpinar et al., 2007). The environment has been on the receiving end and has become overburdened due to human excesses in their struggle for survival. Our environment is a complex web of physical, chemical, and biological factors that interact and impact all living things and their surroundings (Ewubare et al., 2021). The environment is the source of a global economy that must be managed and protected sustainably (Ewubare et al., 2021, p. 82). All efforts geared at controlling and governing the environment ensure the continuous presence of diverse biological entities on the earth, of which humans are the prime species; without them, humans cannot exist (Ewubare et al., 2021; Aluko, 2005).

According to the World Health Organization (WHO), air pollution is the leading cause of death globally, accounting for 3 million fatalities yearly. Outdoor air pollution was responsible for 11.6 percent of global mortality in 2012, equivalent to 6.5 million deaths (Ewubare et al., 2021; Yakubu, 2017). Seven hundred eighty thousand (7800,000) people die prematurely because of air pollution in Africa yearly, which is caused by industrialization in Nigeria and South Africa, and a smaller extent, by fire emissions in Central and West Africa (Bauer et al. 2019). Air pollution occurs when harmful substances other than their natural constituents are present in the air, detrimental to human health and the ecosystem (Whyte et al., 2020; Natural Resources Defense Council, 2018). These substances can take the form of gases, particulate matter (PM), or even energy, such as heat (Whyte et al., 2020; Godish and Davis, 2015). Air pollution is perhaps more widespread in areas where natural resource extraction is performed at both artisanal and regulated levels without regard for best practices or accepted norms (Whyte et al., 2020; Efobi et al., 2019). In such countries as Nigeria, human health is subjected to disproportionate and avoidable amounts of air pollution, posing significant health concerns to local people.

Noncommunicable diseases, such as cardiovascular disease (CVD), chronic obstructive pulmonary disease (COPD), and lung cancer, account for 94 percent of the approximately 90 percent of air pollution-related mortality in low and middle-income nations (Yakubu, 2018). Also, Industrial operations constitute a significant contribution to the cause of air pollution. Similarly, the world bank environmental data showed that in 2015, 94 percent of Nigerians were exposed to high air pollution levels above the WHO guidelines (Whyte et al., 2020; World Bank, 2015). Several studies have been conducted in the state to investigate the impacts of air pollution, most notably acid rain and, more recently, soot pollution (Whyte et al., 2020; Chuks, 2015; Nduka and Orisakwe, 2010; Yakubu, 2017).

1.1 1 Purpose of the Study

The broad aim of the studies is to analyze soot pollution as a grand societal challenge in Port Harcourt, Nigeria, and critically understand the role of environmental governance among different stakeholders concerning soot pollution in Port Harcourt, Nigeria.

1.1 2 Research questions

i. How can we understand different stakeholders' perspectives towards soot pollution in Port Harcourt, Nigeria?
ii. How is soot pollution a crisis of governance?

1.1 3 Structure of the Thesis

This thesis begins with an introduction that leads the reader through a discussion of the paper's objectives and research questions, the background of the study, and the problem area. The literature review is organized so the reader can find the material needed to address the research questions with relevant theories. The methodology chapter will come after, showing how the author acquired data. The empirical data will be compared to the theoretical framework in the analysis chapter. Finally, the last section of the research paper will address the research questions, draw conclusions, and provide the reader with a discussion.

1.2 Background to the study

In recent years, Port Harcourt, Nigeria's oil-rich city in the Niger Delta, has encountered a slew of environmental degradation, which constitutes a source of tension among different stakeholders (government, oil industries, community members, and civil societies). However, the most

devastating of these is soot pollution (black carbon), affecting the city and its environs. Port Harcourt, one of the nine states in Nigeria's oil-rich crude town, is the heart of oil and gas exploration in the region and thus faces increasing air pollution problems (Whyte et al., 2020). The usage of biomass fuels such as firewood, indiscriminate burning of plants and garbage, traffic and industrial pollutants, and gas flaring have all been linked to air pollution (Whyte et al., 2020; Adejoh et al., 2015; Fagbeja et al., 2008; Godson, 2011). The immense oil exploration and production operations and the high population growth rate are significant factors of this problem (Whyte et al., 2020; Olowoporoku et al., 2012; Yakubu, 2017). Nigeria has suffered substantial environmental degradation for more than 50 years of oil and gas exploration and production due to gas flaring and oil spills (Whyte et al., 2020; Brandt, 2020; UNEP, 2011; Zabbey et al., 2017). Despite its commitment to climate change, Nigeria predominantly relies on fossil fuels, which constitute a significant source of flared gas (Whyte et al., 2020; Brandt, 2020).

Although, the residents and activists believe it is a result of the flaring of petroleum products and the burning of tires and refineries that have contributed to the soot pollution in Port Harcourt (Salami, 2018). Also, theft of crude oil from pipelines, in which people destroy pipes and divert the oil to illicit (or artisanal) refineries built up in the bushes, has expanded in recent years in the oil-rich Niger Delta region environs. These refining activities are challenging to predict, as most occur at night and vary daily. More than 40 illegal refineries were discovered in Port Harcourt, Niger Delta (Ihesinachi et al., 2019). This aided in spreading soot pollution – the impure carbon particles produced by the incomplete combustion of hydrocarbons. Some people complained that the government was slow to respond and only acted when individuals expressed their concerns publicly on social media and challenged their inaction.

Traditionally, fishing and farming have been the primary sources of employment in the region, accounting for more than half of all occupations. However, extensive pollution accumulated over time ruined their environment and, as a result, their livelihoods (Yakubu, 2017).

Furthermore, various communities and ethnic groups have been involved in long-term conflicts with oil companies, law enforcement, and the government, particularly over their rights, including land acquisition and ownership, monetary compensation settlements, environmental degradation, and deprivation. Underemployment and unemployment are the highest among youths, accounting for almost 40 percent. Youth unrest in the region is attributable to challenges arising from the

prevailing substandard environmental and attendant socioeconomic conditions (Yakubu, 2017, p.4).

1.2.1 The discovery of Soot in Port Harcourt, Nigeria

According to sources, the first observation of a high concentration of soot in parts of Port Harcourt was in November 2016 (Yakubu, 2017). The soot first appears as clouds laden with dark particulate matter on the skyline in various parts of the state. The black soot accumulates in homes and makes everywhere appear dirty, even when cleaned thoroughly and regularly (Kalu, 2018). It is visible on window nets, streets, walls, floors, and bedsheets, both private and public places, even on children's feet, innocently playing.

Residents frequently wake up to toxic hydrocarbon emissions from nearby creeks and waterways that remain in the air for hours. A visitor could easily conclude that heavy rain was on the way. Still, for the residents who have grown accustomed to the situation, it's a sobering reminder of an environmental problem that refuses to go away (Ojoye, 2017).

Soot pollution has contributed significantly to the unavailability of safe drinking water—76–80 percent in rural areas and 50–55 percent in urban areas lack access to safe drinking water. These circumstances explain why indigenes feel marginalized and disadvantaged in various ways (Yakubu, 2017; NDDC, 2004). This supports the April 2018 ranking of Port Harcourt as one of the most polluted cities in the world, with an air index of 188 (Efekalam, 2022). Similarly, Air Visual ranked Port Harcourt as "very unhealthy" for sensitive groups, having attained an air index of 207.817 in December 2020 (Efekalam, 2022).

Soot pollution is not only a societal problem; it could also be an organizational problem. For example, research shows that employees from the black carbon and rubber industries suffer from severe occupational diseases due to exposure to soot and carbon black (Niranjan & Thakur 2017). Also, in 1987, Bourguet et al. identified soot as a major cause of skin cancer in the tire and rubber industry (Niranjan and Thakur 2017). Environmental pollution has become a severe environmental issue for the citizens of the state, the government, the country, and the international community (Efekalam, 2022).

1.2.2 Different stakeholders' reaction to soot pollution

The Government Action

The Federal Ministry of Environment declared the air pollution in Port Harcourt and its environs an "Emergency Situation" in February 2017 (Ovuakporie 2017; Global Patriot 2017). Subsequently issued a notice to temporarily shut down an asphalt processing plant in Port Harcourt that is spewing out thick smoke from its operation to bring the situation under control while an investigation into the cause of the air pollution was ongoing (Yakubu, 2017). In the same year, the river´s state government set up a task force to tackle the soot polluting with the State Commissioner for Environment, and Special Duty counterparts, as members. The task force went into action and shut down companies to address the issue; Chinese Government Company (CGC), H&H Engineering Company, and AUC Asphalt Company. All three, located in the Aluu community, were discovered to be emitting high volumes of emissions, thus violating environmental regulations, shortly after its inauguration. Although, the residents of Port Harcourt and its environs were still exposed to the pollution (Ojoye, 2017; Yakubu, 2017).

In 2019, following the recent increase in illegal refinery and bunkering activities, according to a report reviewed by a technical team formed by the Rivers State government and led by the state's former Commissioner for Environment, approximately 22,077 people have suffered from respiratory-related illnesses in the last five years (Godwin, 2021). The team of 20 experts from various inter-disciplinary and relevant fields, including a consultant physician and dermatologist at the University of Port Harcourt Teaching Hospital, had conducted investigations into the airborne particulate (soot) in Port Harcourt, and the report stated that illegal bunkering and gas flaring are two major sources of soot in the state (Godwin, 2021).

However, the public believe that the lack of political will by the state administration, alongside failure by the Federal Government, its relevant agencies, international health, and environmental organizations, to implement the report or swiftly initiate moves to tackle the air plague or put in place regulations that will reduce it, has made the challenge of soot to linger (Peterside, 2021).

The Public Reaction

In April 2018, there was a peaceful Streets Walk Campaign against soot pollution in the city and other areas of the state (Yakubu, 2017). The protesters demanded that the authorities take more aggressive and transparent action to reduce the pollution. The situation of the soot pollution

became unbearable that citizens and nongovernmental organizations, including Social Action, began raising concerns and raising awareness, as well as demanding that the government and the International Oil Companies (IOCs) stop the soot (Social Development Integrated Center, 2018) To further the campaign, hashtags such as "#StopTheSoot" and "#StopTheSootNow" were created and trended on Twitter, Facebook, and other social media platforms (Social Development Integrated Center, 2018). The position of the state government was the public should direct their agitation to the federal government that the state government has no power to shut down the refinery which would be regarded as economic sabotage.

Civil Society´s Reaction

In December 2019, the Rotary Club of Port Harcourt Eco a conference titled “Stop the soot Conference”. The organizers wanted a multi-stakeholder approach to raising awareness, teaching residents to take personal safety precautions, proposing solutions to the pollution, and hopefully persuading the government to act (Ajala, 2022). Representatives from the government, traditional institutions, civil society groups, student bodies, multinational oil companies, religious bodies, and media groups were all present. Speakers were mostly health and environmental experts, demonstrated with evidence the short-term (asthmatic attacks, respiratory infections, child pneumonia, and heart conditions) and long-term (cancers, infertility, and congenital disabilities) effects of soot (Dukor, 2021; Ajala, 2022)

For this study, it is necessary to discuss oil production and the historical perspective on illegal bunkering and artisanal refining as one of the major factors that contributed to soot pollution in Port Harcourt and Niger Delta at large Nigeria.

1.2 3. Oil Production in Nigeria

Oil and gas occupy a strategic position in the Nigerian Economy. Petroleum is indeed the life wire of Nigeria’s national Economy. Nigeria is Africa’s largest oil producer and the world’s sixth largest, according to the Organization of Petroleum Exporting Countries (OPEC). The discovery of oil has transformed Nigeria’s political Economy as oil generates 80 percent of the government’s revenue and 90 percent of the country’s foreign exchange (Abdulhaleem, 2021; NDDC 2006;). According to the Central Bank of Nigeria’s Statistical Bulletin (CBN, 2004), oil contributed 93 percent of government export and national revenues between 1970 and 2004 (Emoyan et al., 2008).

