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Community Perceptions and Experiences of Air Pollution Monitoring in Soweto, Johannesburg

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UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

Community Perceptions and Experiences of Air Pollution Monitoring in Soweto, Johannesburg

A report on a research study presented to

The Department of Social Work

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ABSTRACT

Air pollution remains one of the most urgent environmental and public health issues in rapidly urbanising areas like Soweto, Johannesburg. Despite growing awareness of its adverse effects, community experiences and knowledge remain underrepresented in air quality research and policy frameworks. This study examines community perceptions, lived experiences, and collaborative potential in air pollution mitigation using the Good Participatory Practice (GPP) framework. The study employed a qualitative methodology, drawing on purposive sampling to engage 21 diverse stakeholders, including residents, educators, NGO workers, informal business owners, and government officials. Data was collected through in-depth interviews and focus group discussions, analysed thematically to derive key insights into the perceptions of air quality, sources of pollution, health impacts, and current community-level responses. Findings revealed a widespread perception of deteriorating air quality, attributed primarily to domestic fuel burning, waste fires, and vehicle emissions. Participants said that the effects included high rates of respiratory illnesses, mental stress, and damage to the environment. Children, the elderly, and people who lived in shacks were especially affected. Participants expressed frustration with fragmented governance, inaccessible air quality data, and a lack of meaningful participation in environmental decisions. Strong community-driven solutions also emerged, including calls for tree planting, youth engagement, better enforcement, and decentralised monitoring. The study concludes that Soweto functions as a "sacrifice zone", where systemic neglect compounds environmental injustice. Using the GPP model, the research demonstrates the transformative potential of community participation in air pollution monitoring and governance. Recommendations include institutionalising participatory platforms, improving communication of air quality data, and supporting community-led innovations. This research contributes to the discourse on environmental justice and offers a replicable model for inclusive, grassroots-driven responses to urban air pollution.

Key words: Air Pollution, Community Engagement, Stakeholder Collaboration, Good Participatory Practices (GPP), Environmental Sustainability, Public Health and Soweto

LIST OF ABBREVIATIONS

ABBREVIATION	TERM IN FULL
CABs	Community Advisory Boards
COJ	City of Johannesburg
EJ	Environmental Justice
FDGs	Focus Group Discussions
GPP	Good Participatory Practice
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
TB	Tuberculosis Bacterial
NGOs	Non-Governmental Organisations

CHAPTER ONE: INTRODUCTION

1.1 Introduction

Environmental hazards such as air pollution have emerged as persistent consequences of swift urbanisation and industrial expansion in a region, adversely affecting its inhabitants (Manisalidis, et al., 2020). According to Ogwu and Izah (2024), the impact of air pollution intensifies respiratory diseases and various public health challenges, ultimately obstructing progress towards Sustainable Development Goals (SDGs). Current research does not adequately include community input, resulting in shortcomings in its efforts to prevent such occurrences. This study sought to bridge the divide between the knowledge generated through research and the requirements of the community, while promoting community engagement in decision-making processes. It emphasises the active participation of all stakeholders, including researchers, policymakers, and residents (Banks, 2022). This approach seeks to enhance and sustain the environment while promoting a healthier population, emphasising the importance of participatory involvement from various stakeholders and collaborative solutions.

1.2 Statement of the Problem

Air pollution inflicts negative health impacts, environmental degradation, and reduced quality of life on residents of Soweto which has been worsened with rapid urbanization and industrial expansion (Eriksen & Visentin, 2024). Another important argument stems from using the global air quality data, emphasizing that air pollution cannot be regarded as a single issue; it interacts with the environment, public health, and socioeconomic factors, suggesting that air pollution requires a multi-faceted and inclusive approach to its examination and eradication (Ru, 2020). Ethical stakeholder engagement has become a focus of contemporary research beyond medical fields to include environmental research (Pritchard, et al., 2023). In this context, the utilization of stakeholder engagement frameworks serves as a potential strategy in the empowerment of collaborative partnership between the following: researchers, the community members, policymakers, and other appropriate stakeholders (Abma, et al., 2019). Nevertheless, research often neglects community opinions and does not incorporate local knowledge while devising mitigation strategies (Lam, et al., 2020). The study intends to bridge the gap between the scientific research and community needs by fostering collaboration among researchers, policy makers and residents. Air pollution abatement in Soweto area contributes to both environmental sustainability and population health equity (Masheula, 2023). The research problem underlines, therefore, a need to extend stakeholder engagement models, such

as Good Participatory Practice (GPP), into the non-medical research setting as a ready means to effectively tackle emergent environmental problems and promote community wellbeing (Metz, et al., 2019).

Despite the wealth of global and regional air quality research, there remains a striking underrepresentation of studies that prioritise the perspectives of marginalised urban communities, especially those in historically disadvantaged areas like Soweto. Previous interventions have predominantly relied on top-down governance and technological solutions, often ignoring the socio-cultural context and local knowledge systems (Goel, Yadav & Vishnoi, 2021). In areas like Soweto, where informal settlements, low household incomes, and service delivery backlogs intersect with industrial activity and vehicular congestion, community-led insights are essential for shaping interventions that are both contextually relevant and sustainable (Sonono, 2021). This study is therefore justified by the urgent need to elevate community voices in air quality governance, inform policy from below, and challenge existing structures that perpetuate environmental injustices.

This study considers the serious effect of air pollution to public health and the environment in the context of a rapidly urbanizing Soweto, within Johannesburg. It fills the gap between scientific research and local realities by grounding public policy decisions in the perceptions and experiences of communities and promotes an ethos of inclusion in navigating air quality challenges. The work relies on the Good Participatory Practice (GPP) model centered on collaboration among residents, researchers and policymakers. This method guarantees that air pollution mitigation strategies are not only effective but also community driven and sustainable. By tackling the environmental determinants of health inequities, the research support global objectives including Sustainable Development Goal 3, health and well-being. It also joins a growing body of knowledge on the integration of local information into nonmedical environmental research and provides a replicable model for other urban areas to use. The study thus contributes to environmental justice, and public health and equity, by empowering the Soweto community to practice active participation in decision making. Its outcomes have potential to guide both broader policy development and partnership around collaborative, long term responses to air pollution and associated health risks.

1.3 Research Questions

The study aimed to answer the following questions:

- What are the perceptions and experiences of the Soweto community regarding air pollution and community air pollution measurements?
- What are the perceptions on primary sources of air pollution in Soweto, according to community members?
- What is the perceived and experienced air pollution impact by the population of Soweto?
- How can the GPP model enable community-driven collaboration in Soweto for the effective use of air pollution measurements to monitor and mitigate air pollution?

1.4 Aim of the Study

The aim of the study is to explore the sources of air pollution and understanding factors for developing prevention strategies for air pollution within Soweto area.

1.5 Objectives of the Study

To achieve the above aim, the following study objectives shall be pursued:

- To explore the experiences of the Soweto community regarding air pollution and community air pollution measurements.
- To identify the perceptions of primary sources of air pollution in the Soweto community
- To explore perceptions and experiences of the impact of the air pollution to the population of Soweto.
- To utilise the GPP model to enable community-driven collaboration in Soweto for the effective use of air pollution measurements to monitor and mitigate air pollution.

1.6 Definition of Concepts

1.6.1 Stakeholder Engagement

Stakeholder engagement is a deliberate act nurturing partnerships among individuals, groups and entities with vested interests or concerns in a specific issue or project (Amey & Eddy, 2023). The primary goal is to ensure inclusivity, transparency and mutual benefit by actively seeking input, sharing information and involving stakeholders in decision-making procedures.

1.6.2 Community Stakeholders

Community stakeholders refers to residents, leaders, and any organisation that actively participated or whose input was sought in the study on air pollution (Ferguson, et al., 2022).

1.6.3 Non-Medical Research

Non-medical research involves researching areas excluding clinical, medicine or health care aspects. This includes almost all aspects of life and well-being such as social sciences, environmental studies, engineering, and humanities among others (Newington, et al., 2022).

1.6.4 Air Pollution

Air pollution is the presence of harmful or excessive quantities of substances in the air including harmful gases, particulates and molecules. An air pollution may have adverse effects on human health and the environment in Soweto, Johannesburg (Kampa & Castanas, 2008).

1.7 Chapter Summary

In this chapter, the study is introduced by focusing on the great environmental and health challenges that air pollution in Soweto, Johannesburg poses, engendered by the urbanisation and industrial growth. It recognises the absence of community participation in the air quality research. This study takes a participatory approach following the Good Participatory Practice (GPP) model, in bridging the gap between scientific research and community needs. It looks at community perceptions and experiences of air pollution and the main sources of air pollution and is in pursuit of empowering local stakeholders to design sustainable mitigation strategies. This chapter then further defines key concepts such as stakeholder engagement and non-medical research and highlights the relevance of the study to Sustainable Development Goal 3 and environmental justice. In the following chapter, the theoretical basis of this study is presented, which is primarily based on existing scholarly practice and models.

CHAPTER TWO: THEORETICAL FRAMEWORK

2.1 Introduction

This chapter provides the theoretical frameworks that inform the study, which was conducted to investigate air pollution in Soweto, Johannesburg. The study integrates three key theoretical perspectives: Good Participatory Practice (GPP) framework, sacrifice zones, and environmental justice theory. In combination, these frameworks offer a more complete and dynamic perspective on how air pollution disproportionately affects vulnerable communities, and on ways to engage them in successful collaborative work to mitigate air pollution challenges.

These three components are integrated in the GPP framework in which the framework's three central pieces establish a mechanism of structured and ethical stakeholder engagement; the environmental justice theories point out systemic inequities in exposure to pollution; and the sacrifice zone concept shares the concentrated burden of the exposure of marginalized populations to environmental degradation. Each framework is elaborated and thereafter how they are combined into an innovative research structure is discussed. To illustrate the conceptual relationships and methodological flow of these frameworks, visual representations are included.

2.2 Good Participatory Practice (GPP) Framework

2.2.1 Evolution of the Framework

The inception of the Good Participatory Practice (GPP) framework was to guide ethical stakeholder engagement in biomedical research related to HIV/AIDS clinical trials (Baron, et al., 2018). Its principles have been adopted and used in various other fields in environmental research, community health initiatives and public policy in recent times (Ntabe, 2020). The GPP framework is designed such that research and policy processes are inclusive, transparent and sensitive to all stakeholder needs. The GPP framework brings the research community, policy makers and affected communities closer together, by emphasising mutual respect, shared decision making and trust building (Davies, et al., 2023).

The GPP framework provides a structured methodology to engage stakeholders, particularly in the context of research. It provides an appropriate framework to work with stakeholders

including residents, industrial representatives, government officials, and non-governmental organisations (NGOs) in environmental research particularly in the context such as Soweto. That in turn ensures that the interventions put in place are both ethical and contextually relevant.

The GPP framework is built upon five key principles that ensure ethical and effective stakeholder engagement. These principles include stakeholder mapping and analysis which provide a strategy to identify, understand and recognize the stakeholders for a project (Ioanna, et al., 2022). Stakeholder mapping defines the people, organisations and institutions who have a vested interest in the research. Influence, resources, and roles of stakeholders are categorized to design designated engagement strategies that correspond to the different needs and capacities of each group (Franco-Trigo, et al., 2020). The stakeholders in this research comprised of local residents, community leaders, environmental NGOs, health advocacy groups, academic institutions, local government officials, and employees of industrial representatives. Collaboration strategies would be designed based on how an analysis of each stakeholder's influence and concerns would support the project.

Figure 2.1: Stakeholder Mapping Process



Source: Own

Figure 2.1 above represents the Stakeholder Mapping Process, showcasing six key groups: Communities, Researchers, Policymakers, NGOs, Industries, and Academics. It highlights their interconnected roles in collaboration and decision-making processes, emphasizing diverse participation for achieving goals in policy, research, and community development.

This study relies on the GPP framework to organise efforts by diverse stakeholders in Soweto's air pollution crisis. Using stakeholder mapping, and feedback mechanisms, the research facilitated inclusive and ethical collaboration allowing the relevant communities to contribute in a meaningful way to the solutions.

2.3 Environmental Justice Theories

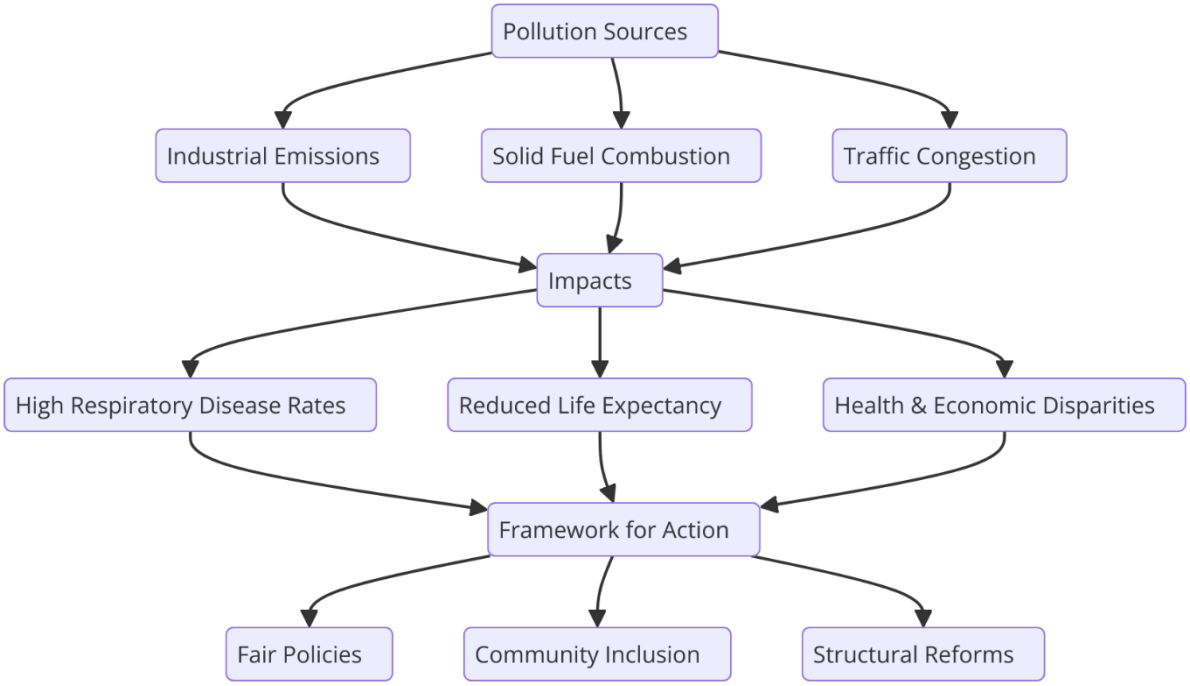
The environmental justice (EJ) is a framework for understanding as well as addressing inequitable distribution of environmental risks and benefits. The environmental movement started as a social and environmental movement in the United States in the 1980s with grassroots organisations fighting for minorities disproportionately affected by environmental dangers (Taylor, 2019). Environmental justice theories reflect these core beliefs in fair treatment and in involving all people regardless of race, colour, national origin, or income, collectively in environmental decision making regarding a given facility or program (Brinkley & Wagner, 2024). The Environmental Justice comprise of the three core tenets, that is fair treatment, meaningful involvement and focus on vulnerable populations. These tenets are briefly described below.

Fair treatment questions systemic policies and practices that put those most marginalized from society at greater risk to pollution, hazardous waste and other environmental harms (Laurent, 2023). Meaningful involvement place emphasis on community representations, especially through putting more attention on the affected community's participation. This may be through inputs in decision making process, both having their concerns heard and addressed (Brinkley & Wagner, 2024). Lastly, focus on vulnerable populations is guided by the imperative to address the environmental, economic and social needs of vulnerable populations (Hendricks & Van Zandt, 2021). This includes low income, racial and Indigenous communities, who often experience disproportionate effects from environmental and socio-economic challenges that compound to 'double jeopardy'.

For many Southern African cities and their surrounding areas, conceptions like 'development' and 'growth' are faced with competing perspectives about what priorities are most important to address through legislation and policy. Environmental injustice is epitomised in Soweto. Air pollution levels in the city are the result of industrial emissions, vehicle fumes and reliance on solid fuels for cooking and heating, thus disproportionately high for its residents. Systemic

socio-economic inequities such as poverty, unemployment and lack of health care are a matter of magnification of these challenges (Banerjee 2021).

Figure 2.2: Illustration of Environmental Justice in a flow chart



Source: Own

Figure 2.2 above illustrates the environmental justice challenges in areas like Soweto, starting with pollution sources: industrial emissions, solid fuel combustion, and traffic congestion. These lead to impacts such as high respiratory disease rates, reduced life expectancy, and health-economic disparities. The framework for action emphasizes implementing fair policies, ensuring community inclusion, and enacting structural reforms to address these issues comprehensively. It highlights the interconnectedness of sources, impacts, and solutions to achieve justice and sustainable improvements in health and equity.

Soweto's environmental justice challenges echo with global trends characterised by environmental degradation borne by the marginalised communities. For example: in the United States, areas like Flint, Michigan and Cancer Alley in Louisiana have come to symbolize environmental justice, as low-income minority populations are often exposed to polluted water and air far more than other groups (Njoku & Sampson, 2023). In cities of India like Delhi, the slum dwelling population are enduring severe air pollution from industrial activity, vehicular emissions and inadequate waste management systems (Kandpal, 2024). By embedding

Soweto's air pollution crisis amidst the global struggle for environmental equity, EJ theories reveal the universal nature of environmental inequity, and the inevitability of a comprehensive fight against environmental inequity.

2.4 Sacrifice Zones

Sacrifice zones are geographic areas that are subject to disproportionate physical environmental harm from industrial or economic development. In other words, these zones are typically established in the poor and marginalised neighbourhoods where residents are politically powerless or devoid of the means to combat exploitation (Rosenbloom, 2024).

