Evaluating the effectiveness of air quality management plans as a governance instrument in South Africa

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ABSTRACT

Since the 19th century, industrialised societies introduced technologies to enhance economic production and productivity, most notably related to energy generation. These caused ever-increasing levels of air pollution. The ambient air quality has subsequently deteriorated significantly globally to become a major human health and environmental concern. Ambient air pollution was found to be the cause of death of around 4.5 million people globally. According to the GBD's 2019 study, outdoor and indoor air pollution collectively contributed to an estimated 6.7 million premature deaths globally in 2019. In response, governments worldwide, including South Africa, have developed various policy responses and instruments to inform decision-making related to air emissions at different phases of the decision-making cycle. Conceptually, responses can be categorised along four approaches, namely command and control-based approaches, incentive and disincentive or fiscal-based approaches, agreement-based approaches and civil-based approaches. Each approach employs a range of policy instruments. One of the widely used instruments in managing air quality internationally and in South Africa is so-called air quality management plans (AQMPs), which is the focus of this research. An AQMP is defined as a policy instrument that critically considers the state of air quality in particular regions and provides measures to address identified air quality and pollution challenges. Moreover, these plans are expected to inform lower tiers of decision-making at the project level. However, despite introducing policy instruments such as AQMPs, the observed levels of particulate matter and ozone are increasing in many countries including South Africa's areas declared as air quality priority areas or hotspots. This raises questions as to the effectiveness and efficacy of policy instruments. In considering different policy instruments, AQMPs are particularly important, because they provide strategic direction for decision-making and set overall objectives and strategies to be achieved in a particular context.

Evaluating the effectiveness of AQMPs is a critical first step in gaining a better understanding of the performance of the overall national air quality governance system. For this reason, the research aims to evaluate the effectiveness of AQMPs in South Africa. To achieve this, a conceptualisation of air quality governance instruments in South Africa was conducted followed by the justification of theory of change (ToC) as a novel evaluation method for AQMPs. Subsequently, a criterion for evaluating AQMPs was developed and also applied to evaluate the effectiveness of the selected AQMP reports. Through the application of ToC, this research identified 15 key assumptions underpinning the AQMP development and implementation. This was done through workshops with different stakeholder groups (government officials, industry, consultants, academia and civil society). These key assumptions are translated into 57 key performance indicators used to evaluate nine selected AQMP case studies within the South

African context. In addition, open-ended interviews were conducted with relevant air quality officials responsible for implementing the selected case studies as well as other stakeholders involved in the AQMP system. These interviews were done to verify or address some of the KPIs that could not be verified using document review.

The research results show that engineering control, air quality modelling, identification of sources, emission quantification, as well as air pollution risk assessment are the skills and competencies lacking among air quality officials (AQOs). This supports previous studies that found that lack of critical skill sets in municipalities is indeed still one of the underlying factors for poor or no implementation of AQMPs in South Africa. The results further show the lack of key resources such as lack of budgetary provisions, ambient air quality monitoring network within municipalities, no existing or non-functioning monitoring stations, no human and/or skills capacity for monitoring towards AQMP development and implementation. Other issues identified include poor or a lack of cooperative governance, stakeholder engagements, quality assurance and control of data, and cost-benefit intervention strategies. Results also found several gaps relating to report quality and completeness, including poor description of key matters such as geographical area, land use, topography, landscape and natural resources, demographics, socio-economic status, list of areas that use fossil fuels for domestic use, health status, inventories of industries that may cause air pollution and are not listed (e.g., controlled emitters), international agreements and best practice guidelines, pollutants affecting health, environmental impacts and matters related to climate change. These issues are found to be affecting the effectiveness of the current AQMP development and implementation process in South Africa. This research further finds that AQMP as a central air quality management policy instrument across the different spheres of government (i.e. some provincial, district and local municipalities) is currently not effective in achieving its outcomes as designed and as intended. These objectives and intended outcomes include realising the NEM:AQA objectives, achieving compliance with the NAAQS, as well as realising a human environmental right prescribed in section 24 of the South African constitution.

This research has successfully justified that ToC is a suitable method to evaluate AQMPs in South Africa. Through robust and extensive engagements and networking with various stakeholders, experts, as well as literature and case studies reviews, this research has developed a ToC map and logical framework for evaluating and transforming AQMPs which can be applied anywhere in the world towards a better understanding of the AQMPs and similar policy instruments. The study also identified and tested key underlying assumptions affecting the effectiveness of AQMP development and implementation. Recommendations are provide that can be adopted towards minimising the risks associated with the assumptions and towards the overall improvement of the South African AQMP development and implementation system.