Although, in recent years, a significant proportion of the oil has been lost to theft, more than six billion dollars' worth of its oil production or 6.25 percent of total export value (Emoyan et al., 2008). The irony is that the region that generates such a significant proportion of national income continues to suffer from abject poverty, psychosocial and environmental abuse, and degradation due to the intense exploration and exploitation of the petroleum resource that generates the wealth (Emoyan et al., 2008). This condition is made possible by distorted and cynical national legislation on natural resource ownership, years of bad governance, and ineffective policies implemented by bureaucratic government and leadership (Emoyan et al., 2008). Because of the continued absence of environmental monitoring and surveillance systems in the region, even in the face of overwhelming evidence of degradation, this effort reviews in broad strokes the current state of available information on the environment and attempts to further draw attention to some of the factors that have continued and will continue to entrench environmental degradation in the delta while denying overlying communities, access to judicial and constitutional remedies (Emoyan et al., 2008). The oil wastes are discharged into the environment; often, the processing and spill sites catch fire and vast scorching areas of forest and marine vegetation. These are major ecological consequences of oil theft and artisanal refining, compounding the environmental crisis resulting from oil production by the international oil companies (IOCs) (Naanen & Tolani, 2014).

1.2 4. Illegal bunkering and artisanal refinery in Nigeria

Nigeria's onshore production has been concentrated in three states: Bayelsa, Port Harcourt in Rivers state, and Delta states (Yakubu, 2017). These states of the Niger Delta constitute the center for illegal bunkering and artisanal refinery in the country. Nigeria officially classifies nine states as oil-producing states that benefit from the 13 percent oil derivation fund. The states are Abia, Akwa Ibom, Bayelsa, Cross River, Edo, Imo, Ondo, and Rivers (Yakubu, 2017). Akwa Ibom state in 2012 overtook Rivers, officially becoming Nigeria's largest oil-producing state, but most of its oil is produced off-shore, where oil theft is not conspicuous. Hence the state is not mainly affected by the effects of illegal bunkering (Yakubu, 2017). "Bunkering" is the supply of fuel to marine vessels. It becomes unlawful when it is unauthorized. Illegal bunkering in the Nigerian context is the unauthorized lifting of crude oil and processed Petroleum products (Naanen & Tolani, 2014). In official circles, this is oil theft. However, the term "oil theft" has become contentious and emotional in the Niger Delta communities where illegal bunkering is thriving and among advocates of local or regional control of natural resources. They reject the terminology on several grounds;

one of their biggest arguments is that one cannot steal what belongs to himself (Naanen & Tolani, 2014). This complex argument brings into question the issue of sovereignty and constitutional control over certain categories of natural resources, especially minerals (Naanen & Tolani 2014, p. 23).

The petroleum Act of 1969 (as amended) vests ownership and control of oil and gas in Nigeria (including under its territorial waters and continental shelf) in the Nigerian state. The ownership of oil and all minerals in Nigeria is further reinforced under section 44(3) of the 1979 constitution of the Federal Republic of Nigeria. Given the legal position, any unauthorized appropriation of crude oil and processed petroleum products through siphoning from pipelines or other channels should be considered theft. This clarification, therefore, justifies the use of the term "oil theft" or "illegal bunkering" in the present until there is a change in the constitutional position regarding the control of oil and gas resources, is changed (Naanen & Tolani, 2014).

1.2 5. History of illegal Bunkering and Artisanal refining

Illegal bunkering is not new in Nigeria; it seems the practice originated in the late 1970s. Initially, cases of bunkering were dominated by the theft of refined petroleum products, but by early 1980, the illegal bunkering of crude oil had become a growing practice. What is relative to recent provident is widespread artisanal refining. The techniques derive from the distilling process that has been used to produce local gin from fermented palm wine in the swamps of the Niger Delta for centuries (Naanen & Tolani, 2014).

The process was applied to crude oil in producing low-quality fuels, which served the energy needs of the defunct state of Biafra in late 1960 (Naanen & Tolani, 2014). After the collapse of Biafra, the relatively low fuel price made the industry go into temporary suspension. As a result, Nigeria's growing deregulation, and consequently, the increasing process of fuel and scarcity in the hard–to–reach communities of the Niger Delta, revived the practice of artisanal refining in 2004 (Naanen & Tolani, 2014).

Though recent studies suggest that the new wave of artisanal refining originated in Tuomo Community in Buruta L.G. A of Delta State, from where it spread to other parts of the Niger Delta, including Port Harcourt, the study area (Naanen & Tolani, 2014), it may not be correct to describe the revival and commercialization to any single community as artisanal Niger Delta distilling technique is known to most Niger Delta communities. However, the market opportunity provided

by rising fuel prices and scarcity in hard-to-reach Niger Delta communities might have stimulated artisanal refining in several sites (Naanen & Tolani, 2014).

While the broad and remote socioeconomic origins of artisanal refining are fundamentally linked to the country's overall economic, social, and political circumstances, there are two sets of actors who steal and refine oil for the internal market and are affected by varying degrees of poverty and unemployment. The big operators who export stolen oil to the international markets are, by no means, poor people. They are primarily motivated by capital accumulation (Naanen & Tolani, 2014).

They are in the business to make money, and these are the people who can muster the high financial capital requirements of a high-risk illegal international trade and the political capital to protect the business. The local actors are much more numerous than the international players; according to available records, as of 2014, it was estimated that more than 26,000 people are directly or indirectly connected to the local bunkering and illegal refining economy. In 2022, this figure had doubled, with local players found in almost every nook and craning of the Niger Delta accompanied by high-ranked military officers who take part in the business of illegal refining (Naanen & Tolani, 2014).

During the fieldwork, an individual who pleaded anonymously stated that high-ranked military officers sent to curb activities of illegal bunkering and artisanal refinery or secure crude oil pipeline as well as end crude oil theft, bunkering, and illegal refining in the Niger Delta are deeply involved in the business of artisanal refinery.

All the issues mentioned earlier led the people of the oil-bearing communities to continuously be involved in oil theft, illegal bunkering, and artisanal refining. They believe that since they have been completely ostracized from the benefits or proceeds from crude oil, the people took laws into their hands to have a fair share of the profits of their land (Naanen & Tolani, 2014).

2. Reviewed Literature

This session will provide the readers with a general idea of existing knowledge on the topic under consideration. Also, the influence of soot pollution on climate change globally. Deeper understanding of Grand societal challenges and Environmental governance.

Soot sometimes called black soot or black carbon (BC), is a fine black or brown powder that can be slightly sticky and is a product of incomplete combustion. In pollution terms, soot is a common word for a type of particle pollution known as PM 2.5—particulate matter with a diameter of 2.5 micrometers or less. These microscopic particles are even smaller than dust and mold particles, or around 1/30 the size of a human hair (Elem, 2021; American Public Health Association, 2020). The tiny particles in soot (PM2.5) pose unique health challenges. When inhaled, the small particles' size allows them to penetrate deep into bronchiolar tissue, producing oxidative stress, pulmonary inflammation, and potentially deoxyribonucleic acid damage (Whyte et al., 2020; Niranjan and Thakur, 2017; Valavanidis et al., 2013). Soot is released into the air as either very minute particles or liquid droplets. PM2.5 has been related to adverse impacts on ecosystems, visibility impairment, reduced agricultural production in some parts of the world, and materials soiling and degradation (EPA, 2012).

A primary component of soot is black carbon which absorbs light more than any other particle matter. For example, black carbon may absorb a million times more energy than the same mass's carbon dioxide (CO2). Because of this energy absorption and interaction with clouds, black carbon is a significant source of concern for climate change. It's linked to rising temperatures, ice, and snow melting, especially in sensitive areas (EPA, 2012).

Soot pollution is created by the incomplete combustion of fossil fuels (coal, diesel, gasoline, etc.), biofuels (biodiesel, biogas, ethanol, etc.), and biomass (woods, shrubs, dry leaves, etc.) (Rajesh et al., 2018). According to the United States Environmental Protection Agency (EPA), soot pollution is one of the deadliest air pollution agents worldwide. It is one of the most severe environmental hazards to human health and climate change. The World Health Organization (WHO) estimates that air pollution causes seven million fatalities globally each year, with 23 percent - around 12.6 million - of all global deaths attributable to the environment, and 9 out of 10 people breathe air containing high levels of pollutants.

A study conducted by Niranjan and Thakur (2017) titled "The toxicological mechanisms of environmental soot (black carbon) and carbon black: Focus on oxidation stressed and inflammatory pathways stated that the environmental soot and carbon black could constitute health problems for humans. It was revealed in their study that soot and carbon black can cause various diseases. Another study was conducted by Parent et al. (2000) to detect a relationship between exposure to black carbon (BC) and lung cancer risk assessment in a population-based study in Montreal, QC, Canada. This study reinforces the growing body of evidence that BC exposure leads to the development of lung cancer.

Similarly, the American Lung Association adds that particle pollution can potentially cause "cancer and developmental and reproductive problems. The report shows that nearly 6 million people in the United States live in areas where particle pollution levels are harmful all year. Children, the elderly, low-income populations, and persons with pre-existing heart and lung ailments are among the most vulnerable members of the population (Weidman & Marshal, 2012).

An additional study by Ihesinachi et al. (2019) titled "exposure to heavy metals in soot samples and cancer risk assessment in Port Harcourt, Nigeria" supports previous research. These researchers confirmed that soot promotes leukemia, cancer of the liver esophagus, and skin cancer. Their findings claim that there is a high incidence of cancer in the study area and that its prevalence is related to the presence of soot in the study area (Port Harcourt).

Furthermore, Ewubare & Okadigwe (2018) researched the effect of environmental emission and dispersion of pollutants from black carbon on the income of rural farmers in the Etche area in Port Harcourt, an epicenter of high-yielding various agricultural products. The study reveals that black carbon reduced agricultural products as a unit rise in oil leaks decreased harvest wage by 2.45 naira. In addition, a percentage increase in black carbon emissions reduced farm income by 3.69 percent.

2.2 Soot (Black Carbon) Effect on Climate Change Globally

Black carbon (BC) has recently gotten a lot of attention from scientists and policymakers because of its effects on global and regional climate. Though significant and immediate reductions in long-lived greenhouse gases (GHG) are required to solve the long-term problem of climate change, BC offers a promising mitigation opportunity to address climate effects in the short term and slow the rate of climate change (Cho, 2016). The high absorption capacity of BC and its role in key

atmospheric processes link it to a variety of climate impacts, including increased temperatures, accelerated ice and snow melt, and disruptions in precipitation patterns (the United States Environmental Protection Agency, 2012).

According to Cho (2016), black carbon, a significant component of soot, is the most solar energy-absorbing component of particulate matter, absorbing one million times more energy than CO2 (carbon dioxide). The amount of energy stored in the atmosphere is measured in watts per square meter of the earth's surface; according to a 2013 study, black carbon has an effect of 1.1 watts per square meter per year, second only to carbon dioxide, which has an impact of 1.56 square meter. In other words, after CO2, black carbon is the second most significant contributor to climate change. However, unlike CO2, which can remain in the atmosphere for hundreds to thousands of years, black carbon, as a particle, only remains in the atmosphere for days to weeks before being washed back to earth by rain or snow. Since black carbon absorbs solar energy, it warms the atmosphere. When it falls to the ground as precipitation, it darkens the surface of snow and ice, lowering their albedo (the ability of a surface to reflect light), warming the snow, and hastening to melt.

In addition to the impact of BC on atmospheric warming, Black carbon, like all particles in the atmosphere, influences cloud reflectivity, stability, duration, and precipitation. It has different effects depending on how much soot is in the air and where black carbon is in the atmosphere. It will evaporate if it absorbs heat at the level where clouds are forming. It has a cooling effect when it is located above lower stratocumulus clouds that block the sun. Scientists do not know how much black carbon directly contributes to global warming because it interacts with other components of particulate matter, such as sulfates and nitrates, which reflect sunlight and cool the atmosphere (Levitsky, 2011).

According to recent emissions inventories, Asia, Latin America, and Africa account for most global BC emissions. The patterns and trends of emissions vary greatly across regions, countries, and sources (United States Environmental Protection Agency, 2012). Arctic nations (including the EU's Denmark, Finland, and Sweden, as well as Canada, Iceland, Norway, Russia, and the United States) contribute about 10% of global human black carbon emissions (include wildfires, residential burning, the burning of agricultural and solid waste, , maritime shipping, gas flaring and the combustion of diesel fuel), but their contribution to Arctic warming is thought to be greater

because most black carbon particles do not travel far from their source (EU Service for Foreign Policy Instruments, 2019). Developing countries in Asia, Africa, and Latin America account for more than 75% of global black carbon emissions, primarily from cookstoves and the use of solid fuels such as coal and wood for heating, which has a particularly negative impact on the health of women and girls. Diesel vehicles and open biomass combustion, the world's largest source of black carbon, both contribute significantly to emissions (Cho, 2016).