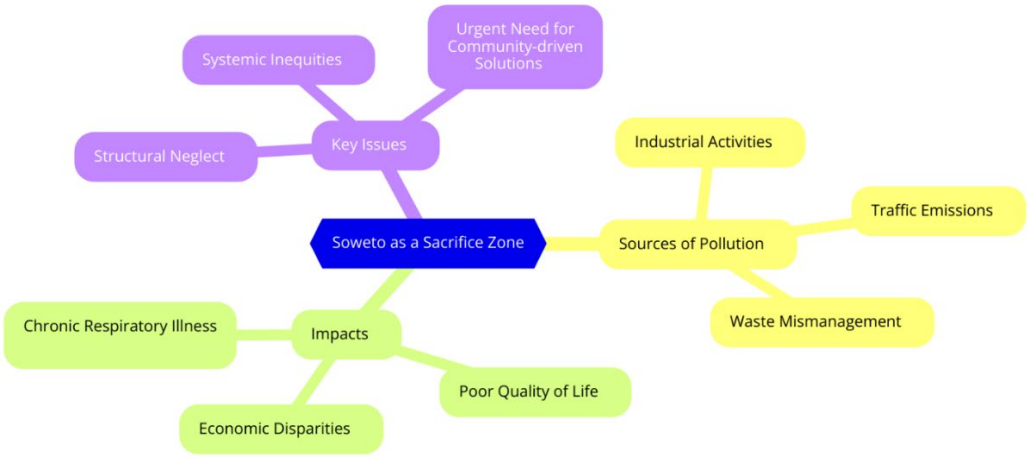
Key characteristics of sacrifice zones include concentrated environmental hazards, socio-economic marginalization, environmental trade-offs. Concentrated environmental hazards sacrifice zones are defined by among other features the chronic exposure to pollutants and environmental hazards (De Souza, 2021). Socio-economic marginalisation characterises communities in sacrifice zones, which are often poor, unemployed, and, in most cases, marginalised and neglected. These conditions compound existing community vulnerabilities (Farley, 2022). Environmental trade-offs are the short-term profit of economic or industrial activity that reigns over long-term environmental and public health sustainability. (Juskus, 2023). These trade-offs often lead to detrimental consequences, such as pollution, habitat destruction, and the depletion of natural resources. As society grapples with the implications of these choices, it becomes increasingly essential to prioritise sustainable practices that ensure the well-being of both our planet and future generations.

Soweto as a Sacrifice Zone

Soweto exhibits many characteristics of a sacrifice zone, for example:

- **Sources of Pollution:** It is facing industrial emissions, traffic congestion and indoor pollution from burning coal and wood (Samet & Spengler, 2024).
- **Health Impacts:** Soweto has above average levels of chronic respiratory diseases, cardiovascular disease and premature mortality rates (Schmidt-Sane, et al., 2023).
- **Socio-economic Challenges:** Soweto is a region that currently suffers from a dual cure: systemic neglect and economic disinvestment on one side and limited healthcare access on the other (Magidimisha & Chipungu, 2019). This serves to amplify the challenges of the environmental burdens.

Figure 2.3: Visualisation of Soweto as a Sacrifice Zone



Source: Own

Figure 2.3 above highlights Soweto as a "Sacrifice Zone," emphasizing sources of pollution, their impacts, and key issues. Industrial activities, vehicle emissions and the poor management of waste have resulted in pollution, and a chronic splurge of respiratory illness and poor quality of life, as well as economic disparities. Structural neglect, systemic inequities and a desperate need for community led solutions are key. This visual network presents the challenges confronting Soweto, illustrating the need for response that recognizes pollution sources and impacts as issues of environmental justice and the necessity of inclusive action to address these challenges to improve living conditions in affected communities.

Implications for Policy

Addressing Soweto's status as a sacrifice zone requires systemic changes, including:

- There is a need for tighter environmental regulations.
- Increased investments in green infrastructure are essential going forward.
- Community-driven and locally applicable interventions are the way to go.

2.5 Integration of Frameworks

The integration of GPP, environmental justice theories, and the sacrifice zone concept provides a multi-dimensional approach to analysing and addressing air pollution in Soweto, as shown in the breakdown below:

2.5.1 GPP as Methodology

It furnishes a structured approach for engagement of various stakeholders and fights against unethical collaboration and lack of transparency (Davies, et al., 2023).

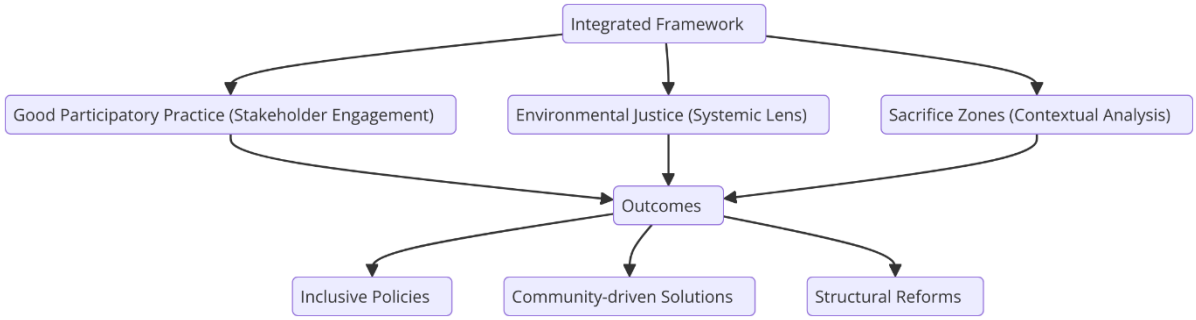
2.5.2 Environmental Justice as a Lens

The systemic inequities that render the Soweto air pollution crisis possible are framed, and an appeal for fair treatment and inclusive decision making is made (Laurent, 2023).

2.5.3 Sacrifice Zones as Context

The environmental challenges in Soweto place into context pollution's concentration in the lives of marginalised residents (Weimann & Oni, 2019).

Figure 2.4: Integrated Frameworks Visualised



Source: Own

An enhanced flowchart of the "Integrated Framework" in Figure 2.4 above represents a framework that brings together the core components of Good Participatory Practice (Stakeholder Engagement); Environmental Justice (Systemic Lens); and Sacrifice Zones (Contextual Analysis), to deliver outcomes. These are inclusive policies, community driven solutions and structural reforms which stand for targeted goals to improve systems. The central framework drives directly to actionable results from each input. The figure shows the interconnectivity and flow from stakeholder engagement, systemic understanding and context specific analysis to practical, inclusive and structural solutions through a whole systems lens for addressing complex social and environmental problems.

2.6 Chapter Summary

This chapter has discussed theoretical perspective through which this study has been led. Together, environmental justice theories, sacrifice zones' model and the Good Participatory Practice (GPP) framework offer a powerful lens through which Soweto's air pollution crisis can be viewed. While focusing on discrimination and highlighting systematic inequities and demanding equal treatment, and involvement of local people in research and policy decisions makes up for environmental justice theories, ethical and inclusive stakeholder engagement designed under the GPP framework fosters impact of research and policy decisions on local people.

The sacrifice zone concept draws attention to the high concentration of environmental burdens and socio-economic vulnerabilities in the resident's lived experience of Soweto within the broader patterns of neglect and exploitation. The study brings these frameworks together and into one comprehensive approach of assessing and tackling Soweto's air pollution problems in an equitable, community driven manner. The literature review in the following chapter engages with the existing literature such as studies on air pollution, environmental justice and participatory frameworks to contextualize this project within wider analytical discourses.

CHAPTER THREE: LITERATURE REVIEW

3.1 Introduction

The following literature review covers factors of air pollution and various forms of stakeholder engagements. Further, it also explains the stakeholder engagement approaches to tackle air pollution and underlines the necessity of involving communities and establish mechanisms for improving the success and sustainability of such solutions. It will also seek to offer a clean perspective of these aspects in the investigation of environmental research.

3.2 Primary Sources and Factors Driving Air Pollution

Primary pollutants of air in the world include, industrial emissions, vehicle emissions, fossil fuel burning among others while countries like China face bad smog due to high industrialization coupled with high car usage (Miao, et al., 2019). Some of the causes in Africa include urbanization, use of biomass for cooking, and uncontrolled industries, which have escalated respiratory diseases and environmental pollution (Kohnert, 2024). South Africa mainly deals with air pollution from burning of thermal power for production of electricity, mining and the growing use of automobiles, especially influential in the Highveld industrial and Johannesburg metropolitan area (Muyemeki, 2021). It is on this premise that a catalogue of factors, that hitherto have been analysed, pose a menace to public health; this therefore calls for sustainable practices coupled by a more stringent legislation on the developed countries

Industrial emissions as a concern originate from the industrial sectors such as factories manufacturing plants and processes involving industries. These emissions cover a wide spectrum of pollutants such as particulate matter, sulfur dioxide, nitrogen oxides, volatile organic compounds and other undesirable substances (Nilsson, et al., 2023). The combustion of chemicals, and the manufacturing of metals cause considerable emissions of gases, fumes, and chemicals into the atmosphere hence degrading the quality of air around them. In its gaseous form, these emissions can be inhaled causing several illnesses to residents while in the wet form they cause acid rain, smog and are very destructive to ecosystems (Yoro & Daramola, 2020). It is crucial to adopt strict compliance measures and standards, use new technologies, and embark on the pollution control program if emissions from industries are to be dealt with and the quality of air protected (Holappa, 2020). In the following section, the discussion focuses on the contributors to air pollution.

According to the generated images, urban areas experience air pollution due to transportation sector, particularly the road traffic. Some of the emissions found from vehicle exhaust include carbon monoxide (CO), nitrogen oxides (NOx), volatile organic chemicals (VOCs, particulate matter (PM), and sulfur dioxide (SO2) (World Health Organization, 2021). Cities like Johannesburg experience problems such as traffic congestion a high rate of vehicle turnover density; and old Models which worsens the effects of emissions on the environment. Vehicle emissions not only exacerbate local air pollution, but they also contribute to acute global environmental problems, including smog formation, acid deposition and climate change (Manisalidis, et al., 2020). To counter these emissions the measures such as encouraging the use of public means of transport, setting standards for exhaust emissions, sheer incentives for eco-friendly cars and improvement of transport systems so as to minimize congestion are critical (Shahzad & Cheema, 2024).

Most of the gases, notably CO, PM, NO2 and VOCs, are emitted by urban areas with special emphasis on those that heavily rely on solid fuels for heating and cooking purposes (Puzzolo et al., 2019; Ali, 2021). Turning around in return, these emissions—including smoke from kerosene lamps—expose risks to health, mostly women and children indoors. Their residential emissions degrade outdoor air quality (Wu, 2021). Some of the measures applied in addressing these include promoting cleaner cook stoves, enhancing home ventilation, and using alternative heating sources (Tran et al., 2020).

Open burning of plastics and rubber domestic wastes generates a vast amount of PM, CO, VOCs, and HAPs, among other pollutants (Srivastava, 2020; Schmidt-Sane, et al., 2023). The most hazardous ones, such as dioxin, furans, and PAHs, are released through open waste burning, which is adjudged to be very dangerous to humanity and the climate (Letcher, 2021). Indeed, there is the urgent need for proper modes of waste disposal that include recycling and controlled incineration to minimize this impact on air quality (Mor & Ravindra, 2023). Air quality is also affected by several natural factors, including dust storms, fires, and biogenic emissions (Fowler et al., 2020; Saxena & Sonwani, 2019). While less control can be exercised over such sources, monitoring systems and land management strategies can reduce their impacts (Motlagh et al., 2020).

The mine dumps in Soweto are remnants of historical gold mining in Johannesburg, are another major source of air pollution (Howe, 2022). They are made up of fine particulate matter, heavy

metals and silica dust that becomes airborne when dry and windy. These tailings are very close to residents, and inhalation of their dust causes problems such as asthma, silicosis and other chronic conditions (Zack & Lewis, 2022). The problems go further, as mine dumps are poorly managed. The lack of vegetation in poorly managed mine dumps prevents the stabilisation of the dust and aggravates pollution (Vosloo, 2024). This pollution source needs to be cleaned up and stricter regulations on other existing sources are required along with reclamation projects, and community driven efforts to reduce its environmental and public health impact.

3.3 Impact of Air Pollution on Health (respiratory) and Well Being

Air pollution is a factor that has negative effects on health, it worsens respiratory diseases including asthma and chronic obstructive pulmonary disease as well as lowers the standard of living (Tiotiu, et al., 2020). Newer publications have also substantiated that exposure to air pollution leads to hospitalization and higher mortality rates (Manisalidis et al., 2020; WHO, 2021). The situation in South Africa is devastating due to the predominance of Tuberculosis (TB) and its drug-resistant forms. In this country, a simultaneous HIV epidemic raises the levels of the TB burden, with an infection rate of 13.7% in adults aged 15-49 in 2020 (Mid Year Population Estimate 2020, n.d.). Industrial pollution aggravates air quality as companies frequently violate laws, exposing workers and other citizens to dangers. The interplay of TB with HIV further clouds respiratory health. Given that TB accounted for 6.5 percent of deaths in South Africa in 2020, the extent of crisis to respiratory health is extreme (Osman et al., 2021). Much better monitoring and regulation, accompanied by better health practice and industry standards, will help to mitigate these impacts.

3.4 Pollution Source Identification and Reduction

Collaborative research partnerships with local councillors, non-governmental organisations and research institutions help deepen the understanding of pollution sources and their impacts (Brooker, et al., 2019). The co-created strategy focuses on engaging local industries to implement cleaner production techniques and reduce emissions. Developing traffic management plans promotes carpooling, public transportation, and non-motorized transport, thereby reducing vehicular emissions. Additionally, advocating for stricter local regulations on emissions from factories and vehicles helps mitigate pollution at the source (Tilt, 2019).

Strengthening of the planning and constructing green infrastructure in cities involve asking the people and or community through a number of consultations on proposed projects (Kiss, et al.,

2022). The ideas and solutions also have to be realistic, and co-operating with urban planners, architects and environmental organizations makes sure of this. The key strategies that were co-created for improving air quality and to have other social benefits related to greenery are the creation of more parks, community gardens, and green roofs. New tree planting campaigns make more green space within urban areas and are believed to help purify the air (Willems, et al., 2020).

The current ongoing study in air quality management (https://www.sacaqm.org) will require raising awareness, sensitization, and training of stakeholders on air quality data collection, sampling, and interpretation (Mukherjee & Sastry, 2022). Community participation in data collection also promotes the trust of residents in the research process since they engage in the instance. The co-created strategy comprises of the creation of exercises that would appropriately allow members of that community to gain routine assessment of air quality (Ramírez-Andreotta, et al., 2023). Making this data available to the community and developmental partners offers a clear background against which decisions and advocacy shall be made so that all players get information they require. In view of the serious health effects caused by air pollution, in particular, respirational conditions such as asthma, Chronic Obstructive Pulmonary Disease (COPD), and TB have a need to devise mechanisms for prevention and reduction. It is important for preparedness in view of the changing environment and community well-being, through informed decision-making and advocacy.

3.5 Community Preparedness and Response in the Reduction and Elimination of Pollution

Community preparedness encompasses environmental sensitization and its impact of health, public awareness campaigns, and planning towards the effects of pollution (Linares, et al., 2020). Community involvement encompasses environmental response measures such as clean-up drives and working with the local government to enforce rigorous laws that aim at eradicating pollution sources (Khanam, et al., (2023). Engaging everyone especially through groups of people from the community, local leaders and NGOs provides conformity in policy change support advocacy. Some of the measures that are being canvassed are the establishment of local air quality standards and the enforcement of the measures on the polluters. This also helps in the development of public health policies that will tackle the effects of air pollution which include providing healthcare services to people affected (Manisalidis, et al., 2020).

3.6 Community Perceptions and Experiences of Air Pollution and Community Air Pollution Measurements

Most communities only get worried about air pollution when its effects become obvious or when it starts affecting their day-to-day activities directly. Perceptions of air pollution in areas such as Soweto, where industrial emissions, vehicular exhaust and solid fuel combustion occur, are based on personal experience, cultural belief and environmental awareness (Mukwevho, 2023). Air pollution is often linked to negative health outcomes, including respiratory disease, allergies and eye irritation by residents (Manisalidis, et al., 2020). Residents report an increase in asthma, chronic bronchitis and other respiratory diseases especially among children and senior citizens who blame the poor air quality in their neighbourhoods.

Air pollution usually has reflected itself as visible effects such as smog, reduced visibility, dust accumulation, and discolouration of buildings (Lazaroiu & Jarcu, 2024). These signals together encapsulate a collective perception that environmental quality is deteriorating, also affecting health, the aesthetic and economic value of neighborhoods. In certain communities with limited access to education or environmental resources, awareness about what the causes and what are the consequences of air pollution can may be superficial (Rosário Filho, et al., 2021).

Residents might know the impacts but may not know what is causing them or why. Gaps in environmental education may be exposed when some refer to possible ‘natural’ causes instead of industrial or vehicular emissions. Air pollution perceptions are almost always related to social and economic realities. In marginalized communities, the fight to survive day to day overshadows the environmental fight (Marquardt, 2022). For example, people who cook with coal or wood will be willing to accept the long-term health risks from indoor pollution in exchange for affordability. Air pollution is perceived with urgency and feasibility in terms of these socio-economic constraints.

3.7 Chapter Summary

In this chapter, the literature on community perceptions, experiences, and collaborative approaches to addressing air pollution were reviewed. The study highlighted the communities’ perceptions on the health, environmental and socio-economic impacts on residents, and showed that vulnerable groups are disproportionately affected. The chapter covered how community measurements of air pollution empower residents, promote advocacy and create what are possible participatory solutions, alongside the barriers to engagement.

The next chapter discusses the methods used in the study, by explaining the approach and tools used to elicit community perceptions, experiences, and participation related to air pollution measurement and mitigation.

CHAPTER FOUR: RESEARCH METHODOLOGY

4.1 Introduction

The research methodology employed in this study is outlined in this chapter describing the approaches, designs and techniques used to examine community perceptions and experiences of air pollution in Soweto. The data collection procedure as well as the method of data analysis, ethical considerations, study limitations and delimitations of the study are outlined. This study is thorough in its methodology and consequently an aspect that guarantees its trustworthiness.