Key words: air quality management plan (AQMP), system, evaluate, effectiveness, air quality, theory of change (ToC), assumptions, key performance indicators (KPIs).

ABBREVIATIONS AND ACRONYMS

AEL	Atmospheric emission licensing
AQMP	Air quality management plan
AQMS	Air quality management system
AQMN	Air quality monitoring network
AQO	Air quality official/officer
AQOF	Priority Area Air Quality Officer's Forum
APPA	Atmospheric Pollution Prevention Act, 45 of 1965
BCMM	Buffalo City Metropolitan Municipality
CaC	Command and control
CAJ	Clean air journal
CBA	Cost-benefit analysis
CO_2	Carbon dioxide
CDP	Carbon Disclosure Project
CDM	Clean development mechanism
CO	Carbon monoxide
CoJ	City of Johannesburg
DEA	Department of Environmental Affairs
DFFE	Department of Forestry, Fisheries, and the Environment
DPME	Department of Planning Monitoring and Evaluation
EAPASA	Environmental Assessment Practitioners Association of South Africa
EMP	Environmental management plan
EIA	Environmental impact assessment
EIP	Environmental implementation plan
EPA	Environmental Protection Agency (United States)
GDARD	Gauteng Department: Agriculture and Rural Development
GHG	Greenhouse gasses
GP	Gauteng province
HPA	Highveld Priority Area
IDP	Integrated development plan
IEM	Integrated environmental management
ISO	International Organisation for Standardisation
ITT	Implementation task team
JSE	Johannesburg Stock Exchange
JTGDM	John Taolo Gaetsewe District Municipality
KPI	Key performance indicator

LEDET	Limpopo Department: Economic Development, Environment and Tourism
LLM	Langeberg Local Municipality
LP	Limpopo
MSRG	Multi-stakeholder reference group
NAAQS	National Ambient Air Quality Standards
NACA	National Association for Clean Air
NAQO	National air quality officer
NC	Non-conformance
NEAF	National Environmental Advisory Forum
NEMA	National Environmental Management Act, 107 of 1998
NEM:AQA	National Environment Management: Air Quality Act, 39 of 2004
NEPF	National Evaluation Policy Framework
NFAQM	National Framework for Air Quality Management
NGO	Non-government organisation
NQF	National Qualifications Framework
NWU	North-West University
NO_X	Oxides of nitrogen
O_3	Ozone
PAJA	Promotion of Administrative Justice Act
PM	Particulate matter
PSC	Project Steering Committee
QA	Quality assurance
QC	Quality control
SAAQIS	South African Air Quality Information System
SACNASP	South African Council for Natural Scientific Professions
SMART	Specific, measurable, realistic and timeous
SANS	South African National Standards
SO_2	Sulphur dioxide
STML	Steve Tshwete Local Municipality
ToC	Theory of change
UK	United Kingdom
US	United States
WBPA	Waterberg-Bojanala Priority Area
VTAPA	Vaal Triangle Air-shed Priority Area
VEJA	Vaal Environmental Justice Group
WCDM	West-Coast District Municipality
WHO	World Health Organization

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CHAPTER 1: INTRODUCTION

1.1 Background

Due to the human activities that introduce pollutants into the atmosphere, the ambient air quality has been gradually deteriorating over the years and has now become a major global human health, climate change and environmental concern (Cohen *et al.,* 2017; Roomaney *et al.,* 2022; Sinha, 2018). Air pollution and its impact on air quality is a worldwide problem that affects different regions in different ways, depending on various aspects such as the politics, economy and technological landscapes of each region or country, as well as on the nature of the available energy sources (Sinha, 2018). Rapid population growth, urbanisation, burning of fossil fuels, deforestation, economic growth, vehicular transportation and other human activities in recent decades have increased the introduction of air pollutants associated, resulting in a range of acute and chronic effects on human health (Afroz *et al.,* 2003; Carson *et al.,* 1997; Farzin & Bond 2006; Jion *et al.,* 2023; Parrish *et al.,* 2016; Shikwambana *et al.,* 2021).