Similarly, Levitsky, (2011) stated in his writings that the resulting extensive brown haze in areas with high BC emissions can affect temperature and precipitation. Early evidence suggests that large amounts of BC emitted in India and China have caused changes in the Indian monsoon and Chinese rainfall patterns. The effect of BC on ice and snow, and thus on water accumulation, is becoming increasingly important in determining the overall impact of climate change in the Arctic and Himalayas. The specific local effects of BC compound the impact of global warming in these regions, causing temperatures to rise much faster than the global average. Organic carbon does not offset the effects of BC at the regional level, and all sources of BC emissions, including biomass burning, contribute to BC's net emissions.

It is important to discuss grand societal challenge and soot pollution as a crisis of governance for the purpose of this research.

2.3 Understanding Grand Societal Challenges

Grand Societal Challenges (GSCs) are major social and environmental challenges that cut across national boundaries - such as pollution, climate change, inequality, disruptive migration, and global pandemics – and have the potential or actual detrimental effects on large numbers of individuals, communities, and the planet. They needed to be addressed collaboratively because the development and implementation of effective responses rely on contributions from a diverse range of state and non-state actors (C. Voegtlin et al., 2022; Griggs et al., 2013; Whiteman et al., 2013). Grand issues, by definition, affect large populations, implying that their effects reach beyond the confines of a single organization or society.

According to Ferraro et al. (2015), the writers highlighted three facets of grand challenges in their organizational research:

1. Grand challenges are complex, entailing numerous interactions and associations, as well as emergent understandings and nonlinear dynamics.

2. Grand challenges confront organizations with radical uncertainty, which means that actors cannot define the possible future states; as a result, they cannot predict the consequences of their current actions or whether others will appreciate them in the future.
3. Grand challenges are evaluative, spanning jurisdictional boundaries, implicating multiple criteria of worth, and revealing new concerns even as they are addressed.

These three factors, when combined, represent substantial organizational obstacles. The three (3) characteristics are explained in detail below.

- ***Complexity***

GSCs are highly complex in nature because the number of elements and interrelationships that make up the challenges or lead to their resolution outnumber any comprehensive analysis and cannot be fully understood and thus difficult to solve (C. Voegtlin et al., 2022; Schneider et al., 2017; Schreyögg and Steinmann, 1987). Typically, GSCs influence and are affected by multiple actors and domains, multiple locations, and multiple time frames. For instance, Ferraro et al. (2015) cited pollution, climate change, and poverty as complex societal problems. Also, the root causes and key perpetrators are often considered to be single actors but may be systems, institutions, and networks**.**

- ***Uncertainty***

Grand societal challenges are also characterized by an extreme or high level of uncertainty, making it difficult to predict their outcomes and the actors' perspective. Outcomes are not merely a matter of risk or random probability distributions but are hampered by Knightian uncertainty (Ferraro et al., 2015; Knight, 1921). Actors cannot enumerate what the probable future states of GSCs, let alone assign probabilities to them (Ferraro et al., 2015; Knight, 1921).

- ***Evaluative***

Grand societal challenges can be 'understood and approached in multiple ways' (Ferraro et al., 2015, p. 366). People bring diverse viewpoints, interests, and fundamental philosophies to problems of environmental governance (Ferraro et al., 2015; Dietz, Ostrom, & Stern, 2003, p. 1909), as well as other grand challenges. As a result, the issue at hand cannot be classified as only economical, political, or social issues (Ferraro et al., 2015; Ansari, Gray, & Wijen, 2011). From a social constructivist standpoint, GSCs necessitate not just ontological (i.e., what is given by nature or created by humans) and epistemological (i.e., what is true or false) judgments but also value-based judgments (about what is good or bad). Individuals and social groups utilize such judgments

to assess and develop their understanding of the nature, meaning, and importance of GSCs (C. Voegtlin et al., 2022, p. 7).

Grand societal challenges (GSCs) are complex, multi-level, multi-dimensional issues that must be successfully addressed collaboratively by various actors - public, private, and non-profit entities. Businesses are essential players in this regard since they serve as a source of innovation, whether acting alone or in collaboration with governmental and non-profit institutions (C. Voegtlin et al., 2022). However, the growing rate of environmental degradation worldwide, particularly in Nigeria, is alarming. Even though governance is widely acknowledged as one of the most critical factors in achieving sustainable environmental management, environmental governance remains a distant dream in Nigeria (Ogunkan, 2022).

2.4 Environmental Governance

Scholars have observed a gradual shift in the way the environment is governed during the last few decades. Historically, environmental issues have always been the concern of the national governments, but in these present days, environmental governance now comprises the activities of multiple actors, including states and industry, nongovernmental organizations (NGOs), and the public (Benson & Andrew, 2017).

It is important to discuss the general meaning of governance. it is generally taken to mean the deliberate endeavor to steer, control or manage sectors or facets of society in certain directions (Evans, 2012 p 4; Kooiman 1993). The writer further explained that governance extends the practice of governing to non-state actors, or stakeholders, who have an interest or "stake" in governing, such as charities, non-governmental organizations (NGOs), corporations, and the public (Evans, 2012 p 4).

According to Bennett & Satterfield (2018), governance is broadly defined as the institutions, structures, and processes that determine who makes decisions, how and for whom decisions are made, whether, how, and what actions are taken, and by whom and to what effect the decisions are made. Governance operates by establishing common goals or targets that allow different actors to devise the most suitable ways to achieve a sustainable development. Good governance advocates for transparency and accountability. Transparency represents a mechanism for encouraging good governance and public trust in a democratic and modern government (Jashari &

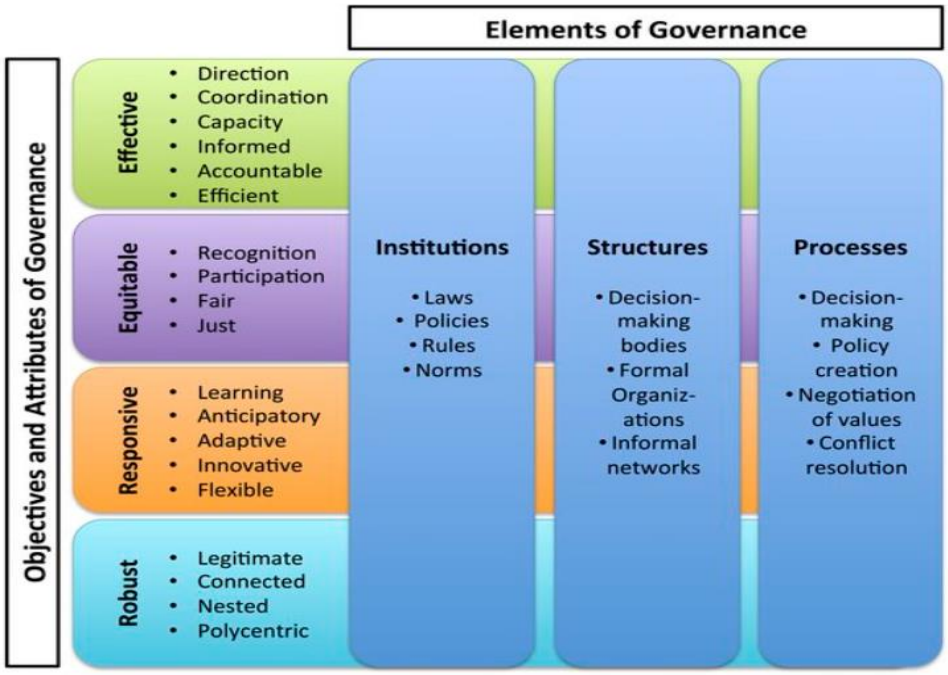
Pepaj, 2018). Governance as self-organizing networks, in which the state is only one of many actors involved in governing (Evans, 2012).

Environmental governance can be described as the patterns of interaction that result from the strategies of these divers' actors to governor "steer" society towards achieving environmentally related goals (Benson & Andrew, 2017; Adger and Jordan, 2009).

The goal of environmental governance is to control individual behaviors or group activities in order to promote public environmental benefits and associated societal consequences (Bennett & Satterfield, 2018; Armitage et al. 2012 Termeer, Dewulf, and Van Lieshout (2010). Understanding environmental governance is knowing how environmental decisions are made and determining if the outcomes of the resulting policies and procedures are environmentally and socially sustainable.

Drawing from the work of Bennett & Satterfield, (2018), they identified four (4) objectives and attributes of environmental governance as follows: (1) effective governance; (2) equitable governance (3) responsive governance and (4) robust governance The summary of the attributes is being highlighted on Figure 1.

Figure 1. **A practical framework for understanding the objectives, attributes, and elements of environmental governance**.



Bennett, N.j. & Satterfield, T. (2018).

- ***Effective Environmental Governance***

A central goal of effective environmental governance supports the maintenance of system integrity and functioning. These attributes include direction, coordination, capacity, informed, accountability, and efficiency. Direction provides effective communication of vision, goals, and aims to all stakeholders, as well as the establishment of clear boundaries on action and scope (Bennett & Satterfield 2018; Graham et al., 2003; Lockwood et al., 2010; Wyborn, 2015b). Coordination of various governments and agencies' roles, functions, and mandates, perhaps through a coordinating body or co-management unit, provides a forum for discussion, debate, negotiating, and resolving trade-offs. Capacity includes the availability of skills (e.g., leadership, conflict resolution) and resources (e.g., financial, infrastructure) that are being actively developed, enables successful decision-making and the initiation, organization, implementation, and evaluation of actions. When planning and management decisions are informed by the best available knowledge, including diverse and integrated knowledge types (natural and social) and systems (scientific, local, and indigenous), the likelihood of effective outcomes increases. Clear accountability mechanisms for governors can help to ensure that mandated decisions are followed, and effective actions are taken. Accountability is enabled by transparency in communicating the means and rationales for decisions, as well as the outcomes of potential future or past actions. Efficient governance necessitates that actors' time demands are reasonable, that efficacy guides the selection of management actions and the deployment of public resources, and that costs and actions are proportionate to system productivity (Bennett & Satterfield, 2018; Ostrom, 1990; Secco et al., 2014).

- ***Equitable Environmental Governance***

To achieve the goal of social equity, environmental governance should involve decision-making processes and produce socioeconomic outcomes that are inclusive, participatory, fair, and just. As cited by Bennett & Satterfield (2018) equitable environmental governance starts with policies and procedures that recognizes, respect, and are inclusive of the perspectives, knowledge systems, values, cultures, and rights of diverse stakeholders, including the viewpoints of the minority. Effective participation requires processes and structures that allow stakeholder groups to be included, represented, and engaged in collective decision-making (Lockwood, 2010; Reed, 2008).

It facilitates a fair and just distribution of power among all stakeholders, allowing parties to debate decisions democratically and maintain dignity.

- ***Responsive Environmental Governance***

The objective of responsiveness ensures that environmental governance is adaptable to changing environmental and social conditions as well as diverse contexts. The attributes of responsive environmental governance include learning, anticipation, adaptability, innovation, and flexibility. Continuous monitoring and evaluation, communication, and reflection on the social and ecological performance of environmental governance all contribute to institutional and social learning. The institutionalization of anticipation or foresight, which includes consideration, analysis, and planning for the consequences of both chronic and acute risks, can also improve knowledge and capacity to address disturbances. Adaptive environmental governance is enabled by institutionalized spaces for dialogue, reflection, and deliberation, as well as clear processes and steps to ensure that policies, institutions, and management actions are evaluated on a regular basis and actively updated or changed as needed. A culture of innovation, combined with a higher risk tolerance, encourages experimentation with new ideas, as well as the monitoring and documentation of successes and failures, allowing for the development of effective management actions (Bennett & Satterfield, 2018; Chaffin et al., 2016; Dietz et al., 2003). Rather than promoting one-size-fits-all approaches, institutional and policy flexibility allows environmental management and conservation models to be calibrated to diverse local realities (Bennett & Satterfield, 2018; Epstein et al., 2015; Gaymer et al., 2014). This necessitates making efforts to comprehend and document the social, cultural, political, economic, and environmental contexts in which interventions are implemented, as well as deliberating on necessary adjustments to idealized models.