4.2 Research Approach

For this study, a qualitative research approach was used because it gives a thorough analysis of the issue and aims to capture the complexity of social realities that might be out of reach when using quantitative approaches (Priya, 2021). A wide range of qualitative research methods were applied in this study to investigate the perceptions, experiences and insights of the residents in Soweto about air pollution. These methods enable a complete understanding of the specific obstacles confronted in communities, specifically in regard to the social, cultural and environmental factors that can contribute to poor air quality. Using interviews, focus groups and participatory techniques, the investigation succeeded in gathering a range of diverse perspectives that quantitative methods often miss out (Tracy, 2024). A big component in engaging with the community and reporting findings is trust and collaboration with the community. This way the results are meaningful, actionable and relevant to the real-life experience of people living in the communities.

Qualitative approach provides a broader picture through detailed description whereby the meanings and the experiences of participants in view of the study are made to venture out. This includes interviews, focused group discussion, ethnography and content analysis (Sullivan-Bolyai & Bova, 2021). It is an essential method for understanding participants' point of view and for having an insight into their perceptions of the social realities. However, the resultant findings are case sensitive, making the process of generalizing the result more difficult (Tracy, 2024).

4.3 Research Design

According to Pandey and Pandey (2021), a research design is a structured framework which stipulates the steps that must be taken during the study to collect, measure and analyse the collected data. An exploratory research design was used in this investigation. The use of the

exploratory research design is done when the research problem of a study is not clear. The goal is that before going in depth you get to know your subject in their environment (Swedberg, 2020). These instances include a literature review, a qualitative study and a pilot study. Finally, exploratory research is important because it offers a clearer understanding of a problem and helps in creating theories that answer the subsequent research on that topic applying more structured methodologies (Hanks, 2019). It serves as a tool for gaining fresh insights and reflecting on their objectives beyond their professional endeavours. This design was chosen for its appropriateness in initiating an inquiry into a poorly defined issue, testing hypotheses, and directing the progression of subsequent, more rigorously controlled studies, which is thus termed exploratory research design in this context.

4.4 Population, Sample, and Sampling Procedures

4.4.1 Population

A study population refers to the entire group that the researcher aims to generalise their findings to, and among whom the research study is currently being conducted (Fellows & Liu, 2021). The target population comprised individuals residing in Soweto, as well as workers and business owners operating within the area. It also included members of environmental organisations and representatives from government departments engaged with or concerned about air pollution and its consequent effects. The study was conducted in Soweto, a popular and vibrant section of the city of Johannesburg. Soweto is a critical case in understanding how and what led to the current state of development of the greater South African community (Horn, 2021). Greater Soweto and its environs have been faced with several challenges which have emerged from the continuing industrialisation and urbanisation in the country. Among others, they are facing challenges related to air pollution, which is devastating with regards to their public health, social wellbeing and quality of environment (Shrivastava, et al., 2020).

4.4.2 Sample

A sample is smaller, more manageable part of the larger study population that is used in investigations to permit the extrapolation of results to the larger population itself (Lakens, 2022). The study's target audience consisted of three selected local leaders, three government officials in the health sector, three government officials in the environment, three government officials in the education, three environmental non-government organizations. Each of these categories refers to individual participants rather than institutions. For instance, one representative was selected from each of the three environmental NGOs, resulting in three individual participants representing three different organisations. A total of eight (8) community members in Soweto area who were confident and inclusive were chosen to participate to have a diverse range of responses from participants for the sample size and 13 participants interviewed. Therefore, the total sample included: 3 individual local leaders, 9 individual government officials across health, environmental, and educational sectors (3 per sector), 3 individuals representing 3 NGOs, and 8 community members, bringing the total number of participants to 23. Out of these, 13 participants took part in in-depth interviews, while the remaining 8 formed part of a focus group discussion (FGD).

4.4.3 Sampling Methods

The sampling methods encompass random, stratified, systematic, convenience, and purposive sampling (Lohr, 2021). Purposive sampling involves a deliberate selection process by the

organisation to identify individuals possessing specific attributes that are advantageous for the role (Lohr, 2021). Considering the study's focus, purposive sampling was instrumental in identifying and engaging residents, businesspersons, environmental NGOs, and officials, who were approached through community events, business networks, NGO gatherings, or governmental avenues. The individual ensured that each category was represented as planned.

4.4.3.1 Inclusion and Exclusion Criteria for the Air Quality Management Study

Inclusion Criteria:

Community Residents

- The candidate must be a resident in the study area, Soweto, City of Johannesburg.
- Must be 18 years or older.
- Must be able to converse in any other common local language used in the area.

Business Persons

- Must own or manage a business within Soweto.
- Must have operated their business for at least three years.
- Must be able to converse in any other common local language used in the area.

Environmental NGOs

- Must be registered and operational within Soweto.
- Must have been active for at least three years.
- Fluent in English on must be able to converse in any other common local language used in the area.

Officials

- Must be employed at local government or environmental regulatory agencies in Soweto.
- A minimum of three years previous work experience in a related area is required.
- Fluency in English or any other official language is a must.

Exclusion Criteria

- A person who does not stay or work within the jurisdiction of Soweto, City of Johannesburg.
- Individuals with less than three years of experience in their respective roles or businesses.
- Environmental NGOs and companies which are not impliedly registered or recognized by local officials.

4.4.4 Research Instrument(s) and Pre-Testing of the Research Instruments

The research instrument is a tool that facilitates the method of collecting, measuring, and analysing data in research activities, for example in surveys or interviews (Sukmawati, 2023). The tools used in this study included an interview guide and a focus group discussion guide. Before the actual data collection started, two representative samples from the different categories underwent the testing of questions and five pre-tested tools were developed. The contribution of the phase of pre-testing was crucial because the clarity and reliability of the

questions derived from the refinement process before the entire administration among the participants.

4.4.5 Data Collection

According to Schildkamp et al., (2019), data collection is the organized process of obtaining information for analysis to make reasonable decisions and conclusion. Methods of data collection that can be employed are interviews, focus group discussion, observation, survey and data analysis. For this study, interviews were used. These are mainly direct face to face encounters and significantly detailed on the part of the participants (Emans, 2019). Interviews are carried out with extensive and detailed personal accounts of exposure which offered crucial and unique insights into the wide-ranging effects of air pollution among some within the community. The interviews took place in the participants' residences, workplaces, and/or community centres. The duration of each interview ranged from 45 to 60 minutes.

Focus group discussions utilise the focus group technique to engage all participants and gather insights regarding their collective experiences and responses (Sim & Waterfield, 2019). The FDGs took place in the community halls, lasting between 90 to 120 minutes. All these exercises were completed in under 3 months.

Comprehensive insights were obtained from individuals directly impacted by air pollution through interviews with those experiencing respiratory issues, community leaders, local councillors, business owners in heavily polluted areas, and representatives from environmental or healthcare agencies, particularly focussing on sensitive or personal topics. Ultimately, shared experiences, challenges, and perceptions regarding air pollution were exchanged during focus group discussions, fostering dialogue on the subject and delving into a variety of perspectives. The targeted groups included affected residents, community organisations, non-governmental organisations, sector stakeholders, and a diverse mix of residents and policymakers. Interviews provide a nuanced understanding and confidentiality, whereas focus group discussions offer a wider perspective and engagement, facilitating both individual and collective insights.

4.5 Data Analysis

The process of data analysis involves conducting a thorough examination of a collection of data points to derive accurate conclusions (Tracy, 2024). Thematic analysis was the most

appropriate method for this qualitative study, exploring participation patterns and response themes to apply growing insights from participants with respect to community perceptions and consequences of air pollution. Thematic analysis is exploratory, descriptive, and predictive analysis with its focus on identifying and interpreting themes in the qualitative data (Braun & Clarke, 2022). Using this method offers a nuanced and complete knowledge of the facts and enables a deep reading of participants' points of mind and practice (Christou, 2022). This approach is essential for gaining profound insights and interpretations in qualitative datasets, as demonstrated in the six steps outlined below.

Step one: Getting Familiar with the Data

I transcribed all interviews and focus group discussions verbatim. In the case of multiple readings of transcript, notes were taken to record first impressions and recurring ideas. This step enabled me to become familiar with the content before beginning formal coding.

Step two: Generating Initial Codes

I systematically reviewed the whole dataset manually before employing tools to extract initial codes. Consequently, I labelled the important characteristics of each line of data. For example, 'from factories smoke,' and 'burning waste' were coded to 'industrial emissions' and 'waste management issues,' respectively.

Step three: Searching for Themes

The identified codes were grouped into broader themes, which represent patterns of meaning. The codes were clustered into broader themes such as perceived sources of air pollution, health impacts and community coping mechanisms. At this point, an attempt was made on the process of developing a map of relationships between themes with sub themes.

Step four: Reviewing Themes

I reanalysed the themes and crosschecked them with the raw data to make sure that all were represented. Overlaps, and/or redundancy between themes was eliminated through mergers or redefining the themes to maintain coherence. For instance, the themes "solid fuel usage" and "indoor pollution" were integrated into a single theme: "household energy practices."

Step five: Defining and Naming Themes

I refined and clearly specified the definition of each theme, in relation to its focus and scope. These themes were given descriptive names very closely related to what they are, with supporting data excerpts. For instance, the theme 'health impacts of air pollution' was defined

as the physical and emotional effects mentioned by participants, like respiratory diseases and stress due to bad quality of air.

Step six: Producing the Report

Finally, the themes were synthesized into a coherent narrative that is backed by data excerpts. In the study's results chapter, the researcher presented the findings as a narrative built around themes, substantiated with direct quotes from participants. For example, in the theme 'visible impacts of industrial emissions', there was an inclusion of participant statements such as 'we wake up to layers of soot on our windowsills'.

Through this process the thematic analysis enabled the study to obtain deeper, in-depth insights in the perceptions and experiences of Soweto residents in relation to air pollution and its effects. This was clear from the systematic and meaningful analysis of the provided data, as illustrated above.

4.6 Trustworthiness

Trustworthiness is reliability of qualitative research pertains to the accuracy of the study and the confidence that there is minimal chance of random or systematic error in the findings (Belur, et al., 2021). Trustworthiness can be divided into four essential elements: credibility, dependability, transferability, and confirmability, which are elaborated upon below.

4.6.1 Credibility

Credibility ensures that the study accurately reflects the experiences and perspectives of the participants involved (Tracy, 2024; Singh, et al., 2021). The credibility of the data collected was upheld by extending the time spent with participants, asking them to verify what had been captured during the interviews, and consolidating the data. According to Guba and Lincoln (1989), member checks are considered the most essential method for ensuring credibility.

4.6.2 Dependability

Dependability involves the utilisation of data that is not only accurate and precise but also reliable and replicable in comparable studies (Haq, et al., 2023). This results from a rigorous commitment to maintaining a transparent audit trail and employing systematic methods. The study employed meticulous transcription methods, a structured approach to systematic coding utilising computer software, along with quantitative analysis (Gunawan, 2015). The study meticulously outlined all research procedures and decisions to highlight the intricate and interconnected nature of the process.

4.6.3 Transferability

Transferability examines the connections between the conclusions and different contexts, highlighting the broader applicability of the findings (Drisko, 2024). The rationale for providing extensive details is that the reader is the most qualified to assess the relevance of the context presented to their situation. The detailed contextual information provided allowed readers to evaluate the transferability of the findings.

4.6.4 Confirmability

Confirmability enables one to be sure that the findings of a study are informed by the participants' narratives and not the researcher's bias (Haq, et al., 2023). In this study, confirmability was strengthened by the detailed documentation of the research process, namely, raw data, coding notes, and thematic memos. Reflexive journaling was used extensively to recognise the researcher's positionality and prevent leading from subjectivity. Neutrality was further strengthened and interpretations were more reliable as the result of triangulation across interview and focus group data.

4.7 Ethical Considerations

Ethics in research refers to the foundational principles that direct researchers in the responsible conduct of their investigations (Bos, 2020). This study adhered to ethical considerations as described in the sections that follows.

4.7.1 Informed Consent

Pietilä et al. (2020) assert that the principle of informed consent is upheld when prospective study participants are told about the study's nature and voluntarily decide whether to participate. Cohort members received information sheets detailing the study's objectives, data collection techniques, associated hazards, and the assurance that participation was entirely voluntary, free from any coercion.

4.7.2 Confidentiality

Bos (2020) underscores that confidentiality as a research principle pertains to the act of concealing any sensitive information that participants may disclose during the data collection process. The identities of the participants were not disclosed, and the data was processed in a manner that did not reveal or identify any of the participants in this study. For interviews, participants were identified using pseudonyms, while for FGDs, they were identified using numerical values.

4.7.3 No Harm to Participants

The researcher is accountable for ensuring that all participants are not harmed during the research process (Gordon, 2020). In the preparation of the study, all participants were informed of the fundamental principle of research involving minimum harm to all participants. They were thus assured that they would receive the very best protection against any risks that may arise during the study.

4.7.4 Respect

According to Henrickson et al., (2020), respect is an ethical factor in research that requires recognising and maintaining the dignity and value of an individual who is participating in the study. Respect as an ethic was demonstrated by following policies that ensured all of participants in the study were treated fairly as well as through respecting their capacities and privileges.

4.7.5 Transparency

According to Pietilä et al. (2020) transparency is a fundamental principle in research ethics. Study participants were not excluded from seeing study related material. This in turn created authentic interest in the study. The researcher assured the participants of integrity and clarity regarding the research procedures and results.

4.7.6 Ethical Clearance and Permission

The researcher submitted a comprehensive research proposal to the departmental human research ethics committee and obtained ethical clearance. The researcher further obtained permission from the City of Johannesburg to conduct research and collect data from Soweto stakeholders. An outcome of this was that all participants had to give informed consent before the actual data collection.

4.8 Limitations and Delimitations

A limitation is something specific to the study, in that it can impede or diminish the validity of findings (Cooper, et al., 2019). In addition, limitations refer to the actual or likely weaknesses of the study that could influence the study outcome, e.g. sample size and outside factors. Miles (2019) defines delimitation as restrictions an investigator imposes on the investigation to narrow the scope of the circumstances to explore, for example, geographic areas, population groups and volume of data to collect among others.

One major limitation of the study was that the responses from the participants were self-reported, so they may have been biased. The findings may have been affected by this, in that perceptions and experiences that influenced these were affected by personal perspective. It was very challenging to get hold of environmental NGOs and thus only two were interviewed. Furthermore, the data is collected from only the greater Soweto area. This limits the collected views only to that location, ignoring other regions facing similar environmental concerns.

The study excluded other stakeholders, and this in turn constitutes a delimitation. Collection and analysis of the data included Soweto residents, the local business community, environmental organisations and municipal officials. This targeted approach offered a deep understanding of local dynamics and foundation but was necessarily blind to directions in larger geographic or institutional contexts. It is recognized that this study has limitations and delimitations, the aim was to produce a manageable study that could hopefully meet the aim of appraising community perspectives on air pollution in Soweto.

4.9 Chapter Summary

In this chapter, the research methodology presented how community experience and perceptions of air pollution in Soweto was explored. This chapter lays the groundwork for how the collected data will be analysed and presented in the next chapter.

CHAPTER 5: PRESENTATION AND DISCUSSION OF FINDINGS

5.1 Introduction

This chapter presents and discusses the research findings derived from eleven semi-structured interviews and a focus group discussion conducted in Soweto. The study aimed to investigate the perceptions, experiences, and suggestions of community members and institutional stakeholders concerning air pollution and mitigation strategies in the area. These findings are thematically analysed and interpreted using the Environmental Justice theory, Stakeholder Theory, Good Participatory Practice (GPP) Framework, and the Sacrifice Zone concept. These frameworks, detailed in Chapters 2 and 3, help position air pollution not only as an environmental issue but as a complex social justice and governance challenge.

The structure of this chapter mirrors the thematic patterns that emerged from the coding process. Each theme is substantiated by rich verbatim quotes from participants—coded as P1 to P21—to ensure anonymity and reliability. The themes are also interpreted in relation to previous research and theoretical constructs. Ultimately, the chapter illustrates that while Soweto faces numerous environmental challenges, its residents also offer a wealth of contextually grounded solutions that, if supported by inclusive and responsive governance, could transform air pollution management in the city.

5.2 Interview Response Rate

A total of 21 data sources were successfully gathered, consisting of 13 in-depth individual interviews and one focus group discussion (FDG) involving eight (8) participants. The response rate was 99%, fulfilling the intended representation from various stakeholder groups. The breakdown is as follows:

Table 5.1: Summary of Responses from the Participants

Stakeholder Category	Targeted	Completed
Local community members (FGD)	8–10	8
Environmental NGOs	3	2
Government (Health sector)	2	3
Government (Environment sector)	2	2
Government (Education sector)	3	3
Local business owners	3	3

Total Participants	21- 23	**21**

All interviews and the FDG were transcribed and analysed, offering diverse insights that strengthened the thematic depth, and the reliability of patterns identified across the data.

5.3 Demographic Details of Participants

Participants were assigned pseudonyms (P1 to P21) to maintain confidentiality. The selection ensured diversity in age, gender, role, and experience, enabling a multifaceted exploration of air pollution impacts and governance gaps in Soweto.