Poor air quality can cause respiratory diseases, heart disease, stroke and cancer in humans, damage ecosystems, and contribute to climate change (Arias-Pérez *et al.,* 2020; Cohen *et al.* 2017; GBD, 2015; Lim *et al.,* 2012; Lovett *et al.,* 2009; Risk Factors Collaborators, 2016; Roomaney *et al.,* 2022; Sinha, 2018; Yang & Tang, 2020). Several studies have found a direct correlation between the emission of pollutants such as carbon monoxide (CO), sulphur dioxide (SO_2), oxides of nitrogen (NO_X), ozone (O_3), toxicants, and particulate matter (PM) and public health implications in developing countries (Dugard & Alcaro, 2013; Henneman *et al.,* 2016; Sinha, 2018). In addition, in 2019, ambient air pollution was found to be the cause of death of around 4.5 million people globally (Murray *et al.,* 2020). According to the GBD's 2019 study, outdoor and indoor air pollution collectively contributed to an estimated 6.7 million premature deaths globally in 2019. In 25 cities across Iran, the annual count of deaths resulting from prolonged exposure surpassing the air quality guideline set by the World Health Organization (WHO) totalled 13,321 cases.

At a local scale, South Africa as a developing country with the second-largest economy in Africa, relies on energy-intensive industries. As a result, the country produces high emissions per capita of greenhouse gases (GHGs) from the predominantly coal-fired power industry (Klausbruckner *et al*., 2016). The biggest contributors to air pollution in the country are electricity generation, industrial processes, domestic energy use and vehicular exhaust emissions (Scorgie *et al.,* 2004; Tshehla & Wright, 2019). As a result of emission from these industries, South Africa has declared three air quality priority areas which are the VTAPA declared in 2006, the Highveld Priority Area declared in 2007 and Waterberg/Bojanala Priority Area declared in 2012 (Tshehla & Wright, 2019). These regions presently exceed or are anticipated to surpass the established ambient air quality standards, either currently or in the near future (DEA, 2016).

Furthermore, South Africa is also the world's 14th biggest contributor of GHG, and its carbon dioxide (CO_2) pollution is mostly due to a reliance on fossil fuel such as coal (McSweeney & Timperley, 2018). Ambient air pollution is serious issue in South Africa due to negative implications for health, especially for the poorer (historically disadvantaged black communities) communities who live close to industries (Dugard & Alcaro, 2013). A recent study shows that in 2012, around 97.6% of South Africans were exposed to $PM_{2.5}$ at concentrations that exceeded the World Health Organization (WHO) guidelines (Roomaney *et al.,* 2022). Furthermore, Klausbruckner *et al.* (2016) contend that domestic fuel use (mainly of coal, wood, and kerosene) is a source of indoor and local air pollution, and this problem occurs particularly in informal settlements near major cities or in rural areas. During cold seasons, ambient particulate matter concentrations can reach dangerously high levels in places such as the Highveld Priority Area (HPA) and townships like Soweto and KwaZamokuhle (Feig *et al.,* 2019; Govender & Sivakumar 2019; Matandirotya *et al.,* 2022; Moletsane *et al.,* 2021; Roomaney *et al.,* 2022; Scorgie *et al.,* 2004). Other air pollutants that have adverse health effects include SO_2 and NO_x, which contribute to the formation of secondary PM and O_3 (Henneman *et al.,* 2016).

In addition to the effects on humans discussed above air pollution can affect the environment in several ways, including disruption of ecosystems, exacerbation of climate change, soil and water pollution and biodiversity loss (Lovett *et al.,* 2009; Thambiran & Diab 2011b). Air pollution and climate change are intrinsically linked and many of the same human activities that cause air pollution also contribute to climate change. Many pollutants such as CO_2, methane (CH_4), and black carbon are emitted into the air and can alter radiative processes that link to climate change [PM can scatter short-wave radiation causing a cooling effect; Certain PM, like black carbon, can absorb radiation and have a warming effect, Certain PM that acts as cloud condensation nuclei (CCN) can alter the microphysics of clouds, thereby changing their albedo, lifetime and other things to have an indirect effect on the radiation balance; SO_2 can form small sulphate particles that can both scatter and act as efficient CCN; NO_x emissions cause O_3, which is a greenhouse gas; CO emissions slowly oxidise into CO_2 which absorbs longwave radiation and causes warming (Brunekreef & Holgate 2002; Cappa *et al.,* 2012; Donohoe *et al.,* 2014; Laaksonen *et al.,* 2000; Wigley 1989; Wu *et al.,* 2021)].