- ***Robust Environmental Governance***

Robust ensures functioning institutions persist, maintain performance and cope with perturbations and crises. The characteristics incudes: legitimate, connected, nested, and polycentric. A collective vision guides legitimate institutions, conferred with formal legitimacy (e.g., through law or policy), and perceived to be legitimate by constituents and stakeholders. This ensures strong political justification as well as local support. Connected, network of organizations and actors are connected vertically and horizontally. There are procedures in place to facilitate the growth of social

networks, interpersonal relationships, and mutual learning. This invariably creates supportive community, encourages communication, information exchange, enables diffusion of innovations, and facilitates collaboration. In nested governance, tasks are delegated to the appropriate levels. Decision-making authority and responsibility are delegated to the lowest possible level. Self-organization is promoted and encouraged. Polycentricity helps to buffer against change and avoid institutional collapse when faced with adversity by providing institutional diversity and redundancy in purpose and function (Bennett & Satterfield, 2018; Morrison, 2017).

2.5 Understanding soot pollution as a crisis of governance

The soot pollution crisis in Port Harcourt Nigeria, reflect governance failure and constitute an intractable problem to all levels of government represented in the region – the federal, state, and local governments. The citizens believed that the Federal Government has failed to make meaningful efforts aimed at honestly addressing the issues that made the people of the region to resort to armed struggle to fight their cause. The government appeared to be more concerned with the uninterrupted flow of royalties paid by oil companies than with the general wellbeing of the people who bore the burden of the soot pollution (Akinbi, 2012).

Similarly, according to the Premium Times-News, the Vice President of Nigeria, visited the Niger Delta regions, including Port Harcourt, River's state in 2017. The visit was part of the Nigerian government's effort to address the Niger Delta ongoing environmental crisis in that region. During that time, regional stakeholders presented reports and recommendations on how to address the region's environmental hazards. Moreso, one of the representatives of Niger Delta Resource Centre made a presentation on the environmental challenge plaguing the Niger Delta regions and Port Harcourt inclusive. The representative stress that there is a need to legalize illegal refineries and upgrade the illegal refineries to modular refineries to curb the problem of soot pollution in the region. But ever since then, the Nigerian government has failed to take little or no action (Ekpali, 2022).

According to Akinola (2008), the citizens viewed the government and oil companies are working together to destroy them. There were situations whereby the Federal Government remained silent on regulations that governed the actions of oil companies, particularly those pertaining to environmental protection; however, due to public agitation, the government only paid lip service regard to such laws on occasion. Although the establishment of the Federal Environmental

Protection Agency (FEPA) appeared to be a constructive response to the crisis, the agency was preoccupied with gathering information and data with the government rather than converting them into discernible effective action (Akinbi, 2012; Akinola, 2008). There have been reports of leniency, sluggishness, and passivity in the monitoring, control, and enforcement roles of the Directorate of Petroleum Resources (DPR) over the activities of multinational oil firms operating in the Niger Delta region (Akinbi, 2012; Oyovwi & Oriavwote, 2012). In terms of enforcing compliance with rules, standards, regulations, and prescriptions, the DPR has not properly occupied its positions or effectively engaged the oil industry operators. The practice of oil industries in waste management and environmental pollution are exceedingly poor and far below international standards (Akinbi, 2012). Despite the existence of environmental laws and regulations such as the Federal Republic of Nigeria's Constitution, the National Oil Spill Detection and Response Agency (NOSDRA) Act (2006), the Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN), and the National Environment Standards and Regulation Enforcement Agency (NESREA) Act of 2007, poor monitoring and regulatory control of the oil industry has contributed to an increase in environmental pollution (Sam et al., 2017). Concerns over environmental pollution in the Port Harcourt have already resulted in agitations and confrontation between community members and industrial companies or authorities, as seen in Ogoniland, Rivers State (Whyte et al., 2020; Richard et al., 2001; Lindén & Plsson, 2013). As a result, it is critical that the current air pollution be tackled on all fronts.

Similarly, David & Andrew (2017), in their study on environmental governance, stated that environmental issues are as old as humanity. The writers discussed about one of the earliest recorded environmental laws was a proclamation issued by Edward I of England in 1272 prohibiting the burning of sea-coal in London in order to reduce smoke pollution. During the Industrial Revolution, air quality issues became increasingly essential. To restrict emissions from the manufacture of chemicals in Victorian Britain, the national Alkali Act 1863 was enacted, coupled with a government inspectorate. Government intervention, on the other hand, did nothing to battle chronic air pollution in Britain's fast increasing cities, with abatement measures, generally regulatory in nature, primarily left to local governments. This situation has been reproduced in various nations, including the United States, where cities such as Chicago and New York implemented their own clean air restrictions in the 1800s, which were mostly left to municipal governments. However, in the early twenty century, there was a shift in the governance of

environmental issues from the state to involving the non-state actors such as businesses, local governments, and communities, in governing for sustainability. At the same time, many countries, including the United States, Canada, and Australia, have seen a shift toward more collaborative and/or participatory forms of environmental governance based at the local or ecosystem level, involving state and non-state actors working together to manage resources such as watersheds, forests, and oceans (David & Andrew, 2017; Benson, Jordan, & Smith, 2013).

2.6 Theoretical Framework

The theoretical framework upon which this study is premised is stakeholder's theory and sense making theory.

2.6.1 Stakeholder's Theory

The stakeholder's theory captures the writer's attention because environmental issues or grand societal challenges involve not just a single actor but multiple actors. Freeman one of the pioneers behind the theory of stakeholders, and the term "stakeholder theory" is now commonly used among researchers (Friedman & Miles, 2006; Andreas & Johan 2011) He established this theory based on his belief that stakeholders "could and should be used to modify the overall view of the organization" (Friedman & Miles, 2006, p. 25).

Stakeholder theory is a large body of knowledge that focuses on simultaneously taking into consideration the interests of multiple actors (Gooyert et al., 2017). Stakeholder theory has been variably described as a viewpoint, a collection of ideas, expression, and metaphors relating to the overriding goal of maximizing stakeholder value (Haataja, 2020). Researchers and practitioners of stakeholder theory emphasize the "jointness" of interests as the foundation for all business value creation (Haataja, 2020).

Due to the financial implication and unpredictable nature of increasingly regular natural disasters, environmental problem has grown to be a serious challenge for business (Haigh & Griffiths, 2007; Mills et al., 2002; Stern, 2006). We now experience severe weather that is unpredictable but increasingly common due to anthropogenic greenhouse gas emissions. This is in addition to incremental climate change brought about by Earth's geographic dynamics, such as gradual changes in humidity and rainfall which has itself displaced entire civilizations (Haigh & Griffiths,

2007; Fagan, 1999, 2004; Schwartz, 1957, Karl and Trenberth, 2003; Paoli and Bass, 1997). As a result, there is a need to consider the environment as an important stakeholder.

According to Freeman (2009, p. 65) as cited by (Haataja, 2020) considering stakeholder interests in management decision-making allows for "better consequences for all stakeholders because it understands that stakeholder interests are joint." If one stakeholder pursues its interests at the expense of others, the others will either withdraw their support or seek to establish a new network of stakeholder value creation." The stakeholder's participation in environmental decision making by government and industry is inevitable and will grow. Building on this, Freeman (1984) outlines the need to change the way we think about business, away from old models of thinking and toward a consideration of the organization's external environment. Thus, he proposes stakeholder theory, which aims to "force organizational managers to be more responsive to the external environment" (Freeman 1984, p. 216). The stakeholder idea, according to Freeman (1984), "provides a new way of thinking about strategic management, that is, how a firm can and should determine and implement strategy". In this regard, Freeman (1984) makes it abundantly clear that stakeholder theory is a new approach to the strategic management of an organization that will help to shed the old, or as he puts it, it is an approach that can "help managers view the world as it is today not as it was 30 years ago (Nick, 2011).

The forces driving the evolution of environmental stakeholder processes include: "a lack of public confidence and trust in many government agencies and corporations; greater transparency of institutions whose decisions affect environmental quality; increased societal expectations for improved environmental quality; enhanced citizens participation in stakeholder processes; the growing diffusion of information technology and an associated decentralization of decision making in large institutions; and policy commitments made by government agencies and industries to expand stakeholder participation in their decision making processes" (Terry & Timothy, 1998 p 1). The natural environment, which was once thought to be only the external environment, has become a major influencing factor in managerial decision making and is now regarded as central to marketing and management strategy (Saleem et al., 2020).

Saleem et al. (2020) identified some categories of stakeholder groups that can influence environmental preservation; boards of directors (BODs) and employees from the internal stakeholder category and regulatory bodies, customers, media, competitors, and activists from the

external stakeholder category. For instance, “employees are becoming more and more environmentally conscious as they feel comfortable working in an organization that shares the same values. Employees’ concern towards environmental preservation can put pressure through "whistleblowing" and it is an important driver for companies to become sustainable” (P.4). Board of directors can influence and encourage organizations to adopt more progressive environmental policies and strategies. Similarly, regulatory rigidity and institutional pressure have compelled businesses to be environmentally conscious. Customers believe that today's environmental problems are severe, and that corporations are not acting responsibly in response to these issues. Customers will prefer to patronize companies that adhere strictly to the environmental regulations to ensure a sustainable environment. Businesses that use proactive environmental technologies will be recognized by market forces; these recognitions by industry forces will put pressure on companies to change their environmental strategy in order to compete in the industry. According to Luo et al., the media is an important stakeholder that can exert pressure on businesses to be environmentally friendly. Community groups and non-governmental organizations (NGOs) can put pressure on organizations to adopt an environmentally friendly plan. They can put pressure on the firm by influencing the legislative process, changing purchasing habits, bringing third-party and citizen lawsuits, and terminating future development with the firm.

2.6.2 Sense-Making Theory

Sense making theory is seen as a key leadership capability for the complex and dynamic world we live in this present day (Ancona, 2012, p.3). Sense making theory was pioneered by Karl Weick (1995). It refers to how we structure the unknown to enable us to act in it. Sensemaking enables leaders to have a greater understanding of what is going on in their environments, thus facilitating other leadership activities such as visioning, relating, and innovating (Ancona, 2012, p.5). This theory enables stakeholders or leaders to come up with a plausible understanding—a map—of a changing environment; testing this map with others through data collection, action, and conversation; and then refining, or abandoning, the map depending based on its credibility.

Drawing from Ancona, (2012) Sensemaking is an emergent activity that requires the ability to switch between heuristics and algorithms, intuition and logic, inductive and deductive reasoning, continuously seeking and providing evidence, and generating and testing hypotheses while "playing the game." As a result, leaders must possess emotional intelligence, self-awareness, the

ability to deal with cognitive complexity, and the flexibility to transition between the "what is" of sensemaking and the "what can be" of visioning.

In the business world, sensemaking might refer to learning about changing markets, customer migration, or new technologies. It can imply learning about the organizational culture, politics, and structure of a new venture or previously unseen challenge. It could imply determining why a previously effective business strategy is no longer working. Sensemaking advocates for the participation of all stakeholders in giving a direction to a particular problem. It ensures transparency and accountability.

Why is sensemaking important in today's world? Sensemaking is important because it allows people to act when there are changes in the environment. Whether we look at politics, climate change, economics, resource depletion, environmental pollution, or dozens of other areas.

How does sensemaking work? Ancona (2012, p.6) described in her writings that "sensemaking is like a map". A map can give confidence, hope, direction, which the means to move from anxiety to action. By mapping an unknown situation, some of the fear of the unknown can be alleviated. By having all members of the stake holders working from a common map of "what's going on out there," coordinated action is facilitated. All stakeholders need to note that in the world of sense making there is no "right" map. Sensemaking is not about finding the "right" answer; it is about creating an emerging image that becomes more comprehensive through data collection, action, experience, and conversation.

Weick (1995) identified seven properties of sense making as cited by Robert Purcell (2022).