Table 5.2: Summary of Study Participants' Demographic Details

Code	Gender	Role/Occupation	Sector	Years of Experience
P1	Male	Environmental Officer, CoJ	Government (Environment)	12 years
P2	Female	Solid Waste Official, CoJ	Government (Environment)	10+ years
P3	Female	Health Promoter	Government (Health)	8 years
P4	Female	Health Promoter	Government (Health)	8 years
P5	Female	Nurse	Government (Health)	11 years
P6	Male	Geography Teacher	Government (Education)	15 years
P7	Male	Natural Sciences Teacher	Government (Education)	12 years
P8	Female	Life Orientation & Geography Teacher	Government (Education)	6 years
P9	Female	NGO Coordinator (Air Quality Education)	NGO	5+ years
P10	Male	NGO Leader (Policy and Campaigns)	NGO	10+ years
P11	Female	Informal Food Vendor (Braai Operator)	Business	7 years
P12	Female	Street Vendor (Coal-cooked food)	Business	10+ years
P13	Male	Taxi Operator	Business	5 years
P14–P21	Mixed	Residents (FDG): youth, pensioners, workers	Community	Mixed

This spread provided both institutional and grassroots insights into Soweto's environmental and social landscape.

5.4 Thematic Presentation and Discussion of Findings

Thematic analysis resulted in seven interrelated themes. These themes are not isolated silos but deeply interconnected, reflecting complex realities on the ground.

Table 5.3: Summary of Themes and Sub-Themes

Main Theme	Sub-Themes
1. Perceptions of Air Quality in Soweto	- Air quality perceived to have declined over time - Differences by location (inner vs. outer Soweto) - Underestimation or normalisation of poor air quality - Discrepancy between lived experience and technical data
2. Sources of Air Pollution Identified	- Burning of coal, wood, and refuse in homes and informal settlements - Vehicle emissions, especially taxis and older vehicles - Illegal dumping and open waste burning - Industrial activities (scrapyards, factories)
3. Health and Well-being Impacts	- Increased respiratory issues (asthma, TB, sinusitis, chronic coughing) - Children and elderly particularly affected - Psychological stress due to poor living conditions - Public health services burdened
4. Awareness and Access to Information	- Limited formal education on air pollution - Reliance on informal sources (word of mouth, WhatsApp, radio) - Absence of visible air quality indicators in most schools and communities - Digital divide affects access to information
5. Community Engagement and Participation	- Teachers and NGOs promote awareness at grassroots level - WhatsApp groups used for monitoring and community alerts - Lack of consistent municipal engagement - Civic apathy and mistrust of officials
6. Evaluation of Existing Interventions	- Air quality monitors exist but are underutilised or unknown - School-based campaigns lacking resources - Councelor / Ward-based feedback systems ineffective - City interventions perceived as top-down and insufficient
7. Community Recommendations and Solutions	- Tree planting, recycling, and regular clean-up campaigns - Education through workshops and school programs - Use of solar power and hybrid vehicles - Enforcing fines, reviving by-laws, and employing inspectors - Involving youth and local leaders in planning efforts

This table reflects the diversity of insights across stakeholder groups (e.g. educators, NGOs, local businesses, community members, government officials), while also highlighting the overlaps in lived experience and perception, especially around air pollution as a shared burden and a governance challenge.

5.4.1 Presentation of Themes

Theme 1: Perceptions of Air Quality in Soweto

This theme explores how residents, educators, government officials, and other stakeholders perceive the current state of air quality in Soweto. Participants consistently acknowledged that air quality has deteriorated over time, though levels of awareness and concern varied depending on proximity to pollution sources, professional background, and access to information.

Sub-theme 1.1: Perceived Decline in Air Quality Over Time

Many participants noted that the air in Soweto was once relatively clean but has worsened due to urbanisation, population growth, and informal industrialisation. A strong sense of environmental nostalgia emerged from interviews, particularly among older residents and business owners.

"Soweto used to be clean... now our air will not be clean because we don't have trees." **P11**, Informal Food Vendor

"Soweto used to be clean, but now it's dirty." **P12**, Street Vendor

This perception aligns with the environmental transition theory and supports the assertion that urban growth in marginalised areas often coincides with increased environmental stress when not accompanied by infrastructure expansion (Mukwevho, 2023). This observation is also consistent with findings from Borge, Lange and Kehew (2023), who highlight how unchecked urban development in African cities contributes to rising ambient air pollution levels. Similarly, Cheruiyot and Venter (2024) argue that air degradation is commonly observed in under-resourced urban environments lacking green infrastructure.

Sub-theme 1.2: Localised Differences in Perceptions

Perceptions of air quality differed significantly based on geographical location within Soweto. While some participants from less congested areas described the air as "relatively okay", others near industrial or high-traffic zones (e.g., scrapyards, taxi ranks) reported daily exposure to heavy pollution.

"There's a scrapyard next to us... the air in this place is dirty, you can see that for yourself." P11, Braai Operator

"I don't think it's too high compared to other industrial places... I'm 100% sure we are rating at 40–50%." –P20, FDG Participant

This reflects the situated nature of environmental perception, where spatial proximity to pollutants shapes concern and awareness (Mukwevho, 2023; Sokhi et al., 2021). It also resonates with findings by Davies (2022) and De Souza (2021), who stress that spatial inequalities in air pollution exposure are linked to socioeconomic status and urban geography.

Sub-theme 1.3: Underestimation and Normalisation of Poor Air Quality

Despite acknowledging pollution, some participants appeared to have accepted it as part of normal life, especially those who had lived in Soweto for decades.

"We grew up around the smoke... we did not get sick... it's the first-time people are getting sick." P12, Street Vendor

This mirrors the concept of environmental normalisation from environmental justice theory, where communities exposed to chronic hazards come to view them as inevitable (Brinkley & Wagner, 2024; Banerjee, 2021). This finding is further supported by Pulido (2016), who discusses how structural inequalities lead to communities internalising environmental degradation as part of their lived reality.

Sub-theme 1.4: Disconnection Between Technical Data and Lived Experience

Participants frequently noted that while air quality monitors exist, there is no communication of findings. Without visible or accessible data, most people rely on sensory indicators like smell or visibility.

"We don't even know that there is a monitor in Diepkloof... learners are not aware of any air quality readings." P8, Educator

"I just rely on how the air feels in the morning. That's how I know if it's clean." P13, Taxi Operator

This highlights the disconnect between institutional monitoring and public understanding, as emphasised by the GPP model's emphasis on transparent stakeholder communication (Ioanna et al., 2022). As highlighted by Izah (2025), real-time air quality data must be demystified and made accessible through community-facing tools, such as public displays or digital alerts, to translate scientific monitoring into actionable awareness.

The findings of this theme strongly align with the Environmental Justice Theory, particularly the notions of procedural and recognitional injustice. Communities in Soweto especially informal dwellers and those near pollution hotspots experience environmental degradation without accessible information or institutional feedback (Hendricks & Van Zandt, 2021; Laurent, 2023). Moreover, Stakeholder Theory explains the differing levels of awareness: stakeholders like educators (P6–P8) and NGO leaders (P9–P10) possess more formal knowledge, while ordinary residents (P14–P21) rely on sensory experience and informal networks. The GPP framework's failure is evident in the absence of structured public engagement around air quality monitoring. Effective participatory governance requires stakeholder communication, education, and feedback mechanisms (Baron et al., 2018; Davies et al., 2023) all of which are under-implemented in this context.

Finally, Soweto's characterisation as a Sacrifice Zone is reflected in these perceptions, with residents reporting resignation to pollution, disconnection from interventions, and the steady erosion of environmental quality (Rosenbloom, 2024; Magidimisha & Chipungu, 2019). This theme aligns with global cases where frontline communities experience not only physical pollution but also the psychological toll of abandonment, as noted in studies by Pulido (2016) and De Souza (2021).

Theme 2: Sources of Air Pollution Identified by Stakeholders

This theme focuses on the key contributors to air pollution as perceived by various stakeholders in Soweto. Participants identified a mix of structural and behavioural sources—ranging from fuel use and poor waste management to transportation congestion and informal economic activity. These insights reveal how poverty, survivalist practices, and service failures intersect, creating both causes and consequences of air pollution.

Sub-theme 2.1: Burning of Solid Fuels (Coal, Wood, Waste)

The most consistently mentioned source of pollution was the burning of coal, wood, and refuse for cooking, warmth, and waste disposal. Participants especially those from low-income areas and informal settlements noted that reliance on solid fuels was often necessitated by electricity shortages and affordability issues.

"People are burning down their waste to make fire when there's no electricity... especially in informal settlements." – P8, Educator

“People use coal for lighting fires... those fumes are a problem.” – P21, FDG Participant
“Air pollution is caused by burning of grass and rubbish.” – P20, FDG Participant

These responses align with Environmental Justice Theory, which frames these behaviours not as choices, but as responses to structural neglect—specifically energy insecurity and poor waste services (Mukwevho, 2023). The findings mirror global research that identifies solid fuel use as a major pollutant in low-income areas, leading to indoor and outdoor air contamination (Puzzolo et al., 2019; Tshabalala, Davies & Mohlakoana, 2025). South Africa’s own energy apartheid legacy continues to affect poor communities' access to clean fuels (Adebayo, 2025).

Sub-theme 2.2: Vehicle Emissions and Congestion
Many participants, particularly from the community focus group and education sector, pointed to vehicular emissions as a major contributor to air pollution. The heavy use of old taxis, minibuses, and poorly maintained cars was frequently cited.

“Start with the taxis, then Ubers, and then the private cars… it’s too much.” P16, FDG Participant

“Our cars are smoking… they are part of the problem.” P13, Taxi Operator

This connects to the urban transport critique, where high-emission vehicles and poor enforcement of emission standards in low-income communities exacerbate environmental degradation (Blanco-Montero, A. (2021). Similarly, Mukwevho (2023) note that minibus taxis in South Africa are often unregulated in terms of emissions, contributing significantly to air pollution in densely populated areas. Transport-related air quality concerns are particularly acute in under-serviced urban environments (Tilt, 2019).

Sub-theme 2.3: Illegal Dumping and Waste Fires
Illegal dumping and the subsequent burning of waste were cited as systemic and visible contributors to poor air quality. Participants pointed out the role of community behaviour, weak enforcement, and irregular waste collection.

“It’s because they dump near the river… then they burn it.” P12, Street Vendor
“Pick It Up sometimes never comes, and people can’t wait another week with rotten food.” P19, FDG Participant

This illustrates how infrastructure failure feeds into community-level coping strategies that have harmful environmental consequences. Waste burning is a symptom of deeper service delivery gaps—a dynamic well-explained by Stakeholder Theory (Mitchell et al., 1997).

According to Schmidt-Sane, et al. (2023) and Letcher (2021), open waste burning releases hazardous air pollutants including carbon monoxide, and dioxins, especially where no formal waste disposal infrastructure exists. Furthermore, community frustrations are often heightened by delays in municipal response times (Laurent, 2023; Dlamini, 2019).

Sub-theme 2.4: Industrial and Informal Economic Activity

Some participants discussed how nearby industries, scrapyards, and informal vendors cooking with open flames contributed to constant smoke in residential areas.

"There is a scrapyard next to us… the smoke from there is very bad." P12, Street Vendor

"There are people who burn cow heels and sheep heads behind churches and along the roads." P20, FDG Participant

While formal industries were less frequently mentioned, the informality of local economies emerged as a key contributor. These insights reinforce the Sacrifice Zones framework, where communities are forced to tolerate industrial-level pollution due to weak zoning laws and regulatory oversight (Rosenbloom, 2024). Scholars such as Adebayo (2025) and Blanco-Montero (2021) argue that economic marginalisation often forces communities to accept polluting industries and informal practices as a form of economic survival, thereby perpetuating environmental injustice. In South Africa, this dynamic has been observed in townships where informal economic zones operate in the absence of regulatory frameworks (Velis, et al., 2022).

The pollution sources identified by stakeholders highlight the intersection of inequality, infrastructure gaps, and environmental degradation. Environmental Justice Theory helps interpret the forced burning of fuels and waste as evidence of distributive injustice where low-income communities suffer the worst environmental burdens because of energy poverty and limited alternatives (Brinkley & Wagner, 2024). At the same time, Stakeholder Theory explains how these harmful practices persist in the absence of coordination, accountability, or enforcement from municipal stakeholders such as CoJ's waste and energy departments (Laurent, 2023). Furthermore, institutional silence and fragmented governance structures deepen these problems, as documented by Pandey and Ghosh (2023) and Dlamini (2019), who note that environmental responsibilities in South African municipalities are often diffused across poorly resourced departments.

The GPP model, further highlights the importance of co-implementation and participatory design. If properly resourced, community members could play a key role in identifying pollution hotspots, piloting clean energy programs, or co-developing waste management campaigns. Finally, the Sacrifice Zone framing is evident across this theme. Soweto residents are both exposed to pollution and blamed for it, even though the underlying causes—like unreliable electricity, waste collection failures, and informal economic survival—are beyond individual control. This highlights a double bind where community coping becomes institutionalised harm. This demonstrates a "blame-the-victim" narrative common in under-resourced areas, as explained by Min (2022), where structural failures are internalised as community shortcomings. This highlights a double bind where community coping becomes institutionalised harm.

Theme 3: Health and Well-being Impacts of Air Pollution

This theme explores how participants experience and understand the health impacts of air pollution in Soweto. Across all stakeholder groups community members, educators, health officials, NGOs there was a clear link drawn between air pollution and physical, emotional, and systemic health concerns. These insights reflect both the immediate effects of poor air quality and broader failures in public health infrastructure to respond effectively.

Sub-theme 3.1: Respiratory Illnesses – Asthma, TB, Sinusitis, and Flu

Participants frequently cited asthma, tuberculosis (TB), sinus infections, coughing, and flu-like symptoms as common consequences of polluted air, especially during colder months when more households burn coal and wood for heating.

"Because some have TB, others are asthmatic... others survive on machines because of that." P13, Taxi Operator

"It affects a lot really… this polluted air carries germs, and you can end up being affected by TB." P12, Street Vendor

"When it's dusty, I suffer from asthma that takes time to heal." P21, FDG Participant

"The dryness of the throat, the headaches, the sinuses... even the eyes." P19, FDG Participant

These responses support findings that airborne pollutants exacerbate existing health conditions, particularly in under-resourced communities already facing barriers to healthcare access (Brinkley & Wagner, 2024). Similarly, Manisalidis et al. (2020) and Tiotiu et al. (2020) confirm that particulate matter (PM2.5, PM10), sulfur dioxide, and nitrogen oxides from

combustion sources intensify respiratory illnesses. In South Africa, air pollution has also been found to aggravate the prevalence and severity of TB and asthma in urban settlements (Morakinyo & Mokgobu, 2022).

Sub-theme 3.2: Children, Elderly, and Shack Dwellers as Vulnerable Groups
Participants identified specific vulnerable groups especially schoolchildren, the elderly, and those living in informal housing as more susceptible to pollution-related illnesses.

"Those who are closest to ground zero are living in shacks… the biggest impact is on their respiratory system." P10, NGO Leader

"One of the learners had to survive on oxygen at home after a sinus infection turned chronic." P8, Educator

"Kids miss school when the air is thick with smoke… they're the first to get sick." P6, Teacher

This reflects the cumulative vulnerability principle in Environmental Justice Theory, where spatial, biological, and social disadvantage compound risk exposure (Mukwevho, 2023; Laurent, 2023). Children breathe more rapidly than adults and are thus more exposed to airborne toxins, while elderly populations often suffer from weakened immune systems (WHO, 2021; Morakinyo & Mokgobu, 2022). Informal housing often lacks proper insulation and ventilation, heightening exposure to indoor and outdoor pollutants (Howden-Chapman, et al., 2023).

Sub-theme 3.3: Mental Stress and Environmental Fatigue
Beyond physical ailments, participants described a growing sense of emotional strain, helplessness, and environmental fatigue especially when community efforts are ignored, and conditions remain unchanged.

"People are always angry… you're adding to their issues when you tell them not to dump." P20, FDG Participant

"Our people are too much ignorant, but sometimes it's because they don't know… they are frustrated." P21, FDG Participant

These insights echo discussions around procedural injustice and the psychological toll of chronic exposure to environmental neglect, which can undermine civic participation and emotional resilience (Hendricks & Van Zandt, 2021). According to Davies (2022), prolonged exposure to pollution in neglected environments contributes to mental stress, social

withdrawal, and eco-anxiety. In Soweto, this fatigue reflects the emotional burden of living in spaces continuously overlooked by environmental authorities (Pulido, 2016).

Sub-theme 3.4: Overburdened Public Health System

Government health workers and NGO leaders noted that Soweto's clinics are overwhelmed, particularly during colder seasons, and that many cases they treat especially for respiratory illnesses could be attributed to environmental exposures.

"We already have too many asthma and TB patients in our local clinics… and many of these cases are worsened by the air people breathe." P3, Department of Health

"Sometimes we just treat the symptoms. We know it's the pollution, but there's no policy for that." P4, Health Promoter Worker

"We see more children coming in with blocked sinuses, coughs, and eye problems during winter." P5, Health Official

This shows how environmental health is siloed from public health systems, despite being a key social determinant of well-being. The World Health Organization (2021) has repeatedly emphasised that environmental health risks, including air pollution, should be integrated into primary healthcare strategies. In the South African context, however, environmental health is often poorly resourced and disconnected from mainstream clinical policy (Adebayo, 2025).

Theme 3 provides clear evidence of Environmental Justice Theory in action. Distributive injustice occurs when low-income and marginalised groups disproportionately suffer health burdens tied to environmental hazards (Mukwevho, 2023). In Soweto, the link between air quality and illnesses like TB, asthma, and sinusitis is undeniable and yet, these effects are normalised, untreated, or misattributed due to system gaps.

The theme also illustrates procedural injustice, as there are no channels for communities to influence the public health agenda or air pollution interventions. Residents despite observing and tracking health patterns are excluded from designing health or environmental campaigns. From a Stakeholder Theory perspective, the health and environment sectors operate in silos. The cross-sector collaboration is essential for lasting change. But in Soweto, neither health workers nor environmental officials seem to have joint strategies or shared data systems, leading to missed opportunities for early intervention. This fragmentation has been flagged in

recent South African public health research as a barrier to addressing upstream determinants of disease (Yang, et al., 2025).