- **Identity:** Sensemaking is determined by the sense maker. What they support and how they interpret events are influenced by the type of person they believe they are in the situation. Different types of people in an organization can have various points of view. Obtaining each person's perspective on the subject under discussion is critical to gaining a better understanding of the situation**.**
- **Social Activity:** Sensemaking is a societal activity that is influenced by our culture and pre-existing social interactions. Sensemaking ensures that plausible stories are protected, reserved, or shared. Organizations make sense through discussions, reporting, and idea exchange, and they are influenced by the real, indirect, or fictitious existence of others.

- **Enactment of reality and the environment:** People enact their environment in conversations and records. Enactment occurs through cognitive methods and assumptions about one's current environmental situation. People's first instinct when attempting to create meaning is to speak about the issue or event in response to interpreting what they encounter, consider, or feel. People assume that they will scrutinize, talk, transliterate, contemplate, relate, predict, inquire, comprehend, discuss possibilities, look for facts, structure new methods, and explain their surroundings.
- **Retrospect**: All sensemaking processes differ in terms of retrospection or replication of experience, which provides logic and precision to any outcome. The analysis of early verdicts, incidents, and actions to make meaning is a feature of sensemaking. Retrospection enables people to construct narratives about past events in order to make sense of them. An experience can only be understood after it has occurred, and a reflection on it is made to make plausible sense in retrospect.
- **Identifying and extracting cues:** People take cues from the framework to help them agree on what data is applicable and what clarifications are appropriate. People's perspectives on various incidents are influenced by the incidence of individual objectivity about the experience. When explaining the signs they discern, Sensemakers must incorporate hints into a plan, frames of reference, or depiction of one type or another. The various interpretations are based on the context and an individual's personality, which is determined by one's fascinations, personality, and unawareness. These factors may prevent a person from recognizing all relevant signs or may even influence the decision of which prompts to pay attention to and which to ignore.
- **Ongoing events**: Sensemaking is a dynamic, ongoing process of repeated meaning structure with no beginning or end, in which earlier occurrences are considered in relation to possible futures. Organizational Sensemaking assumes that organizations are constantly amid complex situations from which they attempt to disengage by generating and analyzing hypotheses. Organizations are regarded as Sensemaking systems, and their primary goal is to generate, recognize, and anticipate environmental stabilizing recurring events.
- **Plausible:** Sensemaking is more concerned with plausibility than with accuracy. Arguments and decisions are based on rational discoveries rather than scientific discoveries. Although clarified data will most likely be less precise, it will undoubtedly be

more understandable. Therefore, all Sensemaking demonstrates is that it helps leaders to create a road map or vision amidst uncertainty, build capacity and ensure ownership of change. Because unforeseen circumstances are inevitable, making sense of crisis is never completed; it is always in progress.

3. Methodology

This chapter will discuss about the philosophy of science, methodology used in the research as well as the collection of data. It will further explain why the researcher chose certain research strategies and how the sampling was done. The validity and reliability of the thesis along with the primary and secondary sources will be discussed.

3.1 Philosophy of Science

Looking through the lens of a social constructive perspective

Given the interest in this research, the author decided to view the research problem from a social constructivist perspective. Social constructivism was derived from the seminal work of Vygotsky (1934/1986), who postulated that reality is socially constructed. From a social constructivism standpoint, "people interpret their world through a subjective lens which is influenced by epistemological, axiological, and ontological positions that determine their lived reality (Boyland, 2019, p 30). As individuals live in their personal reality, each interprets that reality in their own unique way, leading the researcher to construct a diverse and complex socially constructed landscape that profiles the collective experience in terms of individual knowledge, actions, beliefs, and personal experience: without any sense of universality" (Boyland, 2019, p 30). According to Foucault, we construct what we perceive as reality through discourse, and when we learn to think about reality in a particular manner, we inhibit our ability to think in other ways (Jørgen, 2022; Johnston, 1986). However, some scholars claim that environmental problems are socially and politically constructed to the advantage of powerful people (Jørgen, 2022; Escobar, 1996, Peet & Watts, 1996, Jarozs, 1996).

Social constructivism offers a paradigm of thought in which the researcher journeys with participants into a space of interpreted reality that is as personal and unique as each person in the collective sampling and as different as the profiled group of lived experiences. Constructivist

research demands fluidity, which necessitates the researcher's acceptance that each participant constructs reality in their unique way. Individual participants acquire, select, interpret, and organize the knowledge they possess and the information they are willing to offer in telling a story that identifies as a world of personal reality in different ways (Boyland, 2019, p 30).

Social constructivism allows for participant sampling. Participant sampling allows for the most extensive and valid profile of relevant data while presenting a holistic image of the individual rather than a universal reality. The social constructivist researcher puts the dialogical self of I, the researcher, to allow each participant to reconceptualize, reframe, re-construct, interpret, and make meaning of the reality that is his or her lived experience. This is the stance that best satisfies the individual participant's need to capture what Shotter and Gergen (1994) defined as a knowing from within presented as conversational knowing. Living dialogue arises into conscious consciousness by combining speaking, listening, reflexively hearing, and seeing within a dialogic interchange process (Boyland, 2019, p 30). From a social constructivist standpoint, data gathering, and analysis processes strive to elicit an understanding of how people create their knowledge constructions and how these constructs contribute to understanding social influences and individual thought processes (Boyland, 2019, p 30).

3.2 Research Approach

When discussing the research approach in general, one often refers to deductive and inductive (Bryman & Bell, 2007). Deductive reasoning operationalizes the theory by putting the same into a testable state, researching by collecting empirical data, and conducting the analysis to confirm or reject the hypothesis. (Bryman, 2012, p. 19; Esterberg 2002, p.12; Saunders et al. 2012, p.144). Inductive reasoning involves the process of moving from a specific observation to a generalized statement. In this case, the author adopts an inductive approach rather than deductive reasoning because observations are made, patterns are drawn, generalizations are made, and explanations are inferred (Lussier, 2011, p.19). This is because the data collection about Soot pollution as a grand societal challenge builds rather than tests a theory. The author of this research paper started with a given theoretical position but was open to what the research process discovered and inclined to open reflections.

3.3 Research Strategy

Due to the limited research in this field, the author of this paper chose a qualitative research approach. Qualitative research can assist researchers in gaining access to research participants' ideas and feelings, creating a better understanding of the meaning people assign to their experiences. Whereas quantitative research methods can be used to assess how many people engage in certain behaviours. In contrast, qualitative research methods can aid researchers in understanding how and why certain behaviours occur (Saunders et al., 2012). Furthermore, qualitative research can be constructed as research that usually emphasizes words rather than quantification in data collection and analysis (Bryman, 2012). By conducting qualitative research, the authors of this paper aim to capture data through observations, interviews, and documents.

The author's choice of the research strategy is guided by the research questions and the research aims, goals, and objectives of the paper. The research question requires the interpretation and perceptions of the people with a shared experience of soot pollution in Port Harcourt, Nigeria, which is why this qualitative research approach is appropriate. The chosen research strategy provides the authors with a better understanding of the subject and research area, which is necessary for answering the research question. However, because theory is generated from the facts, this research strategy may minimize the possibilities of generalizing the study (Bryman & Bell, 2007).

3.4 Research Design

The author decided to adopt a case study design by examining Soot Pollution as a grand societal challenge in Port Harcourt, Nigeria. Case study research is one of several forms of social science research (Yin, 2018). As a research method, the case study is used in a variety of contexts to add to our understanding of the individual, group, organizational, social, political, and related phenomena.

Doing case study research remains one of the most challenging (Yin, 2018). However, one of the advantages of using the case study design is that it's grounded in and applicable to real-life, contemporary human situations and provides in-depth relevant data. As a researcher, the goal is to design good case studies, collect, present, and analyse data reasonably. This type of research design represents an excellent fit for the thesis because it has Social Constructivism as an ontological standpoint. Siggelkow (2007, p. 23) argues that this type of research design has a

weakness: "case-based research papers lack selectivity and presentation of only those details that relate to the conceptual arguments." However, regardless of the case method, data from case studies "usually get much closer to theoretical constructs and provide a more powerful argument about causal forces than broad empirical research can (Lindblom & Ohlsson, 2011).

3.5 Data Collection

To collect data, the author employed both primary and secondary sources.

3.5.1 Primary Data Collection

Primary sources entail using research materials and information collected by the researcher undertaking the study (Saunders et al., 2012). Based on the author's philosophy of science, the researcher of this paper collected data through interviews. Qualitative interviews are relatively loosely structured and open to whatever the respondents feel is relevant and essential to talk about. Research shows that this type of approach is beneficial because it allows for a comprehensive account of the Interviewee's experiences, knowledge, ideas, and impressions may be considered and documented (Alvesson, 2003; Bryman, Bresnen, Beardsworth, & Keil, 1988; Fontana & Frey, 1994; Holstein & Gubrium, 1997; Martin & Turner, 1986).

The author of this paper further emphasizes the importance of selecting the interview technique. This is because if the proper interview technique is employed, the respondents are competent truth-teller who can give valid data that reveals their inner thinking or the realities about a situation or problem. However, the researcher considers semi-structured interviews the best fit for this research paper.

3.5.2 Interview

According to Bryman (2011, p. 471), a Semi-structured Interview refers to a context in which the researcher has a list of questions or specific topics to be covered, often referred to as an interview guide. Still, the Interviewee has leeway on how to reply. Before starting the interview, the author outlined the structure and topic of the research to the Interviewee, as well as the terms and definitions that we will discuss. The interview guide was constructed in an open format with a broad topic to give the author an idea of how the responder felt about the issue.

The interviewees were allowed to respond and build their own responses to the questions addressed. The interview guide served as a reminder to the researcher to stay on track with the topic and, on occasion, to prompt the Interviewee to elaborate on their responses. The researcher,

for example, asked a broad question with sub-questions on the topic, giving the researcher a great deal of flexibility and guiding the interview in the direction of interest. (*Appendix 1 contains the interview guide).*

3.5.3 Interview Selection Process

The researcher's starting point when deciding which persons to interview was to look for a balanced number of respondents from different stakeholders. Due to the nature of the case study, the composition of the target population was selected from various subgroups, all of whom experience the same issue from a different perspective. In this case, among the interviews were two (2) participants from the government parastatal, two (2) from the oil companies, two (2) from the civil societies, and two (2) community members. In summary, eight (8) participants were interviewed.

In this case, interviews were conducted in an unfolding and iterative interaction manner between the interviewer and the participants to obtain quality data. The interview process took place digitally due to proximity. The participants were sent an initial email to seek their consent about the subject matter and availability. When they gave positive feedback towards the invite, a face-to-face meeting was scheduled via zoom. The interview lasted for 45 minutes invariably.

Thus, the researcher had the opportunity to observe the social and non-verbal cues of the Interviewee. As a result, the researcher asked follow-up questions for further clarification, exploration, or elaboration. The flexibility of the semi-structured approach also allows for the discovery and development of information that is important to participants but may not have previously been thought of as pertinent by the researcher.

3.6 Secondary Data Collection

Secondary data involves the use of research material that others have collected. For example, the research has the basis of secondary data where previous data shows the impact of Soot pollution in Port Harcourt, Nigeria. This data is essential to make us understand the background of our problem and come up with resolutions.

3.7 Research Reliability and Validity

As a qualitative researcher, reliability and validity are essential criteria in establishing and assessing the quality of research (Bryman, 2011). Bryman (2011, p. 46) states that "reliability is

concerned with the question of whether the results of a study are repeatable." To secure the reliability of this research is to ensure that the research is credible, transferable, dependable, and confirmable (Bryman, 2011). In order to fulfill this, the author confirmed that a recording device was used during the interview process, which later was transcribed into digital files. The researcher also adopted personal reflexivity to see how they have informed the research to avoid biases. Regular journaling of the researcher's reflections was adopted to keep records of the research project. I also obtained assistance from peers who read and commented on the study's material, enriching the research with their various perspectives.

Bryman (2011, p. 389) further explained that validity refers to whether "you are observing, identifying, or measuring what you say you are." Furthermore, Bryman and Bell (2007) also state that for the research to be valid, the researcher must be consistent in measuring the outcomes in order to draw a conclusion based on the theory. Additional questions were asked for further clarification, exploration, or elaboration. This was done to assure the quality of the data collected and to ensure uniformity throughout all interviews. For example, during the interviews, the author of this paper made sure there were no loose ends and supplemented the interviews by employing the verification method. Verification entails the process of checking, confirming, making sure, and being specific. This strategy allows researchers to proceed, terminate, modify, or continue with the research to attain reliability and validity (Morse et al., 2002).

3.8 Ethical Considerations

We have considered participants' privacy by explaining the purpose of our study. The respondents' stories about Soot Pollution in Port Harcourt, Nigeria, and their positioning could potentially disclose sensitive information due to political involvement. As a result, the confidentiality and anonymity of the empirical data were ensured through the codification of the respondents' entity, guaranteeing no harm because they participated in this research. For example, the interviews began with a recap of the purpose of the research to enable the respondents to participate freely without any bias and fear. After that, respondents were given a consent form to sign, affirming their understanding of their right to withdraw from the study at any time. At the same time, the respondents gave permission to use their shared content and audio responses for the purpose of this study.

4. Empirical Findings & Analysis

Data collected from interviews are presented in this chapter. The interviews provided the author with different stakeholders (two (2) representatives each from the community, oil companies, government parastatal, and civil societies, respectively), perspectives and understanding of soot pollution as a grand societal challenge and soot pollution as a crisis of governance in Port Harcourt, Nigeria. The analysis section will explain and justify how the empirical findings relate to the literature.

4.1 Summary of Respondent Demography

Pseudonym	Gender	Industry	Date/Time of the interviews (Nigerian Time)	Mode of Interview
Stakeholder A	Female	Community	24th March 2022 / 4.00pm -5.00pm	Virtual
Stakeholder B	Male	Community	24th March 2022 / 7.00pm -7.45pm	Virtual
Stakeholder C	Male	Oil Company	2nd Apr 2022 / 7.00pm - 7.40pm	Virtual
Stakeholder D	Male	Oil Company	1st Apr 2022 / 7.52pm - 8.30pm	Virtual
Stakeholder E	Female	Government	12th Apr 2022/ 5.30pm - 6.42pm	Virtual
Stakeholder F	Male	Government	23rd Apr 2022 / 1.30pm -2.30pm	Virtual
Stakeholder G	Male	Civil Society	21st March 2022 / 4.00pm-5.00pm	Virtual
Stakeholder H	Female	Civil Society	21st March 2022 / 6.00pm- 7.10pm	Virtual

4.2 Soot Pollution as A Grand Societal Problem

Two (2) themes emerge from the data gathering concerning soot pollution as a grand societal challenge.

4.2.1 Soot Pollution as a Complex Problem

During the interview, all the participants admitted that soot pollution is a complex problem in Port Harcourt, Nigeria; a member of the community members stated, “Soot pollution is a complex problem in Port Harcourt, Nigeria. Because its impact is felt across the state, affecting people's health and livelihood, nature, and economy since 2016” (Stakeholder A).

When you talk about environmental pollution, it is a problem you cannot fully protect yourself from because there are so many factors that contribute to such a problem. This was also supported by an environmental advocate representing the civil society, *“*Soot pollution is a hydra-headed problem because it is a complex issue that requires the involvement of all stakeholders. … The main reason it is difficult to reach a solution is that different systems and institutions are involved in the problem” (Stakeholder G).

The responses agreed with what Sterman (2001) says that grand challenges are complex because they transcend national borders and negatively affect many people and communities. It involves multiple actors, multiple domains, and a time frame (Ferraro et al., 2015).

4.2.2. Multiple Factors and Root Causes

The root cause and key perpetrators of grand societal challenges are often systems, institutions, and networks (Ferraro et al., 2015). All participants believed that there are so many factors that have influenced soot pollution in the city of Port Harcourt, River's state.

A representative from the community stated that “The primary reason why soot pollution has become a complex problem to solve is that so many factors have contributed to this problem's failure. For instance, most of the people who live where the illegal oil bunkering is taking place cannot even afford three square meals, we live in poverty, and the people are doing everything to survive,” including stealing and breaking oil pipelines (Stakeholders B).

Although oil theft and bunkering are activities that may be driven by the poor economic realities of the affected communities, the environmental damage caused by their actions has a far more reaching impact on society. For example, a government representative said, “The past five years

have been a living hell for the residents of Port Harcourt because the soot has refused to leave and is freely dispensing disease and death" (Stakeholder F).

Also, a participant from the oil company stated that "To say soot pollution is a complex problem is an understatement; due to the effect of the soot particles, the janitors were constantly cleaning the office every hour, and all employees must ensure they wore their nose masks; as a result, this caused the organization more expenses" (Stakeholder C).

Therefore, environmental issues have complex causes that cross many areas of human activity, making coordinated action difficult (Evans, 2012).

4.3 Soot Pollution as a Crisis of Governance

Six (6) themes emerge from the data gathering regarding soot pollution as a crisis of governance.

4.3.1 Stakeholders Participation and Collaboration

The interviewees emphasized the importance of stakeholder's participation in achieving a sustainable environment.

A Stakeholder from the Civil society stated, "Objectively speaking, there is a need to enable community participation and equity. Also, we need to talk about how the people can benefit primarily and directly in the oil gas business and become a stakeholder after which we can provide a lasting solution" (Stakeholder H).

In addition to what was revealed during the interviews, it was stated that each stakeholder has a substantial influence and importance on the environmental issues.

A respondent from the community stated that, "In the 1950's oil was first discovered in Oloibiri, Bayelsa state, there is nothing that depicts that oil was first discovered there in Nigeria, nothing to show for it, rather you see environmental degradation, people dying, no schools, no hospitals, no good roads, no indices of development rather what you see is a people subjugated, oppressed and repressed, their means of livelihood destroyed, they are predominately fishermen and farmers, their farmlands have been destroyed, their waters polluted, their health is negatively impacted and the federal government is not coming to their aid rather they are playing politics with our lives (Stakeholder B).

Also, “We have been ostracized from the oil and gas business and, we do not benefit from the dividends or proceeds accruable from the international oil companies or federal government” (Stakeholder B).

To buttress the importance of stakeholder participation in environmental governance of Port Harcourt, Nigeria. Evans (2012) argued that it makes intuitive sense to involve the public in environmental governance as many environmental decisions directly impact the public. The local communities have extensive knowledge and emotional attachment to where they live and work, making them indispensable partners in the delivery of sustainable development.

Furthermore, one of the rationales behind encouraging public participation is, despite the likely uncertainty that afflicts environmental issues, there is a widespread recognition that governments cannot legitimately maintain the notion that decisions can only be made based on the appropriate knowledge available. “Therefore, there is a need for public participation to increase decision maker accountability” (Evans 2012 p. 192).

4.3.2 Behavioral Change

Further to the discussion, a representative of the government parastatals stated that all stakeholders have a major role to play in the issue of environmental pollution; for instance, government agencies, non-governmental organizations, and the private sector can partner to drive a change in society.

An employee in the oil company said that “I think stakeholders can help give proper sensitization to those involved in illegal refinery and bunkering, informing them of the adverse effect of what it does on their health and to ensure the oil companies are properly oriented on how to dispose of their effluent which can affect the environment” (Stakeholder D).

This sensitization will influence public understanding of the phenomena and instigate behavioral change. For example, Evans (2012) mentioned the importance of collective action as one of the modes of governance which involves networking and voluntary partnerships with diverse stakeholders.

4.3.3 Environmental Responsibility

During the interview, we went further to discuss environmental responsibility. Seven (7) participants agreed that environmental responsibility lies on everyone in the society. Cohen (2021)

stated that Individuals are responsible for considering their environmental impact and, whenever possible, minimizing the harm they cause to the planet.

A participant from the government parastatal said, “I believe it is everyone’s responsibility to protect the environment as an individual, communities, and organizations to create a sustainable and reliable environment” (Stakeholder E).

However, a community member disagrees with the fact that environmental responsibility is collective. ‘‘I do not have any business with the environment; since the government does not care for us, I don’t need to care for the environment. The government should be the one responsible since they are the ones in the helms of power. My only responsibility is to cater to my family, not any environment because our leaders have failed us” (Stakeholder A).

The government is often assigned a pivotal role in environmental protection by implementing environmental policies that directly protect the environment or solve environmental collective action problems (Joakim & Ingemar, 2019).

An environmental activist from the civil society stated, “Most environmental responsibilities lie on the government because environmental issues lie exclusively on the federal government. However, there is little to what an individual can do. For instance, the issue of soot pollution in Port Harcourt has been long overdue; if the problem were in the hands of the community members, we would have proffered a lasting solution” (Stakeholder G).

It was discovered during the interview that the lack of environmental responsibility had an adverse effect on the economy at all levels of government in Nigeria and Port Harcourt Inclusive as funds allocated for environmental and urban renewal are first used to deal with the consequences of citizens’ irresponsibility, rather than being used to build more infrastructure. Also, the people believe that the way to get back at the government is by them not caring or taking responsibility for the environment.

“Our means of livelihood have been destroyed because of the oil spillage, and the government is not coming to our aid. Since we are not benefiting from the oil and gas business despite having pipelines on our streets, we can only break them and get crude oil to sell” (Stakeholder B).

4.3.4 Violation of Environmental Laws and Policies

The participants discussed environmental policies and implementation in Port Harcourt and Nigeria. Six (6) of the respondents believed that Nigeria as a whole and Port Harcourt inclusive lack effective government implementation and enforcement of environmental laws policies. However, two (2) stated that there are sanctions for individuals or businesses that do not comply with environmental laws and regulations.

A civil society representative stated, "Majority of the oil companies in Port Harcourt do not follow the emitting pollutants stipulated standards due to inadequate implementation of current environmental laws and outdated or flawed environmental policy" (Stakeholder H).

Also, during the fieldwork, an environmental advocate explained that environmental issues or regulations fall within the exclusive list of the federal government, and it becomes tough for state or local governments to step up when it comes to matters of the environment, such as oil pollution, oil spill, and soot pollution. "The only thing the local and state government does is make noise about it without taking concrete steps. That is why the environmental advocates are calling for a review of the environmental laws and policies so that the Federal, State, and Local government can legislate on environmental issues within their jurisdiction. So, if there is any environmental pollution, the local government within the area of pollution can act accordingly and could be held accountable" (Stakeholder G).

The stakeholder further explained, "Are we saying there are no existing laws, bills, or acts that protect the environment in the Nigerian state? of course not; however, those in charge of the implementation process have been compromised and bought over by the oil companies. Especially in the case of soot pollution in Port Harcourt, it has been found that some high-ranking military officials and regulatory agencies who are responsible for enforcement are involved in illegal bunkering and artisanal refinery. So, you see why the federal government cannot prosecute itself or regulate itself" (Stakeholder G).

Contrary to what the previous 6 participants said earlier, enforcement is laid down to ensure that people adhere to those laws and regulations.

One of the stakeholders in an oil company stated that, "We have comprehensive regulations and policies that guides all oil companies when disposing of their effluent, and most oil companies

tread cautiously. Failure to adhere to the laws, such a company, will lose its license" (Stakeholder C).

Similarly, a government representative stated, "The Nigerian federal government has established regulatory agencies and acts that govern the activities of individuals and businesses to ensure a cleaner and healthier environment."

The participant further emphasized that NESREA (National environmental standards and regulations enforcement agency) provides measures for penalizing offenders who violate numerous Acts' established laws. "… Section 27 of the NESREA Act forbids the unintentional discharge of hazardous materials into the environment. The maximum fine for breaking this rule is one million naira, which includes five years in prison. Additionally, a fine of 50,000 naira is added for every violation" (Stakeholder E).

4.3.5 Transparency and Accountability

Transparency and accountability are essential aspects of environmental governance. Studies show that transparency enables stakeholders to make informed decisions, confront disclosers, and hold them accountable (Christina et al., 2021). However, the respondent believed that the government lacks transparency and accountability in the governance issues of the state.

A civil society respondent said, "Some security agencies which the federal government saddled with the responsibilities to stop the soot pollution are also involved in illegal bunkering, and the federal government is not doing anything about it" (Stakeholder H)."

The respondent further alleged that "some of the Local Government Areas have about 112 artisanal refineries sites in River's state, and the government is benefiting from the proceeds that come from the refineries. So, it is evident that the government is playing politics with our collective conscience" (Stakeholder H).

Studies by Jashari & Pepaj (2018, p 63) shows that "transparency is a fundamental requirement for the reliability and integrity of public institutions to foster public trust and public support."