The GPP model's breakdown is evident. Community Advisory Boards (CABs) are either absent or inactive. There is no participatory health–environment forums where residents' concerns can be heard or incorporated into planning. If implemented, these structures could translate community knowledge into preventive care, especially for at-risk groups like children and the elderly. GPP advocates for ongoing consultation and co-decision-making between researchers, governments, and affected populations (Baron et al., 2018). If implemented effectively, these structures could translate community knowledge into preventive care, especially for at-risk groups like children and the elderly (Lemanski, 2022).

Theme 4: Awareness and Access to Information

This theme explores how informed residents and stakeholders are about air pollution, the sources they rely on for this information, and the barriers they face in accessing accurate or useful data. A consistent message from participants was that while awareness exists in experiential and informal forms, there are major gaps in formal environmental education, real-time data access, and institutional communication.

Sub-theme 4.1: Limited Formal Education on Air Quality

Participants from the education sector and the broader community noted that environmental topics especially air pollution are minimally covered or poorly contextualised within the formal school curriculum. Several educators expressed frustration with the theoretical focus of lessons that lack real-world application.

"Yes, I teach about air pollution in class… but it's not practical, just theory for writing tests." P6, Geography Teacher

"I was only informed about this at school, back in primary. Since then, nothing." P20, FDG Participant

"I don't have much information, but I can feel when the air is dirty." P12, Street Vendor

These quotes highlight the gap between formal education and lived realities a problem exacerbated by the lack of teacher training and learning materials that connect air quality to students' daily environments. This reflects research by Mngomezulu and Ramaila (2025), who argue that South African curricula often overlook place-based environmental learning,

especially in under-resourced schools. Moreover, environmental education remains largely theoretical and fails to build critical literacy about air pollution (Tshabalala, Davies & Mohlakoana, 2025).

Sub-theme 4.2: Reliance on Informal and Inconsistent Sources

Most community participants said they relied on WhatsApp groups, neighbours, local radio, or television for environmental news. However, this information was often inconsistent, anecdotal, or not specific to Soweto.

"I just listen to the news… sometimes they mention global warming, then it's gone." P14, FDG Participant

"WhatsApp groups work in our area… when someone dumps or burns, we report there." P17, FGD Youth

This reflects a grassroots surveillance network where informal communication substitutes for official reporting or alert systems. Yet such networks exclude residents who are not digitally connected or literate. This finding aligns with observations by Izah (2025), who cautions that while digital platforms offer opportunities for community-level environmental monitoring, they also reinforce digital divides and information inequalities. Additionally, Powell (2024) notes that informal networks often carry misinformation or lack the specificity needed to prompt effective health responses.

Sub-theme 4.3: Digital Divide and Exclusion of the Elderly

Participants noted that older residents and those without smartphones were excluded from digital information channels, leaving them dependent on word-of-mouth or lived sensory experience.

"We can Google, yes, but what about a granny who doesn't have a smart phone?" P19, FDG Participant

"Some elders just wake up and see the smoke. That's their weather report." P10, NGO Leader

This represents a clear case of recognitional injustice where environmental communication fails to account for age, language, or digital literacy differences (Mukwevho, 2023). According to Ferreira, Lupp and Mahmoud (2023), elderly residents in townships often face compounding barriers such as low literacy levels, language exclusions, and lack of digital access.

Environmental alerts designed around mobile technology risk excluding those most vulnerable to air pollution.

Sub-theme 4.4: Absence of Local Air Quality Monitoring Information

While the City of Johannesburg has installed air quality monitors in areas like Diepkloof, most participants said they were unaware of the monitors' existence or had never seen or received data from them.

"We don't even know that there's a monitor in Diepkloof… and if we don't know, how will we use the data?" P8, Educator

"We need something like what Eskom does for loadshedding… a screen that shows the pollution level every day." P16, FDG Participant

This points to a serious breakdown in institutional communication and stakeholder feedback, directly contradicting the GPP model's emphasis on transparency and co-ownership. As documented by Fischer (2000), technical systems such as pollution monitors must be accompanied by social mechanisms that translate data into usable knowledge. Public signage, air quality dashboards, or SMS-based alerts could serve this function (Izah, 2025).

Theme 4 illustrates several critical governance failures as understood through the lens of Environmental Justice, Stakeholder Theory, and the GPP model. From the Environmental Justice perspective, the lack of access to air quality information constitutes both recognitional and procedural injustice. The information is not just a technical asset it is a human right. When air quality data is available but not shared in accessible formats or languages, marginalised communities are effectively denied the tools needed to advocate for their health (Laurent, 2023; Hendricks & Van Zandt, 2021).

Stakeholder Theory points out that key sectors such as schools, NGOs, and community leaders should serve as information hubs. Yet in this case, those actors are either under-resourced or excluded from coordinated communication systems, leading to patchy awareness and ineffective outreach. This reflects the systemic weakness of inter-sectoral environmental education in post-apartheid urban governance (Mngomezulu & Ramaila, 2025).

The GPP model further emphasizes the role of communication in enabling citizen participation. Without visual tools, signage, or real-time air pollution alerts (e.g., digital dashboards, SMS

warnings), residents remain spectators to environmental risk, rather than empowered partners in risk reduction. In fact, the suggestion by a participant to model alerts after Eskom's load-shedding schedule reflects a practical, scalable solution rooted in local knowledge. This resonates with community-led data sharing models in India and Brazil where localised air quality maps and SMS alerts have improved public engagement (Singh, 2025; Archer, et al., 2022).

Moreover, this theme highlights the socio-technical divide where the presence of infrastructure (air monitors) is not matched by institutional design that bridges technical systems and community engagement (Baron et al., 2018; Fischer, 2000).

Theme 5: Community Engagement and Participation

This theme focuses on the extent to which Soweto residents and local stakeholders are engaged in air quality management efforts. While participants described some active grassroots involvement, many also expressed frustration with formal exclusion, lack of institutional support, and burnout from repeated neglect. The findings highlight a dual reality: community-led innovation on one side, and institutional disengagement on the other.

Sub-theme 5.1: Informal Participation Through WhatsApp and Street Committees

In the absence of formal structures, many participants relied on WhatsApp groups, resident forums, and street committees to organise clean-ups, report dumping, and raise awareness.

"In our area, we have street committee meetings where we talk about safety, pollution, and recycling." P9, NGO Coordinator

"We have a WhatsApp group… when someone dumps, we report them and confront them." P15, FDG Participant

These forms of informal participation reflect "claimed spaces" where residents take ownership of environmental protection, even without municipal involvement consistent with discussion on community-driven advocacy models. As Kumar (2023) explains, claimed spaces emerge when communities organise independently of formal governance structures to address issues affecting their lives. Similarly, Powell (2024) notes that such bottom-up governance is increasingly common in contexts where state presence is weak or symbolic.

Sub-theme 5.2: Minimal Engagement with Formal Government Structures

Despite repeated attempts to participate in governance processes, participants reported that formal structures (e.g. ward councillors, municipal forums) are either absent, non-responsive, or tokenistic in their approach to community engagement.

"You will only see the councillor during elections… otherwise they are not involved." P9, NGO Coordinator

"You write a letter saying the councillor invited them to a meeting, and that's the only way people show up." P20, FDG Participant

This mirrors what Arnstein's Ladder of Participation classifies as non-participation or symbolic consultation, where engagement is done for compliance, not collaboration. This aligns with Lemanski (2022), who critiques state-led participation mechanisms as often being "invited spaces" that limit public influence to formalities. The lack of genuine co-decision-making further weakens democratic environmental governance (Kumar, 2023).

Sub-theme 5.3: Civic Apathy and Mistrust

Several participants described a broader social apathy, especially among residents who felt environmental efforts are futile due to persistent poverty, neglect, and poor service delivery. Others pointed to emotional burnout and interpersonal conflict triggered by civic frustration.

"People will ask: who are you to tell me not to dump? Are you from Pick It Up?" P18, FDG Participant

"There's anger… I'm angry because I didn't get paid, now you tell me not to dump, and I take it out on you." P19, FDG Participant

This emotional fatigue represents what is described as environmental fatigue a collective sense of despair triggered by unresponsive governance and environmental deterioration. According to Davies (2022), this form of "slow violence" accumulates silently over time, leading to emotional withdrawal and community exhaustion. Lieberknecht, et al. (2024) similarly identify civic burnout as a barrier to sustained environmental activism in underserved areas.

Sub-theme 5.4: Role of NGOs and Educators as Community Mobilisers

Amid these challenges, NGOs and teachers emerged as key community mobilisers launching school projects, awareness campaigns, and even lobbying government departments.

"We created WhatsApp groups, sent monthly updates, and organised petitions with over 10,000 signatures." P10, NGO Leader

"I expect my learners to go home and educate their families." P8, Life Orientation & Geography Teacher

These efforts show that stakeholder agency is not absent it's just unsupported. NGO leaders and educators are often overburdened, operating without funding or coordination. As highlighted by Min (2022), civil society actors are crucial connectors between state policy and grassroots action, but their effectiveness depends on institutional collaboration. In South Africa, however, many of these actors operate in silos without consistent state partnership (Mngomezulu & Ramaila, 2025).

This theme lays bare the procedural injustice in environmental governance, a central tenet of Environmental Justice Theory. While Soweto's residents demonstrate strong civic awareness and willingness to engage, they are excluded from decision-making structures that affect their environment. This exclusion not only denies them a voice it denies them the tools and authority to shape their living conditions (Laurent, 2023; Mukwevho, 2023). Moreover, communities in marginalised zones often find their local knowledge and initiatives disregarded in favour of top-down technical solutions, a problem noted by Goel, Yadav and Vishnoi (2021).

The Stakeholder Theory perspective further shows a breakdown in horizontal and vertical collaboration. Government departments are not collaborating with educators, NGOs, or ward committees, and this siloed approach stunts both coordination and implementation (Baron et al., 2018). NGOs and teachers are acting as bridging stakeholders, but without institutional backing, their efforts are unsustainable. This reflects what Freeman (1984) would call stakeholder exclusion—a failure to identify, support, or integrate key actors into governance frameworks.

This also reveals a failure of the GPP model, especially in stakeholder mapping and feedback mechanisms. Residents are actively monitoring and reporting pollution via WhatsApp, yet these insights are not channelled into any formal system of response. GPP affirms that feedback

loops, such as Community Advisory Boards (CABs), are vital in ensuring that citizen voice translates into institutional action (Ioanna et al., 2022). Where GPP is implemented effectively, in community-based health trials, for example, it helps shift responsibility and leadership back into communities (Martinez & Mahajan, 2024). In this context, however, it is either absent or merely symbolic.

Ultimately, this theme reflects two parallel systems: one where residents improvise to protect their environment, and another where institutions remain passive or invisible.

Theme 6: Evaluation of Existing Interventions

This theme presents participants' reflections on current strategies implemented by government departments, schools, and NGOs to address air pollution in Soweto. While infrastructure such as air quality monitors and by-laws exist, stakeholders described these interventions as poorly implemented, inconsistently enforced, and disconnected from community realities. The theme reveals a persistent policy-practice gap, a hallmark of environmental governance failures in low-income urban settings.

Sub-theme 6.1: Air Quality Monitors Exist but Are Underutilised

While some participants were aware that monitors exist in areas like Diepkloof, most said they had never seen the data or been trained on how to interpret it. NGO leaders noted that while data was being generated, no feedback or education mechanisms existed to help the public make use of it.

"We got City of Joburg to install a monitor in our… it's producing data, but the city does not feedback to us" P7, Educator

"We don't know that there is a monitor here… learners aren't aware either." P8, Educator

This demonstrates a disconnect between scientific infrastructure and public understanding, which is a recurring theme in the GPP model's critique of top-down governance. According to Martinez and Mahajan (2024), air monitoring data must be demystified and localised if it is to empower affected communities. Without interpretation tools or public-facing platforms, these monitors remain symbolic rather than practical interventions.

Sub-theme 6.2: Waste Management Services (Pick It Up) Are Inconsistent

Several participants raised frustrations about irregular or entirely absent waste collection services. In some cases, communities took waste management into their own hands by dumping or burning garbage, despite knowing the environmental risks.

“Pick It Up sometimes never comes… when the garbage rots, people have no choice but to burn it.” P21, FDG Participant

“We are reporting the dumping but Pick It Up is not consistent. So, what must we do?” P15, FDG Participant

These responses reflect a systemic service delivery failure, where municipal inefficiency forces residents into environmentally harmful coping behaviours an issue aligned with distributive injustice in Environmental Justice Theory (Mukwevho, 2023). Blanco-Montero (2021) and Laurent (2023) argue that waste management in South African townships often fails due to chronic underinvestment and poor municipal accountability, resulting in health and environmental harms disproportionately affecting the poor.

Sub-theme 6.3: School and Youth Campaigns Lack Continuity

Educators acknowledged that school-based awareness campaigns had been launched in some areas, including competitions and essay writing activities. However, these efforts were described as episodic, underfunded, and not meaningfully supported by education or environmental departments.

“Yes, we teach about air pollution in Geography… but it’s not practical. Learners leave class and do the opposite.” P6, Geography Teacher

“One of our learners used her knowledge from school to write an essay and win a competition but there was no follow-up.” P7, Natural Science Teacher

The lack of consistent follow-up indicates a failure to institutionalise environmental education as part of behavioural change strategies. As Mngomezulu and Ramaila (2025) note, environmental education in South Africa is often fragmented and limited to short-term projects. This undermines its ability to promote sustainable practices beyond the classroom.

Sub-theme 6.4: Weak or Non-Enforced By-Laws

Participants acknowledged that laws prohibiting dumping and burning existed, but they expressed frustration at the lack of enforcement. As a result, illegal dumping and open burning remained unchecked.

“The laws are there, but no one implements them. Even when you report someone, nothing happens.” – P19, FDG Participant

“We need by-laws that work, with real fines… not R80. Something big, like R800.” P20, FDG Participant

This reflects procedural injustice, where residents are denied meaningful recourse through the legal system, despite living in high-risk environments. Hart (2025) emphasises that enforcement gaps often signal deeper structural inequalities in law implementation, particularly in marginalised communities.

Sub-theme 6.5: Perception of Government Action as Top-Down and Ineffective

Participants across sectors described government interventions as disconnected, bureaucratic, and unresponsive to local needs. Even well-intentioned policies were seen as symbolic, rather than transformative.

"Government only comes when there is a court case or media attention. Otherwise, they do nothing." P10, NGO Leader

"There's no relationship between government and community… policies are good on paper but useless in real life." P8, Educator

This aligns with critiques that describe many state-led interventions as technocratic and poorly adapted to local contexts (Baron et al., 2018). Powell (2024) and Hart (2025) argue that policy design often fails when it lacks mechanisms for grounded participation, resulting in institutional alienation and mistrust.

This theme clearly illustrates the implementation gap that arises when environmental policies are designed without adequate stakeholder input or resourcing. Environmental Justice Theory recognises that access to environmental benefits (e.g., waste collection, clean air, education) is often withheld from marginalised groups not by absence of policy, but by its uneven execution.

From a Stakeholder Theory perspective, the failure lies in the lack of integration between actors. Environmental officers, health professionals, educators, and community leaders are operating in silos. This contradicts the core stakeholder principle that collaboration is essential for legitimacy and effectiveness (Laurent, 2023). Effective stakeholder engagement requires interdependence and shared accountability, yet local actors in Soweto are left unsupported, leading to burnout and policy fatigue (Cheruiyot & Venter, 2024).

While the GPP model adds further insight stipulating that policy development should involve stakeholder mapping, regular feedback, shared monitoring, and capacity building none of which are fully realised in Soweto. Interventions like air quality monitors, school programs,

and by-laws are introduced without public participation, rendering them irrelevant or underutilised. Ferreira, Lupp and Mahmoud (2023) stress that co-design, co-ownership, and co-evaluation must guide intervention design to achieve environmental equity.

This top-down approach erodes trust, reinforces disengagement, and stifles co-production of solutions. The theme also echoes the Sacrifice Zone narrative, where Soweto residents are burdened with pollution while being excluded from enforcement or benefit-sharing mechanisms that might alleviate the harm. As De Souza (2021) argues, such zones operate as spaces of concentrated environmental harm where state responsibility is deliberately minimised. Community knowledge, when unacknowledged by policy systems, becomes marginalised expertise further exacerbating environmental injustice.

Theme 7: Community Recommendations and Local Solutions

This theme captures the ideas, innovations, and calls to action offered by participants across all stakeholder groups. These responses reflect a shared desire for community-driven, participatory, and context-sensitive solutions to address air pollution in Soweto. Participants proposed a wide range of practical interventions grounded in their lived experience, local knowledge, and collective values revealing both the will and capacity to lead change from the ground up.

Sub-theme 7.1: Tree Planting and Greening Initiatives

Tree planting emerged as one of the most widely suggested community-led strategies. Residents across ages and sectors expressed nostalgia for greener environments and saw urban reforestation as both an air filtration solution and a symbol of environmental pride.

"We used to have many trees when I was younger. Now they are gone… we need to plant trees again." P11, Informal Food Vendor

"Pollution is about the air we breathe… the biggest fighter is trees. We are cutting them down, not planting." P20, FDG Participant

This aligns with the ecosystem services perspective, which argues that natural elements like trees can mitigate urban pollution, reduce heat, and enhance collective environmental identity (Pandey, & Ghosh, 2023). Urban greening projects are also linked to improved mental health and social cohesion, making them multidimensional interventions (Edeigba, et al., 2024).

Sub-theme 7.2: Employment of Inspectors and Enforcement of By-laws
Participants called for the revival of municipal inspector roles, suggesting that community-based enforcement could curb illegal dumping and burning, while also providing employment opportunities.

"Growing up, there were inspectors who checked yards and open spaces… we need that again." P19, FDG Participant

"If people knew there would be fines, real ones, they would stop dumping." P16, FDG Participant

This recommendation illustrates the intersection of environmental governance and livelihood generation. As Laurent (2023) notes, justice-based enforcement can empower residents when it is transparent, participatory, and focused on harm reduction rather than punishment. Local employment through environmental regulation also contributes to just transitions in urban governance (Huang & Liu, 2021).

Sub-theme 7.3: Regular Community Workshops and Awareness Campaigns
Participants consistently requested ongoing educational campaigns to keep air pollution on the public agenda. They emphasised that information should be shared in schools, churches, media, and public spaces, using language and formats suited to diverse age groups.

"We need workshops every month, not just once… we need to be reminded." P20, FDG Participant

"If the kids don't know how air pollution affects them, they won't stop burning." P8, Educator

This reflects a bottom-up demand for continuous environmental education, echoing the GPP model's call for co-learning platforms and participatory awareness-raising (Ioanna et al., 2022). Vettriselvan and Ramya (2025) stress that long-term behavioural change requires embedding environmental literacy into public life across generations.

Sub-theme 7.4: Adoption of Solar and Clean Energy Alternatives
Several participants proposed encouraging the use of solar energy and reducing reliance on solid fuels particularly in informal settlements where electricity access is inconsistent. Some also proposed behavioural changes, such as walking more or reducing car use.

"People should stop burning… they must use solar; it doesn't cause air pollution." P21, FDG Participant

"We can even walk more, reduce cars… use hybrid or electric vehicles if we can afford them." P17, FDG Youth

These proposals indicate a readiness for sustainable transitions, provided they are made affordable and accessible, especially for poor households. Energy poverty is a central factor in environmental risk; hence, promoting off-grid renewable solutions aligns with both climate goals and environmental justice (Haldar & Sethi, 2025; Tshabalala, Davies, & Mohlakoana, 2025).

Sub-theme 7.5: Promotion of Reuse, Recycling, and Local Enterprise

The focus group strongly advocated for waste separation education, local recycling centres, and community-based recycling businesses that could reduce burning and provide income.

"Some people burn clothes they could donate or recycle. There's a company in Germiston making mattresses from that." P19, FDG Participant

"We should have local centres for plastic and paper… teach the kids to separate waste." P20, FDG Participant

These ideas highlight community-led entrepreneurship and creative reuse strategies. As cited by Velis, et al. (2022), informal economies and circular systems in African cities often flourish when supported with infrastructure and skills training. These initiatives also meet Sustainable Development Goal 8 (decent work and economic growth) through environmental means.

Sub-theme 7.6: Inclusion of Youth and Local Champions

Participants saw youth as agents of change and proposed involving them in school competitions, community projects, inspection teams, and green enterprise opportunities.

"We must encourage youth to open car washes, recycling stations—turn dumping sites into business spaces." P17, FDG Youth

"Why don't kids have regular workshops in school about air pollution? They are the future." P6, Geography Teacher

This sub-theme reflects a commitment to intergenerational equity and youth empowerment. According to Kumar (2023), genuine youth participation enables long-term environmental stewardship. Including young people in project design and implementation ensures both sustainability and innovation.

Theme 7 provides a compelling demonstration of how marginalised communities are not passive recipients of harm, but active generators of solutions. The recommendations proposed by residents reflect the core principles of the GPP model co-design, partnership, and inclusive governance. These solutions are practical, rooted in local realities, and show a strong desire for shared responsibility and environmental agency. Stakeholder Theory affirms that all actors including informal vendors, students, elders, and teachers are legitimate stakeholders whose ideas and input must be integrated into planning. Freeman (1984) argued that legitimacy stems not from formal titles but from affectedness—a key criterion that applies across Soweto's affected communities. Emphasis is on the value of localised knowledge and frontline experience, which are clearly evident in these solutions.

From an Environmental Justice perspective, these proposals are also calls for procedural and distributive fairness. Tree planting, recycling, and community employment offer both environmental and social restoration, while youth-led initiatives promote generational transfer of stewardship a vital strategy for long-term change. Moreover, these suggestions point to a vision of adaptive governance, where communities are seen not as governance targets but as governance partners (Heaton, et al., 2024). If supported with resources, recognition, and platforms for engagement, Soweto's communities are ready to lead transformative environmental action from below.

5.5 Integrative Discussion: Interpreting Findings Through Theoretical Frameworks

This section draws together the thematic findings discussed above and interprets them in relation to the study's theoretical framework, which includes Environmental Justice Theory, Stakeholder Theory, Sacrifice Zone concept, and the Good Participatory Practice (GPP) Model. By referencing the literature from Chapters 2 and 3, this integrative discussion reinforces how Soweto's air pollution crisis is both deeply systemic and potentially resolvable through inclusive, place-based governance frameworks.

5.5.1 Environmental Justice Theory: Unequal Burdens, Unequal Voices

Environmental Justice (EJ) theory frames the unequal distribution of environmental harms because of structural inequality and political marginalisation. In Soweto, air pollution is not merely an environmental issue; it is an outcome of social neglect, infrastructural disrepair, and economic disempowerment. Participants reported illnesses ranging from sinusitis to persistent asthma especially among children, elderly residents, and women cooking with solid fuels

reflecting what EJ theorists call double jeopardy, where vulnerable populations bear the brunt of multiple interlocking disadvantages.

These lived realities mirror what Brinkley and Wagner (2024) describe as the need for fair treatment in policy decisions that affect environmental health. The focus group participant who said, *"Like me, when it's dusty I suffer from asthma that takes time to heal,"* brings this to life. Additionally, the procedural side of EJ the right to meaningful involvement in decision-making is lacking in Soweto. Few participants knew how to access air quality data or who to contact in the event of hazardous pollution. As per Laurent (2023), this is not merely an information gap but a failure to recognise the agency and voice of the affected population.

5.5.2 Stakeholder Theory: Silos, Gaps, and Mismatched Power

Stakeholder Theory posits that effective environmental governance depends on recognising and integrating the interests of all parties including residents, NGOs, government officials, and industries. Yet, as shown in the findings, stakeholder relationships in Soweto are fragmented. Government departments work in silos. For example, environmental issues are taught in schools but disconnected from real-life interventions, confirming the lack of horizontal stakeholder integration.

"Learners are taught about pollution, but it ends there… it's not linked to real life." P8, Educator

This reflects a breakdown in stakeholder mapping and analysis, a critical starting point in the GPP framework but also foundational to Stakeholder Theory's principles. Moreover, residents who face the most urgency such as street vendors cooking with coal possess the least power or legitimacy in municipal decision-making spaces. This echoes the power-legitimacy-urgency triad discussed in stakeholder analysis, which Soweto's current governance structure fails to balance. NGOs have emerged as intermediaries, often doing the work of government without the structural backing, which is unsustainable without institutional partnership. Residents, on the other hand, offer ideas (e.g. community inspections, youth clubs) that remain unrecognised and unsupported, which undercuts the very purpose of stakeholder theory as a collaborative governance framework.

5.5.3 GPP Model and Participatory Environmental Governance

The GPP Model, originally adapted from HIV prevention biomedical research, has found application in environmental governance due to its emphasis on inclusivity, transparency, and

shared ownership. The model is built on five pillars: stakeholder mapping, communication, education, CABs, and feedback mechanisms. When tested against Soweto's reality, nearly all five areas show critical gaps.

Stakeholder Mapping: There is no systematic coordination between government departments, NGOs, or residents. Stakeholder roles remain undefined or unrecognised, especially at the community level.

Stakeholder Communication: Air quality data remains in technical formats. As noted in the GPP literature, transparency requires communicating data through accessible formats, such as infographics or community radio yet none were found to be in use in Soweto.

Stakeholder Education: While some teachers try to raise awareness, most residents are unaware of causes, risks, or remedies related to air pollution. Education, per the GPP framework, is not simply about messaging it must involve capacity building such as teaching residents to collect air quality data, read and interpret to act.

Community Advisory Boards (CABs): No evidence emerged that CABs existed for environmental governance in Soweto. This omission removes a key accountability structure and a space for residents to shape local interventions.

Feedback Mechanisms: Reports of community complaints going unanswered highlight a breakdown in feedback loops, resulting in frustration, mistrust, and apathy outcomes the GPP model specifically aims to prevent. In sum, the GPP model presents an ideal structure, but its partial or absent implementation in Soweto weakens its impact. The findings suggest that if local authorities wish to reverse environmental degradation, the first step is governance reform not technology deployment.

5.5.4 Sacrifice Zones: Soweto's Inherited Burden

Chapter 2 characterises Sacrifice Zones as communities that bear disproportionate environmental and social harms while receiving minimal benefits from economic development. Soweto fits this model: surrounded by industrial zones, blanketed by coal smoke, and largely disconnected from policy responses. The term 'sacrifice' is apt because it speaks to intentionality and systemic neglect, not just environmental coincidence.

"We report burning and dumping, but nothing happens. No one comes." P20, FGD Participant

Such silence from institutions reinforces the zone's political powerlessness, a hallmark of sacrifice zones as described by Rosenbloom (2024). The community is simultaneously victimised by pollution and blamed for its persistence. Moreover, environmental degradation here is compounded by socio-economic stressors: poverty, unemployment, and lack of healthcare. This is consistent with the observation that sacrifice zones often feature "environmental trade-offs" where public health is sacrificed for short-term convenience or profit.

5.5.5 Participation Models: From Tokenism to Community-Driven Innovation

Participation models such as Arnstein's Ladder describe levels of involvement, from token consultation to genuine co-creation. In Soweto, most resident involvement sits at the lower rungs: awareness and informal monitoring without influence.

"Even WhatsApp groups help… we just need support and coordination." P17, Youth

The study revealed a strong willingness to participate, undermined by a lack of resources, trust, and structured engagement. According to participatory research literature, invited spaces must become claimed spaces, where communities define problems and solutions. Yet systemic barriers remain economic precarity, emotional fatigue, and institutional inertia prevent sustained participation. The model of Advocacy-Based Participatory Action Research, referenced, supports the idea of equipping residents with tools and data to demand policy change a model that aligns with the GPP's deeper goal of not only including, but empowering communities.

Conclusion of Integrative Discussion

In conclusion, this chapter has shown that Soweto's air pollution crisis is not only a scientific or environmental issue it is a manifestation of long-standing social, spatial, and procedural injustices. The application of Environmental Justice Theory, Stakeholder Theory, the Sacrifice Zone concept, and the GPP framework illuminates the intersecting dimensions of harm and potential pathways to reform. The absence of inclusive governance, transparent communication, and collaborative implementation has left residents to cope alone often blamed for the very conditions they did not create. Yet, community members also displayed remarkable insight and energy, offering clear, grounded solutions that reflect a desire for partnership, not dependency.

5.6 Chapter Summary

This chapter presented the detailed findings of a thematic analysis conducted on interviews and focus group discussions with residents, government officials, educators, NGO representatives, and business owners in Soweto. Through seven deeply examined themes ranging from perceptions of air quality to grassroots solutions the chapter has demonstrated that while the impacts of pollution are unevenly distributed, the willingness to act is widely shared. Participants showed a critical awareness of the sources of pollution, expressed frustration with institutional silence, and proposed a diverse range of community-led interventions rooted in local knowledge, cultural values, and lived experience.

Using the theoretical tools discussed in Chapters 2 and 3, the findings were further interpreted to reveal the structural, procedural, and distributive dimensions of environmental injustice in Soweto. Environmental Justice Theory illuminated how spatial and historical inequalities continue to shape exposure to environmental risks. Stakeholder Theory revealed systemic governance failures in communication, coordination, and shared accountability. The GPP model offered a blueprint for participatory governance, against which the shortcomings of the City of Johannesburg's approach were starkly apparent. Finally, the Sacrifice Zones framework captured the reality of communities like Soweto places rendered environmentally and politically disposable despite their rich civic capacity.

Importantly, the chapter has also showcased emergent forms of community resilience and innovation. From informal WhatsApp reporting systems to school-based clean-up drives and proposed youth brigades, residents are not passive victims. They are actively crafting responses, often without institutional recognition or resources. What remains clear is that top-down environmental policy, without grounded participation and inclusive design, cannot resolve the scale of the crisis. The findings call for a paradigm shift from reactive enforcement to proactive, justice-driven governance, where communities are not merely consulted, but become co-authors of the environmental future they seek.

This sets the stage for the final chapter—Conclusions and Recommendations—which will synthesise these findings and propose actionable steps toward just and inclusive environmental governance in Soweto and beyond.

CHAPTER SIX: MAIN FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter provides an integrated presentation of the major findings of the study, offering a detailed discussion of the conclusions drawn and the implications for environmental governance, community health, and participatory development. The chapter responds directly to the study's research questions and objectives and draws on the voices of community members, educators, health professionals, environmental officials, and NGOs, as presented in Chapter 5. Following this, the chapter outlines practical recommendations rooted in the lived realities of the Soweto community and informed by the theoretical frameworks of Environmental Justice Theory, Stakeholder Theory, the Good Participatory Practice (GPP) model, and the concept of Sacrifice Zones. The chapter concludes with a reflection on the significance of the research, its contribution to knowledge, and avenues for future engagement.

6.2 Main Findings

This study set out to explore community perceptions of air pollution in Soweto, its perceived sources and impacts, and the extent to which local stakeholders participate in air pollution measurement, monitoring, and mitigation. Each research question is addressed in turn, using evidence from the data collected and analysed in Chapter 5.

6.2.1 Perceptions and Experiences of Communities Regarding Air Pollution and Air Quality Measurements

The findings indicate that most Soweto residents are aware of the poor state of air quality in their communities. This perception is not based on scientific reports but largely on sensory cues such as visible smoke, odours, persistent coughs, and dust in the air. Participants across all groups, noted a stark decline in air quality over the years, which they attributed to increased pollution, deforestation, and population density. The deterioration of air quality was experienced both visually and physically, with terms such as "heavy air" and "dirty skies" used to describe everyday encounters with environmental degradation.

The research shows that most participants are unaware of formal air quality measurements or the presence of monitoring stations. Although some stakeholders were familiar with scientific data, the majority relied on "how the air feels" to determine its quality. There was a notable disconnection between the existing infrastructure for air quality monitoring (e.g., the Diepkloof station) and the knowledge or use of such infrastructure by residents. The lack of accessible information renders air pollution an abstract and invisible threat, even as its symptoms are

deeply felt. This finding speaks to the critical absence of participatory environmental communication and supports the GPP model's assertion that without access to timely, localised, and understandable data, public participation in environmental governance remains symbolic at best.

6.2.2 Community Perceptions of the Sources of Air Pollution

Most cited sources of air pollution were the burning of coal, wood, and waste practices often resorted to because of energy insecurity and frequent power outages. Many residents in informal settlements burn materials to cook and keep warm, contributing significantly to air pollution. Participants also pointed to vehicular emissions, especially from old, poorly maintained taxis and buses that dominate Soweto's transport system. The concentration of traffic around busy areas such as the Baragwanath Taxi Rank was cited as a major pollution hotspot. Another frequently mentioned source was illegal dumping and burning of waste, a behaviour attributed to the unreliability of municipal waste collection services. When rubbish piles up without collection, residents burn it, releasing thick smoke that settles over the neighbourhood. Industrial zones and informal economic activities such as scrapyards, open-air cooking stands, and animal slaughtering were also noted as contributing to localised pollution.

These insights reveal a sophisticated awareness of both the structural and behavioural dimensions of pollution. Residents do not see themselves as ignorant contributors to pollution but rather as victims of systemic neglect, compelled into unsustainable practices due to failures in energy, waste, and spatial planning. This affirms the concept of Sacrifice Zones, where communities must bear the burden of pollution because their needs are consistently deprioritised.

6.2.3 Perceived and Experienced Impacts of Air Pollution

The study found a correlation between air pollution and health-related problems reported by participants. Respiratory issues were the most cited consequence, with conditions such as asthma, tuberculosis, chronic coughs, sinusitis, and eye irritation frequently mentioned by both health workers and residents. Educators described increased absenteeism among students during winter, when pollution from burning is most intense. Health facilities were reported to be overwhelmed by patients suffering from pollution-related conditions, particularly children and the elderly.

Other than physical health, participants reported emotional and psychological effect. Along with it came helplessness, frustration and anxiety in those trying to raise awareness or, in the case of advocates, trying to pressure policymakers to pursue cleaner environments without the backing of an institution. This is indeed environmental fatigue, 'a stage of psychological burnout resulting from extreme exposure to environmental degradation,' which fits right in with what has been found in the environmental justice literature.

The layered form of impact augments the fact that air pollution is not just an environmental issue; it is also health, and psychosocial justice concerns whose responses require intersectional thinking and systems thinking, both in the planning and in service deliver.

6.2.4 Role of GPP in Enabling Community Participation and Collaboration

A core aspect of the research was the analysis of how the GPP model could enable community driven collaboration on the process of air pollution mitigation. While there is significant potential in this regard, current application is weak. There are already informal participatory initiatives by community members pollution incidents are reported through WhatsApp group, clean ups and awareness campaigns are organized in schools. The success of petitions, youth projects and community forums, for instance, to enable civic environmental action became clear to participants.

Nonetheless, they are often unrecognised by local authorities and minimally supported or funded. Currently there is no institutionalised platform that provides community organisations with regular engagement with government departments about air quality issues. When it occurs, participation is reactive, not proactive, symbolic, not substantive. While the core tenets of the GPP framework are well supported by the finding that participants desired to have a deeper involvement in planning, implementation, and evaluation of environmental interventions. The model's emphasis on co-production, stakeholder equity, and transparency resonates with participants' aspirations, but its practical deployment remains hindered by institutional silos, limited budgets, and a culture of top-down governance. Bridging this gap would require policy reforms and a reimagining of community-state relations.

6.3 Conclusions

Based on the research, it has been illustrated that air pollution in Soweto is a compound problem of the environment, society, and governance. Residents are aware of the pollution that surrounds them, can identify its source, as well as its effects and solutions with great insight and clarity. This is not resulting in a meaningful integration of their experiences and knowledge

into environmental decision making such that their experiences and knowledge appear to be in a continuous state of disconnectedness from policy and practice. The study reveals that community members are not the problem; they are part of the solution. Even though they are exposed to information, do not have decision making platform and enforcement tools, they remain unable to break out of the cycle of exposure, frustration, and inaction. More than technical fixes are needed to address Soweto's air pollution; it entails a shift towards a structural change towards justice oriented, participative and locally anchored governance.