However, a respondent of the community stated that "The well-being of the people is at stake as a result of the government's lack of integrity, accountability, and transparency" (Stakeholder A).

To explain this point further, transparency and accountability, according to Ogunbodede (2018), failed in Nigeria due to environmental factors. These factors include corruption, poor leadership, political instability, ineffective pressure groups, a lack of awareness, and a lack of civic culture. Most citizens are kept in the dark about budgets, and financial audit reports, among other things. In some notable cases, the constitution is treated as a highly confidential document (Ogunbodede, 2018; Olowu, 2002). This context makes responsibility, reporting, performance, openness, and evaluation difficult and unattainable.

When asked about the role of transparency and accountability of the leaders, a participant of the oil company said, "I am not qualified to speak on the issue of transparency and accountability. "Imagine a country blessed with so many minerals' resources like crude oil is still considered one of the poorest countries in the world because we have corrupt leaders who only think about how to embezzle money. Then there is a massive problem with the private and public sectors" (Stakeholder D).

4.3.6. Institutional Failure

Participants complained about the institutions responsible for ensuring accountability and transparency in dealings with environmental issues. A respondent from civil societies further explained that there is also the issue of weak institutions. "In Nigeria, the institutions set up to ensure accountability and transparency are frail. Most of these agencies have failed to carry out their mandates effectively". For example, some of the officials in NOSDRA (National oil spills detection and response agency) and NESREA, together with the federal ministry of environment, have the responsibility to enforce environmental law; however, they have conspired with the oil companies and security agencies, especially in the case of the soot in Port Harcourt" (Stakeholder G).

Similarly, a community participant said, "The government is always swift to call the citizens thieves. What moral justification do you have to call somebody a thief when you are a bigger thief? The oil bunkering, we are talking about, the oil companies, security agencies, and government agencies are also deeply involved" (Stakeholder B).

4.4 Consequences of Soot Pollution in Port Harcourt, Nigeria

When the participants were asked how the soot pollution had affected their daily routine, they stated that they cleaned surfaces and floors more frequently. Other reported effects included

washing their hands and feet more regularly, being concerned about their children's health, and engaging in fewer outdoor activities such as recreation and exercise.

Three (3) significant impacts of soot pollution will be discussed below.

Health Impact

As cited by Yakubu (2017), the particle size of soot is approximately 2.5 microns, a type of particle pollution that is associated with deep lung penetration. Fine particulate fraction is the leading cause of global pollution-related mortality. The upper respiratory tract often traps particles that are 10 microns or larger (PM10), preventing them from entering the respiratory tract deeply. Particles of 5 microns or less have a chance of reaching the lower lung, where the alveoli are where gas exchange takes place.

During the interview, when one of the respondents was recounting his experience, he stated that "… soot pollution has affected the health of many residents. It has aggravated and triggered asthma, bronchitis, pneumonia, heart disease, birth defects, and even cancer among the residents of Port Harcourt" (Stakeholder C).

Additionally, according to the American Lung Association, breathing in soot may result in cancer as well as developmental and reproductive issues. The routes of entry into the human body include ambient and indoor air inhalation, dermal contact, and ingestion of contaminated food.

Soot pollution also causes malignancies in people, according to sufficient evidence from studies on human carcinogenicity. Percivall Pott, a British surgeon, discovered a connection between exposed chimney sweeps and scrotal cancer in 1775 (Evanoff et al., 1993). Numerous epidemiological research conducted during the following years has supported chimney sweeps' increased risk of developing scrotal and other skin malignancies. As follow-up studies among Swedish chimney sweeps revealed an increased risk of the esophageal, hematopoietic, prostate, urinary bladder, and total lymphatic cancer (Yakubu, 2017; International Agency for Research on Cancer (IARC, 1987).

Environmental Impact

Since 2016, the majority of Port Harcourt city has been shrouded in a sooty haze, especially when there is no rainfall. Some of the environmental effects of PM2.5 include reduced visibility, soil,

and water deposition, which alters the chemical makeup of the affected media and stains things. The end outcome includes nitrogen depletion in the soil, altered nutrient equilibrium in rivers and coastal waters, more acidic lakes and streams, and disruption of ecosystem variety. The effects of acid rain are considerably enhanced by particle pollution.

“Our means of livelihood have been destroyed; the rivers have been polluted, the farmers cannot grow, cultivate, and harvest their crops because of the because of the soot pollution”. The respondent also claimed that “soot pollution is one of the reasons for unfavorable climate change that causes consistent heavy rainfall which has resulted into flood and damaging roads and properties” (Stakeholder F).

Socio-Economic Impact

The impact of soot pollution on the socio-economic activities of the people has been tremendous. 88.4% said that they run at a loss because of the pollution, whereas 8.9% of the people make less profit from their primary means of livelihood (fishing), while 2.7% claimed that their business remained profitable (Ipingbemi, 2009). Because of the effects of pollution on fishing and other economic activities, some people have given serious consideration to changing their means of livelihood (Ipingbemi, 2009). The reasons stated include, among others, no catch right away following significant pollution, declining income over time, and poor demand for goods. Lack of training or skill was indicated as a critical reason by people who are thinking about changing their source of income. People who are not schooled in alternative livelihood options find it challenging to shift jobs since they lack the necessary skills, and those looking to change occupations are doing so because of frustration (Ipingbemi, 2009).

“My children now find it difficult to visit the park and have outdoor activities” (Stakeholder E).

The migration of young men and women out of the oil-bearing communities in search of greener pastures in other major urban areas appears to be the major radical adaptable mechanism (Akinbi, 2012).

5. Discussion and Conclusion

In this session, a discussion and conclusion will be drawn based on the analysis in chapter four (4) to answer the research questions. The goal of this study was to understand different stakeholders' perspective towards soot pollution as a grand societal challenge and as a crisis of governance.

5.1 Discussion

Soot pollution exists and has become a complex environmental problem that is currently contributing to the ongoing climate change. The primary source of this problem in Port Harcourt, Nigeria, is the artisanal refineries scattered throughout the city, degenerating into a high public health issue, environmental, political, and social-economic problem, among others. The participants aggreged that soot pollution is a complex problem in Port Harcourt, Nigeria. "Because its impact is felt across the state, affecting people's health and livelihood, institutions, nature, and economy since 2016" (Stakeholder, A). The government has been able to mitigate the issue to a small extent; however, they are yet to provide a lasting solution.

The researcher found out that there are numerous factors that have influenced black soot in this city ranging from illegal oil business due to government failure to meet public demand for petroleum products, frequent burning down of artisanal refineries by the government task force on the illicit oil business, lack of involvement of various stakeholders perspective on environmental issues, accountability and transparency of government leaders, corrupt leaders, high unemployment rate, poverty, lack of education, violation of environmental laws and policies among others.

Similarly, growing evidence suggests a link between PM exposure and various health conditions and mortality in low-income people. Port Harcourt is a city in the Niger Delta, where half of the population lives on less than $1.25 per day. Furthermore, it performs worse than other parts of the country in terms of socioeconomic indicators such as ambient air quality, access to safe drinking water, food safety, chemical exposures, residential environments, educational attainment, access to educational services and healthcare, and household income based on the number of people living below the poverty line (Yakubu, 2017).

Likewise, this supported the argument of Ferraro et al. (2015, p.365) that grand challenges extend beyond the boundaries of a single organization or community. The complexity of grand challenges

involves a large array of actors. Most importantly, despite their involvement, those tackling grand challenges typically cannot see the entire system; instead, they can only discern the local behaviors of a small number of dispersed individuals. It is common to believe that root causes and major perpetrators are single actors, but they may be systems, institutions, and networks.

Ferraro et al. (2015) further explained that as various stakeholders come to grips with grand challenges, they realize there is no one "correct" label or categorization that adequately defines them (Bowker & Star, 1999). Grand challenges, on the other hand, can be approached and understood in a variety of ways: "People bring varying perspectives, interests, and fundamental philosophies to problems of environmental governance" (Dietz, Ostrom, & Stern, 2003, p. 1909), as well as other grand challenges.

The ongoing soot pollution in Port Harcourt and its consequences raise serious concerns about the effectiveness of the State's environmental governance and law systems in promoting sustainable development and environmental sustainability in the State. The fact that Nigeria has a plethora of unimplemented environmental laws, as well as an increasing occurrence of industry violations of environmental legislation that also resulted in a crisis of governance, cannot be overstated. One major issue during the soot pollution episode is that regulatory bodies should have foreseen the event's occurrence in the first place and prevented it from happening. Some schools of thought expressed their worry and brought up important issues like Who is the local government's environmental health officer? Who is responsible for environmental problems? Who should we hold accountable for environmental issues? Is it the State or the private oil companies? They further expressed concern about how the environmental agencies who are saddled with the responsibility of the environment were uncertain about what to do when the pollution began, describing the establishment of the Special Task Force as "inessential" because even a "blind man could perceive the very palpable pollution (Yakubu, 2017).

Furthermore, the government's lack of commitment to environmental matters calls for significant concern. It is saddening that an oil-producing state like Port Harcourt has a Ministry of Environment that ostensibly lacks the tools necessary to assess the air quality of the State regularly. Moreover, it lacks the required personnel on the ground to monitor the environmental impacts of companies operating in the state daily (Ojoye, 2017). Also, the participants complained about the decentralization of environmental responsibility and the lack of participation of the community

members in environmental decision-making, among others. For example, one of the interviewees stated that the Federal government has the sole authority to regulate specific environmental issues, especially those related to multiple states. One can easily say that one of the general ineffectiveness of environmental governance in Port Harcourt is overly centralized systems.

These findings supported what Evans (2012, p. 1,4) stated in his writings about "environmental issues as a crisis of governance or a failure to organize our societies and economies so that they do not harm the environment. Therefore, we must extend the governing practice to non-state actors, or stakeholders, who have an interest or "stake" in governing, including charities, NGOs, businesses, and the public." By expanding the scope of governance, more resources can be applied to solving policy issues, and decision-making support is increased. Also, accountability and transparency can be achieved.

5.2 Conclusion

To conclude, soot pollution is a hydra-headed problem because it is a complex issue that poses a significant threat to the public. Recognizing the importance and complexities of GSCs, the United Nations established the Sustainable Development Goals (SDGs) in 2015. (ICCDI, Africa, 2020; United Nations, 2015). Environmental degradation, such as climate change and air pollution, demonstrated the immediate impact of a GSC and the critical need to achieve clean air for all members of society. Pollution of the air, water, soil, and workplace poses a severe threat to human development. Therefore, the UN Sustainable Development Goals (SDG) strongly emphasize environmental pollution reduction (ICCDI, Africa, 2020; UN, 2015). SDG aims explicitly to significantly reduce the number of deaths and illnesses caused by hazardous chemicals, air, water, and soil pollution and contamination by 2030. Many of the other goals, such as improving soil quality, SDG 7 on clean energy, SDG 9 on clean technologies and industrial processes, SDG 11 on sustainable cities and communities, SDG 12 on responsible consumption and production, and SDG 14 and 15 on water and land conservation, are also related to pollution (ICCDI, Africa, 2020).

Decisive action to reduce exposure to environmental pollution will be required to achieve a sustainable environment. The researcher of this paper recognizes the importance of governance in ecological degradation, like soot pollution, and reiterates the importance of paying more attention to understanding the diverse systems of environmental governance.

Finally, it is crucial to consider the natural environment as a valuable stakeholder because the environment can affect all the activities of an economy. In dealing with an environmental problem, it is necessary to consider the interest of all stakeholders. Furthermore, cooperation among stakeholders is essential for an economy's survival and the creation of value and trade. This gives room for dialogue, negotiation, reflections, and deliberations, as well as transparent processes and steps to ensure that policies, institutions, and management actions are evaluated regularly and actively updated or changed as needed. As cited by Freeman et al. (2012), Gibson proposes that leaders should play multiple roles: steward of values and resources; good citizen; servant to others; visionary who provides inspiration and perspective on a desirable future; and coach who can bring people from diverse backgrounds together to realize a shared vision. The environment is not static, it is ever-changing, and it is faced with uncertainty; stakeholders need to develop a plausible understanding through action, data collection, conversation, and refining to make sense in crisis situations.