6.4 Recommendations

6.4.1 Recommendation 1: Institutionalise Community Participation Mechanisms

The community environmental advisory committees should be formally established by local government at the ward level. Youth, informal traders, educators, health workers and traditional leaders' representation must be included in these structures. The partners would play a role of advising on local air quality initiatives, reviewing data from monitoring stations, and co-developing by laws and enforcement strategies. Participation, however, must involve more than consultation and give communities power over decisions regarding design and implementation of interventions.

6.4.2 Recommendation 2: Improve Communication and Access to Air Quality Information

Data on air quality must be demystified and made available to the public on formats which are accessible. Clinics, schools, community halls, and transport hubs should have localised air quality dashboards installed. To present information about pollution levels and health tips etc., these displays can use visual codes (i.e., colour coded alerts similar to electricity usage alerts). Dissemination of information should also be through local languages such as radio, WhatsApp message broadcasting and SMS alerts to include all age and literacy categories.

6.4.3 Recommendation 3: Strengthen Enforcement Through Community-Based Inspectors

Instead of relying solely on overstretched municipal teams, government should employ, and train community based environmental monitor. They would be authorized to levy fines for dumping and open burning, to mediate disputes and report to local councils. An approach like this will spur employment, along with better enforcement, and make sure enforcement is based on local knowledge and social legitimacy.

6.4.4 Recommendation 4: Integrate Environmental Education into the School Curriculum

Environmental issues, particularly air pollution, should be embedded across subjects in the formal curriculum not just in geography or natural sciences. Practical activities such as measuring air quality, planting trees, organising clean-up campaigns, and visiting local environmental sites can foster environmental stewardship from a young age. Teachers should be trained and resourced to facilitate these engagements in collaboration with local NGOs and experts.

6.4.5 Recommendation 5: Support Community-Led Solutions with Resources and Policy Backing

The solutions proposed by participants including recycling hubs, tree planting, solar adoption, and youth clean-up brigades are low-cost, feasible, and culturally embedded. However, they require material support in the form of tools, space, training, and small grants. Government and NGOs should create a dedicated fund for grassroots environmental innovation, with application processes designed to be simple and inclusive. These interventions should be monitored for impact and scaled where effective.

6.5 Chapter Summary

This chapter has presented the main findings of the study, responded directly to the research questions, and proposed practical, community-informed recommendations. It has shown that residents of Soweto are both aware of and affected by air pollution, but they are rarely recognised as stakeholders in environmental governance. Despite the lack of institutional support, communities have created informal systems of reporting, mobilisation, and advocacy that reflect a deep commitment to protecting their environment.

Moving forward, the challenge is not to create awareness from scratch but to amplify existing civic energy, provide structural support, and embed participatory frameworks like the GPP model in everyday governance. A just, sustainable air quality strategy for Soweto will be one that is not only implemented for the people but with them, by them, and through them.

REFERENCES

Abma, T., Banks, S., Cook, T., Dias, S., Madsen, W., Springett, J., & Wright, M. T. (2019). *Participatory research for health and social well-being*. Cham: Springer International Publishing.

Adebayo, W. G. (2025). Resilience in the face of ecological challenges: Strategies for integrating environmental considerations into social policy planning in Africa. *Sustainable Development*, *33*(1), 203-220.

Agarwal, A. K., & Mustafi, N. N. (2021). Real-world automotive emissions: Monitoring methodologies, and control measures. *Renewable and Sustainable Energy Reviews*, *137*, 110624.

Ali, M. U., Yu, Y., Yousaf, B., Munir, M. A. M., Ullah, S., Zheng, C., ... & Wong, M. H. (2021). Health impacts of indoor air pollution from household solid fuel on children and women. *Journal of hazardous materials*, *416*, 126127.

Amey, M. J., & Eddy, P. L. (2023). *Creating strategic partnerships: A guide for educational institutions and their partners*. Taylor & Francis.

Archer, E. R. M., Vincent, K. E., Dougill, A. J., Soares, M. B., & Funk, C. C. (Eds.). (2022). *Extreme Events in the Developing World*. Frontiers Media SA.

Bainomugisha, E., Ssematimba, J., & Okure, D. (2023). Design considerations for a distributed low-cost air quality sensing system for urban environments in low-resource settings. *Atmosphere*, *14*(2), 354.

Banerjee, S. (2021). Race Discrimination: Evolution and Economic Impact. In *No Poverty* (pp. 731-740). Cham: Springer International Publishing.

Banks, S. (2022). Community-based participatory research: *A guide to ethical principles and practice.*

Baron, D., Essien, T., Pato, S., Magongo, M., Mbandazayo, N., Scorgie, F., ... & Delany-Moretlwe, S. (2018). Collateral benefits: how the practical application of Good Participatory Practice can strengthen HIV research in sub-Saharan Africa. *Journal of the International AIDS Society*, *21*, e25175.

Belur, J., Tompson, L., Thornton, A., & Simon, M. (2021). Interrater reliability in systematic review methodology: exploring variation in coder decision-making. *Sociological methods & research*, *50*(2), 837-865.

Bibri, S. E., & Krogstie, J. (2020). Environmentally data-driven smart sustainable cities: Applied innovative solutions for energy efficiency, pollution reduction, and urban metabolism. *Energy Informatics*, *3*(1), 29.

Blanco-Montero, A. (2021). *Development of an Integrated Model for Urban Sustainable Resilience Through Smart City Projects in the Southern African Context* (Doctoral dissertation, University of KwaZulu-Natal, Howard College).

Borge, R., Lange, S., & Kehew, R. (2023). Analysis of air quality issues and air quality management status in five major African cities. *Clean Air Journal*, *33*(2), 1-22.

Bos, J. (2020). *Research ethics for students in the social sciences* (p. 287). Springer Nature.

Braun, V., & Clarke, V. (2022). Conceptual and design thinking for thematic analysis. *Qualitative psychology*, *9*(1), 3.

Breuer, J. L., Samsun, R. C., Stolten, D., & Peters, R. (2021). How to reduce the greenhouse gas emissions and air pollution caused by light and heavy duty vehicles with battery-electric, fuel cell-electric and catenary trucks. *Environment international*, *152*, 106474.

Brinkley, C., & Wagner, J. (2024). Who is planning for environmental justice—and how?. *Journal of the American Planning Association*, *90*(1), 63-76.

Brooker, E. E., Hopkins, C. R., Devenport, E., Greenhill, L., & Duncan, C. (2019). Civil society participation in the Scottish marine planning process and the role of Environmental Non-

Governmental Organisations. *Journal of Environmental Planning and Management*, *62*(12), 2101-2123.

Cheruiyot, R., & Venter, R. (2024). Complex systems and sustainable leadership: Enhancing resilience and sustainability of community-based social enterprises in Soweto, South Africa. *Sustainability*, *16*(19), 8555.

Christou, P. A. (2022). How to use thematic analysis in qualitative research. *Journal of Qualitative Research in Tourism*, *3*(2), 79-95.

Chu, Z., Bian, C., & Yang, J. (2022). How can public participation improve environmental governance in China? A policy simulation approach with multi-player evolutionary game. *Environmental Impact Assessment Review*, *95*, 106782.

Clayton, S., & Karazsia, B. T. (2020). Development and validation of a measure of climate change anxiety. *Journal of environmental psychology*, *69*, 101434.

Cooper, H., Hedges, L. V., & Valentine, J. C. (2019). Potentials and limitations of research synthesis. *The handbook of research synthesis and meta-analysis*, 517-525.

Crume, R. V. (2019). *Urban health issues: Exploring the impacts of Big-City living*. Bloomsbury Publishing USA.

Davies, T. (2022). Slow violence and toxic geographies:'Out of sight'to whom?. *Environment and Planning C: Politics and space*, *40*(2), 409-427.

Davies, A., Ormel, I., Bernier, A., Harriss, E., Mumba, N., Gobat, N., ... & Cheah, P. Y. (2023). A rapid review of community engagement and informed consent processes for adaptive platform trials and alternative design trials for public health emergencies. *Wellcome Open Research*, *8*.

De Souza, M. L. (2021). 'Sacrifice zone': The environment–territory–place of disposable lives. *Community Development Journal*, *56*(2), 220-243.

Delmas, M. A., & Kohli, A. (2020). Can apps make air pollution visible? Learning about health impacts through engagement with air quality information. *Journal of Business Ethics*, *161*(2), 279-302.

Dlamini, S. Q. (2019). *Municipal solid waste management in South Africa: evaluation of waste to energy technologies for generating electricity from municipal solid waste, Gauteng Province* (Doctoral dissertation, University of the Witwatersrand, Faculty of Science).

Drisko, J. W. (2024). Transferability and Generalization in Qualitative Research. *Research on Social Work Practice*, 10497315241256560.

Duea, S. R., Zimmerman, E. B., Vaughn, L. M., Dias, S., & Harris, J. (2022). A guide to selecting participatory research methods based on project and partnership goals. *Journal of Participatory Research Methods*, *3*(1).

Edeigba, B. A., Ashinze, U. K., Umoh, A. A., Biu, P. W., Daraojimba, A. I., Edeigba, B. A., ... & Daraojimba, A. I. (2024). Urban green spaces and their impact on environmental health: A Global Review. *World J. Adv. Res. Rev*, *21*(2), 917-927.

Emans, B. (2019). *Interviewing: Theory, techniques and training*. Routledge.

Eriksen, T. H., & Visentin, M. (2024). *Acceleration and Cultural Change: Dialogues from an Overheated World* (p. 111). Springer Nature.

Farley, M. (2022). Making the connections: resource extraction, prostitution, poverty, climate change, and human rights. *The International Journal of Human Rights*, *26*(6), 1032-1055.

Fellows, R. F., & Liu, A. M. (2021). *Research methods for construction*. John Wiley & Sons.

Ferguson, D. B., Meadow, A. M., & Huntington, H. P. (2022). Making a difference: planning for engaged participation in environmental research. *Environmental Management*, 1-17.

Ferreira, I., Lupp, G., & Mahmoud, I. (2023). *Guidelines for Co-Creation and Co-Governance of Nature-based Solutions: Insights from EU-funded Projects*. European Commission.

Fischer, F. (2000). *Citizens, Experts, and the Environment: The Politics of Local Knowledge*. Durham: Duke University Press.

Fowler, D., Brimblecombe, P., Burrows, J., Heal, M. R., Grennfelt, P., Stevenson, D. S., ... & Vieno, M. (2020). A chronology of global air quality. *Philosophical Transactions of the Royal Society A*, *378*(2183), 20190314.

Franco-Trigo, L., Marqués-Sánchez, P., Tudball, J., Benrimoj, S. I., Martínez-Martínez, F., & Sabater-Hernández, D. (2020). Collaborative health service planning: a stakeholder analysis with social network analysis to develop a community pharmacy service. *Research in Social and Administrative Pharmacy*, *16*(2), 216-229.

Freeman, R. E. (1984). *Strategic Management: A Stakeholder Approach*. Boston: Pitman.

Gardiner, B. (2019). *Choked: The age of air pollution and the fight for a cleaner future*. Granta Books.

Glenn, B. E., Espira, L. M., Larson, M. C., & Larson, P. S. (2022). Ambient air pollution and non-communicable respiratory illness in sub-Saharan Africa: a systematic review of the literature. *Environmental Health*, *21*(1), 40.

Goel, R. K., Yadav, C. S., & Vishnoi, S. (2021). Self-sustainable smart cities: Socio-spatial society using participative bottom-up and cognitive top-down approach. *Cities*, *118*, 103370.

Gordon, B. G. (2020). Vulnerability in research: Basic ethical concepts and general approach to review. *Ochsner Journal*, *20*(1), 34-38.

Grigorieva, E., & Lukyanets, A. (2021). Combined effect of hot weather and outdoor air pollution on respiratory health: Literature review. *Atmosphere*, *12*(6), 790.

Gunawan, J. (2015). Ensuring trustworthiness in qualitative research. *Belitung Nursing Journal*, *1*(1), 10-11.

Haldar, A., & Sethi, N. (2025). Transitioning to Clean Energy Sources—Confluence of Energy Poverty Alleviation and Climate Change Mitigation. In *Reconciling Energy Poverty and Climate Change: Universal Energy Access and Net-Zero Emission* (pp. 55-120). Singapore: Springer Nature Singapore.

Hamdan, H. A., Andersen, P. H., & De Boer, L. (2021). Stakeholder collaboration in sustainable neighborhood projects—A review and research agenda. *Sustainable Cities and Society*, *68*, 102776.

Hanks, J. (2019). From research-as-practice to exploratory practice-as-research in language teaching and beyond. *Language Teaching*, *52*(2), 143-187.

Haq, Z. U., Rasheed, R., Rashid, A., & Akhter, S. (2023). Criteria for assessing and ensuring the trustworthiness in qualitative research. *International Journal of Business Reflections*, *4*(2).

Hart, A. (2025). Empowerment for People With Lived Experience of the Justice System? Peer Leadership and the 'Spectrum of Public Participation'. *The Howard Journal of Crime and Justice*.

Hausman, C., & Stolper, S. (2021). Inequality, information failures, and air pollution. *Journal of Environmental Economics and Management*, *110*, 102552.

Heaton, L., Halliday, E., Wheeler, P., Ring, A., Kaloudis, H., & Popay, J. (2024). Strengthening community empowerment initiatives as a route to greater equity: An English case study. *Community Development Journal*, bsae046.

Hendricks, M. D., & Van Zandt, S. (2021). Unequal protection revisited: Planning for environmental justice, hazard vulnerability, and critical infrastructure in communities of color. *Environmental justice*, *14*(2), 87-97.

Henrickson, M., Giwa, S., Hafford-Letchfield, T., Cocker, C., Mulé, N. J., Schaub, J., & Baril, A. (2020). Research ethics with gender and sexually diverse persons. *International journal of environmental research and public health*, *17*(18), 6615.

Horn, A. (2021). Pretoria-Johannesburg: Past, present and future urban changes. In *South African Urban Change Three Decades After Apartheid: Homes Still Apart?* (pp. 81-101). Cham: Springer International Publishing.

Howden-Chapman, P., Bennett, J., Edwards, R., Jacobs, D., Nathan, K., & Ormandy, D. (2023). Review of the impact of housing quality on inequalities in health and well-being. *Annual review of public health*, *44*(1), 233-254.

Howe, L. B. (2022). Towards a cooperative urbanism? An alternative conceptualization of urban development for Johannesburg's mining belt. *Environment and Urbanization*, *34*(2), 391-412.

Holappa, L. (2020). A general vision for reduction of energy consumption and CO2 emissions from the steel industry. *Metals*, *10*(9), 1117.

Huang, P., & Liu, Y. (2021). Toward just energy transitions in authoritarian regimes: indirect participation and adaptive governance. *Journal of Environmental Planning and Management*, *64*(1), 1-21.

Ioanna, N., Pipina, K., Despina, C., Ioannis, S., & Dionysis, A. (2022). Stakeholder mapping and analysis for climate change adaptation in Greece. *Euro-Mediterranean Journal for Environmental Integration*, *7*(3), 339-346.

Izah, S. C. (2025). Smart Technologies in Environmental Monitoring: Enhancing Real-Time Data. *Innovative Approaches in Environmental Health Management: Processes, Technologies, and Strategies for a Sustainable Future*, 199.

Juskus, R. (2023). Sacrifice zones: A genealogy and analysis of an environmental justice concept. *Environmental Humanities*, *15*(1), 3-24.

Kakade, S. (2023). Environmental Evidence. *U. Colo. L. Rev.*, *94*, 757.

Kampa, M., & Castanas, E. (2008). Human health effects of air pollution. *Environmental Pollution*, *151*(2), 362–367.

Kandpal, P. C. (2024). Urban Growth and Environmental Issues in Delhi. In *Combating Air Pollution: Comparisons between Delhi and Mexico City* (pp. 37-59). Cham: Springer Nature Switzerland.

Kiss, B., Sekulova, F., Hörschelmann, K., Salk, C. F., Takahashi, W., & Wamsler, C. (2022). Citizen participation in the governance of nature-based solutions. *Environmental Policy and Governance*, *32*(3), 247-272.

Kohnert, D. (2024). The impact of the industrialized nation's CO2 emissions on climate change in Sub-Saharan Africa: Case studies from South Africa, Nigeria and the DR Congo. *Nigeria and the DR Congo (February 17, 2024)*.

Kortoçi, P., Motlagh, N. H., Zaidan, M. A., Fung, P. L., Varjonen, S., Rebeiro-Hargrave, A., ... & Tarkoma, S. (2022). Air pollution exposure monitoring using portable low-cost air quality sensors. *Smart health*, *23*, 100241.

Kumar, A. (2023). Promoting youth involvement in environmental sustainability for a sustainable future. *Edumania-An International Multidisciplinary Journal*, *1*(03), 261-278.

Lakens, D. (2022). Sample size justification. *Collabra: psychology*, *8*(1), 33267.

Lam, D. P., Hinz, E., Lang, D. J., Tengö, M., von Wehrden, H., & Martín-López, B. (2020). Indigenous and local knowledge in sustainability transformations research: a literature review. *Ecology & Society*, *25*(1).

Laurent, É. (2023). *Toward Social-Ecological Well-Being: Rethinking Sustainability Economics for the 21st Century*. Springer Nature.

Lazaroiu, G., & Jarcu, E. A. (2024). Effect of Air Pollutants Produced by Traditional Energy Sources. In *Energy Transition Holistic Impact Challenge (ETHIC): A New Environmental and Climatic Era* (pp. 129-153). Cham: Springer Nature Switzerland.

Lemanski, C. (2022). Citizen Action: Participation and Making Claims. In *The Routledge Handbook of Social Change* (pp. 267-278). Routledge.

Lepenies, R., & Zakari, I. S. (2021). Citizen science for transformative air quality policy in Germany and Niger. *Sustainability*, *13*(7), 3973.

Letcher, T. M. (2021). Global warming—a complex situation. In *Climate change* (pp. 3-17). Elsevier.

Levinson, A. (2023). Are developed countries outsourcing pollution?. *Journal of Economic Perspectives*, *37*(3), 87-110.

Lieberknecht, K., Carlson, N., Stephens, K., Leite, F., Acuña, F., & Lowell, J. (2024). Closing the climate gap: Insights from local knowledge for climate adaptation planning. *Journal of the American Planning Association*, *90*(4), 758-773.

Linares, C., Díaz, J., Negev, M., Martínez, G. S., Debono, R., & Paz, S. (2020). Impacts of climate change on the public health of the Mediterranean Basin population-current situation, projections, preparedness and adaptation. *Environmental research*, *182*, 109107.

Lincoln, Y. S., & Guba, E. G. (1989). Ethics: The failure of positivist science. *The Review of Higher Education*, *12*(3), 221-240.

Lohr, S. L. (2021). *Sampling: design and analysis*. Chapman and Hall/CRC.

Macheca, A. D., Mutuma, B., Adalima, J. L., Midheme, E., Lúcas, L. H., Ochanda, V. K., & Mhlanga, S. D. (2024). Perspectives on plastic waste management: challenges and possible solutions to ensure its sustainable use. *Recycling*, *9*(5), 77.

Madonsela, B. S. (2019). *Assessment of environmental exposure to air pollution within four neighbourhoods of the Western Cape, South Africa* (Doctoral dissertation, Cape Peninsula University of Technology).

Magidimisha, H. H., & Chipungu, L. (2019). *Spatial planning in service delivery: Towards distributive justice in South Africa*. Springer.

Mahl, D., Guenther, L., Schäfer, M. S., Meyer, C., & Siegen, D. (2020). "We are a bit blind about it": A qualitative analysis of climate change-related perceptions and communication across South African communities. *Environmental Communication*, *14*(6), 802-815.

Malhi, Y., Girardin, C., Metcalfe, D. B., Doughty, C. E., Aragão, L. E., Rifai, S. W., ... & Phillips, O. L. (2021). The Global Ecosystems Monitoring network: Monitoring ecosystem productivity and carbon cycling across the tropics. *Biological Conservation*, *253*, 108889.

Manisalidis, I., Stavropoulou, E., Stavropoulos, A., & Bezirtzoglou, E. (2020). Environmental and health impacts of air pollution: a review. *Frontiers in public health*, *8*, 505570.

Mann, J. (2023). Systems Thinking Training and School District Transformation. *Regenerating Education as a Living System: Success Stories of Systems Thinking in Action*, 47.

Marquardt, F. (2022). "Something in the air": Reasserting humanity in a polluted neighbourhood. *Capitalism Nature Socialism*, *33*(2), 26-43.

Martinez, J., & Mahajan, S. (2024). Redefining Environmental Governance: The Socio-Technical Implications of Open-Source Air Quality Monitoring. *Available at SSRN 4991177*.

Masheula, A. (2023). *Assessment of Urban Parks using Green City Index in Metropolitan Cities, Gauteng, South Africa* (Doctoral dissertation, University of Johannesburg).

Maung, T. Z., Bishop, J. E., Holt, E., Turner, A. M., & Pfrang, C. (2022). Indoor air pollution and the health of vulnerable groups: a systematic review focused on particulate matter (PM), volatile organic compounds (VOCs) and their effects on children and people with pre-existing lung disease. *International journal of environmental research and public health*, *19*(14), 8752.

McGookin, C., Gallachóir, B. Ó., & Byrne, E. (2021). Participatory methods in energy system modelling and planning–A review. *Renewable and Sustainable Energy Reviews*, *151*, 111504.

Metz, A., Boaz, A., & Robert, G. (2019). Co-creative approaches to knowledge production: what next for bridging the research to practice gap?. *Evidence & policy*, *15*(3), 331-337.

Miao, Z., Baležentis, T., Shao, S., & Chang, D. (2019). Energy use, industrial soot and vehicle exhaust pollution—China's regional air pollution recognition, performance decomposition and governance. *Energy Economics*, *83*, 501-514.

Miles, D. A. (2019). Research methods and strategies: Let's stop the madness Part 2: Understanding the difference between limitations vs. delimitations. In *5th Annual 2017 Black Doctoral Network Conference, Atlanta, GA*.

Min, B. H. (2022). Hybridization in government–civil society organization relationships: An institutional logic perspective. *Nonprofit Management and Leadership*, *32*(3), 409-428.

Mngomezulu, H., & Ramaila, S. (2025). Integrating Environmental Education into Grade 11 Life Sciences Classrooms: Challenges and Pedagogical Opportunities. *International Journal of Learning, Teaching and Educational Research*, *24*(7), 376-401.

Mohiuddin, A. K. (2019). Chemical contaminants and pollutants in the measurable life of Dhaka City. *Journal of Environmental Science and Public Health*, *3*(1), 57-73.

Mor, S., & Ravindra, K. (2023). Municipal solid waste landfills in lower-and middle-income countries: Environmental impacts, challenges and sustainable management practices. *Process Safety and Environmental Protection*, *174*, 510-530.

Morakinyo, O. M., & Mokgobu, M. I. (2022). Indoor household exposures and associated morbidity and mortality outcomes in children and adults in South Africa. *International journal of environmental research and public health*, *19*(15), 9471.

Motlagh, N. H., Lagerspetz, E., Nurmi, P., Li, X., Varjonen, S., Mineraud, J., ... & Tarkoma, S. (2020). Toward massive scale air quality monitoring. *IEEE Communications Magazine*, *58*(2), 54-59.

Mukherjee, P., & Sastry, S. (2022). Problem definition and community participation in environmental health interventions: an exploratory study of groundwater arsenic remediation. *Health Communication*, *37*(6), 717-725.

Mukwevho, P. P. (2023). *Evaluating the effectiveness of air quality management plans as a governance instrument in South Africa* (Doctoral dissertation, North-West University (South Africa)).

Muyemeki, L. (2021). *An integrated systems approach towards air quality management in the Vaal Triangle Priority Area* (Doctoral dissertation, North-West University (South Africa)).

Nassikas, N. J., McCormack, M. C., Ewart, G., Balmes, J. R., Bond, T. C., Brigham, E., ... & Kipen, H. M. (2024). Indoor Air Sources of Outdoor Air Pollution: Health Consequences, Policy, and Recommendations: An Official American Thoracic Society Workshop Report. *Annals of the American Thoracic Society*, *21*(3), 365-376.

Newington, L., Alexander, C. M., & Wells, M. (2022). What is a clinical academic? Qualitative interviews with healthcare managers, research-active nurses and other research-active healthcare professionals outside medicine. *Journal of Clinical Nursing*, *31*(3-4), 378-389.

Njoku, A. U., & Sampson, N. R. (2023). Environment Injustice and Public Health. In *Handbook of Social Sciences and Global Public Health* (pp. 1987-2006). Cham: Springer International Publishing.

Nilsson, L. J., Bauer, F., Åhman, M., Andersson, F. N., Bataille, C., de la Rue du Can, S., ... & Vogl, V. (2021). An industrial policy framework for transforming energy and emissions intensive industries towards zero emissions. *Climate Policy*, *21*(8), 1053-1065.

Ntabe, A. C. (2020). *Rethinking the practice of community engagement in health research: the case of the tenofovir trials in Cambodia and Cameroon* (Doctoral dissertation).

Ogwu, M. C., & Izah, S. C. (2024). Air pollution and the sustainable development goals. In *Sustainable Strategies for Air Pollution Mitigation: Development, Economics, and Technologies* (201-233). Cham: Springer Nature Switzerland.

Pandey, B., & Ghosh, A. (2023). Urban ecosystem services and climate change: a dynamic interplay. *Frontiers in Sustainable Cities*, *5*, 1281430.

Pandey, P., & Pandey, M. M. (2021). *Research methodology tools and techniques*. Bridge Center.

Pietilä, A. M., Nurmi, S. M., Halkoaho, A., & Kyngäs, H. (2020). Qualitative research: Ethical considerations. *The application of content analysis in nursing science research*, 49-69.

Powell, A. B. (2024). Data-based frictions in civic action: Trust, technology, and participation. In *Knowledge and digital technology* (pp. 169-184). Cham: Springer Nature Switzerland.

Pritchard, A., Coffey, M., & Rance, J. (2023). Striking the Right Balance and Supporting Social Aspirations: How Agency and Choice Play out in a Recovery-Oriented Mental Health Service. *Issues in Mental Health Nursing*, *44*(12), 1237-1244.

Priya, A. (2021). Case study methodology of qualitative research: Key attributes and navigating the conundrums in its application. *Sociological Bulletin*, *70*(1), 94-110.

Pulido, L. (2016). *Flint, environmental racism, and racial capitalism*. Capitalism Nature Socialism, 27(3), pp. 1–16.

Puzzolo, E., Zerriffi, H., Carter, E., Clemens, H., Stokes, H., Jagger, P., ... & Petach, H. (2019). Supply considerations for scaling up clean cooking fuels for household energy in low-and middle-income countries. *GeoHealth*, *3*(12), 370-390.

Ramírez-Andreotta, M. D., Buxner, S., & Sandhaus, S. (2023). Co-created environmental health science: Identifying community questions and co-generating knowledge to support science learning. *Journal of Research in Science Teaching*, *60*(8), 1657-1696.

Rickenbacker, H., Brown, F., & Bilec, M. (2019). Creating environmental consciousness in underserved communities: Implementation and outcomes of community-based environmental justice and air pollution research. *Sustainable cities and society*, *47*, 101473.

Riley, R., de Preux, L., Capella, P., Mejia, C., Kajikawa, Y., & de Nazelle, A. (2021). How do we effectively communicate air pollution to change public attitudes and behaviours? A review. *Sustainability Science*, 1-21.

Rosário Filho, N. A., Urrutia-Pereira, M., d'Amato, G., Cecchi, L., Ansotegui, I. J., Galán, C., ... & Peden, D. B. (2021). Air pollution and indoor settings. *World Allergy Organization Journal*, *14*(1), 100499.

Rosenbloom, J. (2024). Sacrifice Zones. *Nevada Law Journal*, *24*(3), 6.

Ru, M. (2020). *Pollution, Health, and the Economy: Understanding and Modeling Their Interactions* (Doctoral dissertation, Duke University).

Samet, J. M., & Spengler, J. D. (2024). Prevention of respiratory diseases from indoor and outdoor air pollution. In *Prevention of Respiratory Diseases* (pp. 277-303). CRC Press.

Sandham, L. A., Chabalala, J. J., & Spaling, H. H. (2019). Participatory rural appraisal approaches for public participation in EIA: Lessons from South Africa. *Land*, *8*(10), 150.

Schildkamp, K., Poortman, C. L., Ebbeler, J., & Pieters, J. M. (2019). How school leaders can build effective data teams: Five building blocks for a new wave of data-informed decision making. *Journal of educational change*, *20*(3), 283-325.

Schmidt-Sane, M., Cele, L., Bosire, E. N., Tsai, A. C., & Mendenhall, E. (2023). Flourishing with chronic illness (es) and everyday stress: Experiences from Soweto, South Africa. *Wellbeing, space and society*, *4*, 100144.

Schubotz, D. (2019). Participatory research: Why and how to involve people in research. *Participatory Research*, 1-264.

Sepadi, M. M., & Nkosi, V. (2023). Personal PM2. 5 exposure monitoring of informal cooking vendors at indoor and outdoor markets in Johannesburg, South Africa. *International journal of environmental research and public health*, *20*(3), 2465.

Shah, S. K., Miller, F., & Fernandez Lynch, H. (2020). The role of community engagement in addressing bystander risks in research: the case of a Zika virus controlled human infection study. *Bioethics*, *34*(9), 883-892.

Shahzad, K., & Cheema, I. I. (2024). Low-carbon technologies in automotive industry and decarbonizing transport. *Journal of Power Sources*, *591*, 233888.

Shrivastava, P., Smith, M. S., O'Brien, K., & Zsolnai, L. (2020). Transforming sustainability science to generate positive social and environmental change globally. *One Earth*, *2*(4), 329-340.

Sim, J., & Waterfield, J. (2019). Focus group methodology: some ethical challenges. *Quality & quantity*, *53*(6), 3003-3022.

Singh, B. (2025). *Cities of India: Changes and Choices*. Taylor & Francis.

Singh, N., Benmamoun, M., Meyr, E., & Arikan, R. H. (2021). Verifying rigor: analyzing qualitative research in international marketing. *International marketing review*, *38*(6), 1289-1307.

Sokhi, R. S., Moussiopoulos, N., Baklanov, A., Bartzis, J., Coll, I., Finardi, S., ... & Kukkonen, J. (2021). Advances in air quality research–current and emerging challenges. *Atmospheric Chemistry and Physics Discussions*, *2021*, 1-133.

Sonono, M. T. (2021). *South African Informal Settlements in the Age of the COVID-19 Pandemic; An Investigation of Stjwetla Informal Settlement Resilience Challenges Against the COVID-19 Pandemic* (Master's thesis, University of the Witwatersrand, Johannesburg (South Africa)).

Sorenson, R. A., Delph, Y., Wilson, B., Fallah, M. P., & Higgs, E. S. (2024). 18 Good Participatory Practice: Social Mobilization, Communications, and Community Engagement. In *Principles and Practice of Emergency Research Response* (pp. 447-467). Cham: Springer International Publishing.

Sukmawati, S. (2023). Development of quality instruments and data collection techniques. *Jurnal Pendidikan Dan Pengajaran Guru Sekolah Dasar (JPPGuseda)*, *6*(1), 119-124.

Sullivan-Bolyai, S. L., & Bova, C. A. (2021). Qualitative description: a "how-to" guide.

Swedberg, R. (2020). Exploratory research. *The production of knowledge: Enhancing progress in social science*, *2*(1), 17-41.

Taylor, D. (2019). Can the environmental movement attract and maintain the support of minorities?. In *Race and the incidence of environmental hazards* (pp. 28-54). Routledge.

Tilt, B. (2019). China's air pollution crisis: Science and policy perspectives. *Environmental science & policy*, *92*, 275-280.

Tiotiu, A. I., Novakova, P., Nedeva, D., Chong-Neto, H. J., Novakova, S., Steiropoulos, P., & Kowal, K. (2020). Impact of air pollution on asthma outcomes. *International journal of environmental research and public health*, *17*(17), 6212.

Tracy, S. J. (2024). *Qualitative research methods: Collecting evidence, crafting analysis, communicating impact*. John Wiley & Sons.

Tran, V. V., Park, D., & Lee, Y. C. (2020). Indoor air pollution, related human diseases, and recent trends in the control and improvement of indoor air quality. *International journal of environmental research and public health*, *17*(8), 2927.

Tshabalala, T., Davies, M., & Mohlakoana, N. (2025). Contextualising a multi-dimensional perspective on energy poverty for South Africa's just energy transition: a systematic. *Environ. Res*, *2*, 015010.

Vanderslott, S., Van Ryneveld, M., Marchant, M., Lees, S., Nolna, S. K., & Marsh, V. (2021). How can community engagement in health research be strengthened for infectious disease outbreaks in Sub-Saharan Africa? A scoping review of the literature. *BMC public health*, *21*, 1-16.

Velis, C. A., Hardesty, B. D., Cottom, J. W., & Wilcox, C. (2022). Enabling the informal recycling sector to prevent plastic pollution and deliver an inclusive circular economy. *Environmental Science & Policy*, *138*, 20-25.

Verlie, B. (2022). *Learning to live with climate change: From anxiety to transformation* (p. 140). Taylor & Francis.

Vettriselvan, R., & Ramya, R. (2025). Sustainable Curriculum Design and Development: A Comprehensive Approach. In *Smart Education and Sustainable Learning Environments in Smart Cities* (pp. 471-486). IGI Global Scientific Publishing.

Vosloo, J. (2024). Imagining black feminist geographies of Johannesburg through Senzeni Marasela's creative (un/re) mapping of Johannesburg's mine slopes. *Gender & Development*, *32*(1-2), 49-69.

Weimann, A., & Oni, T. (2019). A systematised review of the health impact of urban informal settlements and implications for upgrading interventions in South Africa, a rapidly urbanising middle-income country. *International journal of environmental research and public health*, *16*(19), 3608.

West, S. E., Bowyer, C. J., Apondo, W., Büker, P., Cinderby, S., Gray, C. M., ... & Price, H. D. (2021). Using a co-created transdisciplinary approach to explore the complexity of air pollution in informal settlements. *Humanities and Social Sciences Communications*, *8*(1), 1-13.

Willems, J. J., Molenveld, A., Voorberg, W., & Brinkman, G. (2020). Diverging ambitions and instruments for citizen participation across different stages in green infrastructure projects. *Urban planning*, *5*(1), 22-32.

World Health Organization. (2021). *WHO global air quality guidelines: particulate matter (PM2. 5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide*. World Health Organization.

Wong, M., Wilkie, A., Garzón-Galvis, C., King, G., Olmedo, L., Bejarano, E., ... & English, P. (2020). Community-engaged air monitoring to build resilience near the US-Mexico border. *International Journal of Environmental Research and Public Health*, *17*(3), 1092.

Woodford, C. (2021). *Breathless: Why Air Pollution Matters–and How it Affects You*. Icon Books.

Wu, S. (2021). The health impact of household cooking fuel choice on women: Evidence from China. *Sustainability*, *13*(21), 12080.

Yang, O., Wilbourn, D., Wang, T., Kalatardi, S., Moodley, Y., & Balkrishnan, R. (2025). Preparing for Universal Coverage: Challenges for South Africa's Public Health System. *Integrative Journal of Medical Sciences*, *12*.

Yoro, K. O., & Daramola, M. O. (2020). CO2 emission sources, greenhouse gases, and the global warming effect. In *Advances in carbon capture* (pp. 3-28). Woodhead Publishing.
Zack, T., & Lewis, M. (2022). *Wake up, this is Joburg*. Duke University Press.