References

Abdulhaleem Ishaq R. (2021). Nigeria's oil dependent economy: any lesson from Norway? Published By Premium Times. Https://Www.Premiumtimesng.Com/Opinion/448601-Nigerias-Oil-Dependent-Economy-Any-Lesson-From-Norway-By-Abdulhaleem-Ishaq-Ringim.Html (accessed on 19th January 2022).

Ajala Folakemi (2022) Here's How Activists are Advocating to End Environmental Pollution in Port Harcourt. https://nigeriahealthwatch.com/heres-how-activists-are-advocating-to-end-environmental-pollution-in-port-harcourt/ (accessed on 4th August 2022).

Akinbi J. Olukayode (2012). The Niger Delta environmental crisis in Nigeria: a perspective analysis. An international multidisciplinary journal, Ethiopia Vol. 6 (3). (pp. 150-164).

Akinola, O.O. (2008). The nature of government involvement in the Niger Delta conflicts: implications for nation building, in Babatolu, J.S. & Ikuejube, G. (eds.), Perspectives on Contemporary Socio-Political and Environmental Issues in Nigeria. (pp. 10-19).

Alvesson Mats (2003). Beyond neopositivists, romantics, and localists: a reflexive approach to interviews in organizational research. Academy of Management Review, Vol. 28: (pp.14-17).

Ancona Deborah (2012). Sensemaking: framing and acting in the unknown. The handbook for teaching leadership: knowing, doing and being. (pp. 3-19).

Bauer, S.E., U. Im, K. Mezuman, & C.Y. Gao, (2019). Desert dust, industrialization, and agricultural fires: health impacts of outdoor air pollution in Africa. (p. 4113).

Benson David & Andrew Jordan (2017). Environmental governance.

Bennett Nathan J. & Terre Satterfield (2018), Environmental governance: A practical framework to guide design, evaluation, and analysis.

Bernard Kalu (2018). Black soot. Vol. 6. The Lancet Respiratory Medicine

Bourguet CC, Checkoway H & Hulka BS. (1987). A case-control study of skin cancer in the tire and rubber manufacturing industry. American Journal of Industrial Medicine, Volume: 11.

Boyland Judith R. (2019). A social constructivist approach to the gathering of empirical data.

Bryman Alan (2012). Social research methods. 4th edition, Oxford University Press.

Bryman Alan & Bell Emma (2007). Business research methods, 2nd edition, Oxford University Press.

Cho Renne (2016). The damaging effects of black carbon. Columbia climate school, climate health and society. The Damaging Effects of Black Carbon (columbia.edu) (accessed online on 11th August 2022).

Dukor Pius (2021). Rotary Club of Port Harcourt eco organizes stop-the-soot conference. https://businessday.ng/news/article/rotary-club-of-port-harcourt-eco-organises-stop-the-soot-conference/

Efe Ovuakporie (2017). FG declares air pollution in Port Harcourt an "emergency situation". https://prnigeria.com/2017/02/13/fg-declares-air-pollution-portharcort-emergency-situation/

Efekalam Irene C. (2022), Black Soot Menace and its Impact on Residential Buildings in Rivers State, Nigeria.

Ekpali Saint (2022). "It chokes me": a black soot nightmare in the Niger Delta. https://www.fairplanet.org/story/it-chokes-me-a-black-soot-nightmare-in-the-niger-delta/ (accessed on 19th January 2022).

Elem Maduawuchi (2021). Black Soot and public health of Rumuolumeni Residents in Port Harcourt, Nigeria.

Emoyan, O. O, Akpoborie I. A. & Akporhonor E. E. (2008). The oil and gas Industry and the Niger Delta: Implications for the environment. Vol. 12(3) (pp. 29 – 37).

Ewubare, D. B. & Okadigwe, C. V. (2018). Effect of environmental emission and dispersion of pollutants from black carbon on the income of rural farmers in Etche local government area, Rivers State. International journal of scientific research in social sciences & management studies: IJSRSSMS, 3(2), (pp.130-136).

EU Service for Foreign Policy Instruments (2019). EU Action Sheds Light on Black Carbon Emissions. https://fpi.ec.europa.eu/eu-action-sheds-light-black-carbon-emissions-2019-08-27_en

Evanoff, B., Gustavsson, P., Hogstedt, C. (1993). Mortality and incidence of cancer in a cohort of Swedish chimney sweeps: An extended follow up study. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1012164/

Ferraro F., Dror E., & Joel G. (2015). Tackling grand challenges pragmatically: robust action revisited. (pp. 364-382)

Freeman E., Rusconi G., Silvana S. Strudler A., (2012). Stakeholder Theory(ies): Ethical Ideas and Managerial Action.

Freeman, R. E., (1984) Strategic Management: a stakeholder approach, Pitman-Ballinger, Boston.

Friedman, A.L., & Miles, S. (2006). Stakeholder: Theory and Practice, Oxford University Press, Oxford.

Godwin Ann (2021). The Guardian News. Again, soot spike in Rivers raises fresh health concerns https://guardian.ng/features/again-soot-spike-in-rivers-raises-fresh-health-concerns/ (accessed online 8th August 2022).

Global Patriot News (2017). FG Declares Air Pollution in Port Harcourt an "Emergency Situation". Available online: FG declares air pollution in Port Harcourt an "Emergency Situation" – Global Patriot Newspapers (accessed on 4th August 2022).

Gooyert, D. V., Rouwette J. A, Kranenburg V. H., Freeman E. R. (2017). Reviewing the role of stakeholders in Operational Research: A stakeholder theory perspective.

Haataja David (2020). Stakeholder Theory: The new story of business?

Haigh Nardia & Griffiths Andrew (2007). The natural environment as a primary stakeholder: the case of climate change.

ICCDI Africa, (2020), CleanAirForAll: Air pollution and impacts on sustainable development goals**.** #CleanAirForAll: Air Pollution and Impacts on Sustainable Development Goals | by ICCDI AFRICA | International Climate Change Development Initiative Africa | Medium (accessed on 11th August 2022).

Ihesinachi A. K., Amalo N. D., & Ozioma A. E. (2019). Exposure to Heavy Metals in Soot Samples and Cancer Risk Assessment in Port Harcourt, Nigeria. Research & Development Centre, Kenule Beeson Saro-Wiwa Polytechnic, Bori, Nigeria.

Ipingbemi Olusiyi (2009). Socio-Economic implications and environmental effects of oil spillage in some communities in the Niger Delta.

Jashari Murat & Pepaj Islam (2018). The Role of the Principle of Transparency and Accountability in Public Administration.

Joakim Kulin & Ingema S. Johansson (2019). The Role of Government in Protecting the Environment: Quality of Government and the Translation of Normative Views about Government Responsibility into Spending Preferences.

Jørgen Klein (2022). Social constructivism and environmental problems - epistemological challenges.

Joris Pascal Kalkman (2020). sensemaking in crisis situations: drawing insights from epic war novels.

J.P Evans (2012). Environmental governance. (pp.1-219)

Lussier, R. N. (2011). Research methods and statistics for business; Waveland Press, Inc. ISBN 1-57766-658-5

Lindblom Andreas & Ohlsson Johan (2011). Stakeholders' influence on the environmental strategy of the firm.

Luo, W.; Guo, X.; Zhong, S.; Wang, J. (2019). Environmental information disclosure quality, media attention and debt financing costs: Evidence from Chinese heavy polluting listed companies. J. Clean. Prod.

Levitsky Michael, (2011). Black carbon and climate change considerations for international development agencies.

Morse et al. (2002) Verification strategies for establishing reliability and validity in qualitative research. international journal of qualitative methods.

Naanen Ben & Tolani Patrick (2014) Private gain public disaster. Social Context of illegal oil bunkering and Artisanal Refinery in the Niger Delta. (pp.23-111)

Nick Barter (2011). Stakeholder theory: pictures, the environment and sustainable development - do we have a good enough picture in our heads, or do we need something different?

Niranjan Rituraj & Kumar Ashwani T. (2017). The toxicological mechanisms of environmental soot (black carbon) and carbon black: focus on oxidative stress and inflammatory pathways. Volume 8, Article 763. (pp.1-20).

Ogunbodede Nife (2018). Transparency, accountability, and service delivery in Nigeria: A focus on public service.

Ojoye Taiwo (2017). The Punch News. The black soot plague in Port Harcourt - Punch Newspapers (punchng.com) (accessed online 19th January 2022).

Ogunkan V. David (2022). Achieving sustainable environmental governance in Nigeria: A review for policy consideration.

Parent M., Siemiatycki J., & Fritschi L. (2000). Workplace exposures and Oesophageal cancer. (pp. 325–334).

Peterside Dakuku (2021). Playing politics with soot and our collective conscience. https://www.premiumtimesng.com/opinion/502746-playing-politics-with-soot-and-our-collective-conscience-1-by-dakuku-peterside.html (accessed on 4th August 2022).

Rajesha T.A., Ramachandran B, S. (2018). Black carbon aerosols over urban and high-altitude remote regions: characteristics and radiative implications.

Robert Purcell (2022). Sensemaking. https://study.com/learn/lesson/sensemaking-approach-model.html (accessed online 12th August 2022).

Salami Temilade (2018). The strange black soot: the city of port harcourt and "the hanging black cloud". Https://Medium.Com/@Eruditetemi (accessed on 19th August 2022).

Saleem F., Zhang-Zhang Y., Malik M. I. & Allui A. (2020), Revisiting Stakeholder Theory and Environmentalism: Evidence from an Emerging Economy.

Saunders M., Lewis P. & Thornhill A. (2012). Research methods for business students. 6th edition Pearson Education. Pearson Publishers – ISBN 978-0-273-75075-8

Social Development Integrated Center, citizens walk against soot pollution in Port Harcourt, Nigeria's oil city. https://saction.org/citizens-walk-against-soot-pollution-in-port-harcourt-nigerias-oil-city/ (accessed online 4th August 2022).

Terry F. Yosie & Timothy D. Herbst (1998). Using Stakeholder Processes in Environmental Decision making. An Evaluation of Lessons Learned, Key Issues, and Future Challenges.

This Day News, Menace of soot in Rivers State. https://www.thisdaylive.com/index.php/2022rotr/01/24/menace-of-soot-in-rivers/# (accessed online 8th August 2022).

United States Environmental Protection Agency (EPA). (2012). Report to Congress on Black Carbon. Department of the Interior, Environment, and Related Agencies Appropriations Act, 2010.

Voegtlin C., Andreas S., Günter K. S. & Olga H. (2022). Grand societal challenges and responsible innovation. (pp.1-24)

Weidman J. & Marshall S. (2012). Soot pollution 101. https://www.americanprogress.org/article/soot-pollution-101/ (accessed online 19th January 2022).

Yakubu Okhumode H. (2017). Particle (Soot) pollution in Port Harcourt, Rivers state, Nigeria—double air pollution burden? understanding and tackling potential environmental public health impacts.

Yin Robert K. (2018). Case study research and applications: designs and methods. Sixth Edition, London SAGE.

Appendix

Interview Guide

Topic: Soot Pollution in Port Harcourt (PH) Nigeria; A grand societal challenge.

Eight (8) participants from four different stakeholders; two members of the community, two participants from the NGO's, two government representatives, two participants from the existing oil companies in Port Harcourt, Nigeria.

The interview questions are divided into two sessions (general and specific questions).

General questions

1. How do you understand responsibility concerning environmental issues?
2. What is your perspective on soot pollution as a problem in Port Harcourt? Do you feel it is a complex issue and why?
3. How has the problem affected you and the people in your environment?
4. What are the contributing factors to soot pollution in Port Harcourt, Nigeria?
5. How has soot pollution influence your behavior?
6. How have you been able to survive during this crisis?
7. What kind of leadership could be successful concerning this issue?
8. How do you perceive accountability and transparency of the leaders (government)?
9. Do you think there are ways to address this problem?

Specific Questions

Government representative

1. What polices and structures are in place to control environmental degradation?
2. What measures has the government placed to collaborate with other stakeholders in mitigating soot pollution?
3. How have the government responded to the issues?

Organizations (Oil companies)

1. What is the Impact of soot pollution on the business and brand image?

2. How can we address these problems from the organization's perspective?
3. In what ways has soot pollution affected the organization routines?

Civil Society

1. What are the responses of environmental NGOs to the present problem?
2. How can the civil societies help in addressing this problem?

Is there anything else that you would like to add?

Thank you for your time!