Air pollutants contribute to climate change by trapping heat in the atmosphere and causing the greenhouse effect (Ramanathan & Feng, 2009). Climate change has numerous negative effects on the environment, including rising temperatures, altered weather patterns, sea level rise, and loss of biodiversity (Oliver & Morecroft, 2014). Moreover, air pollution can have direct impacts on ecosystems (Edwards, 2002; Lovett *et al.,* 2009). Acid rain, for example, is caused by emissions of sulphur dioxide and nitrogen oxides, which react with water vapor in the atmosphere to form sulfuric acid and nitric acid (Shammas *et al.,* 2020). Acid rain can damage forests, lakes, and soil, leading to reduced biodiversity and ecosystem services (Aherne & Posch, 2013).

Addressing air pollution and climate change together can lead to more efficient and effective solutions that will save lives, protect the environment and address climate change. While individuals and businesses can take steps to reduce their own emissions, government policies and regulations are needed to manage our activities to ensure that all sectors of the economy are doing their part to reduce pollution. For example, policies that reduce emissions of greenhouse gases can also help to reduce air pollution, while policies that reduce air pollution can have the added benefit of mitigating climate change (Thambiran & Diab, 2010; Thambiran & Diab, 2011b).

In response to these challenges, governments all over the world, including South Africa, have developed various measures. One such measure is the development of environmental governance and management instruments or tools to influence different phases of decision making (Emilsson *et al.,* 2004). These air quality governing instruments may be conceptualised into four environmental management approaches as described in literature (Nel & Du Plessis, 2001; Nel & Wessels, 2010; Nel & Alberts, 2018): a) command and control-based instruments, b) incentive and disincentive or fiscal-based instruments, c) agreement-based instruments and d) civil-based instruments. These four governing approaches are used to conceptualise all the air quality management instruments and are discussed in detail in Chapter 2 of this study.

One of the policy instruments used widely for managing air quality internationally and locally is air quality management plans (AQMPs), which is the focus of this research. Sivertsen and Bartonova (2012) state that in Europe and North America, AQMP is defined as a tool that describes the state of air quality in each area and also provides measures to address challenges associated with air pollution impacts. This instrument stipulates the goals and objectives for a region and describes short and long-term policies and controls to improve air. Governments must therefore prioritise air quality management and the development and implementation of efficient AQMPs as a key policy tool is needed to protect public health, preserve the environment, and mitigate the effects of climate change. In South Africa, the objectives of the legislation regulating air quality matters (the National Environmental Management Air Quality Act, 39 of 2004 (NEM:AQA) are to protect the environment by providing reasonable measures to protect air quality and prevent air pollution and to give effect to section 24(b) of the Constitution (Nel & Alberts, 2018). As one of the air quality governing instruments, NEM:AQA requires the development and implementation of air AQMPs by all spheres of government (i.e. provincial, district and local municipalities). Moreover, the development of AQMPs by municipalities must follow the guidelines stipulated in the *Manual* *for Air Quality Management Planning* (henceforth referred to as the Manual in this study) to establish best practice guidelines on the definition of objectives, strategies, plans, and procedures for the municipalities to meet the requirements of the NEM:AQA on air quality management planning and reporting (DEA, 2012).

As a strategic approach, AQMPs are a central tool aimed to assist government departments in planning NEM:AQA implementation, including control measures and financial provision (Naiker *et al.,* 2012). Through the implementation of intervention strategies, AQMPs do provide a link to a number of other tools that are prescribed in NEM:AQA for managing and governing air quality matters, including emission standards for listed activities, air quality officer (AQO) appointment within each environmental authority, controlled fuels and emitters, and National Ambient Air Quality Standards (NAAQS) (DEA, 2012, Naiker *et al.,* 2012, Republic of South Africa, 2005). The effective implementation of AQMPs is therefore essential for the government to do its duty of ensuring an environment that is not harmful to human health and wellbeing.

1.2 Problem statement and rationale for the study

The effectiveness of AQMPs can vary depending on a number of factors. Studies show that developed economies have been successful in effectively developing and implementing AQMPs, while most developing economies have not been so successful (Gulia *et al.,* 2015). Many of the cities in low- and middle-income countries, for instance Shanghai, New Delhi, Mumbai, Guangzhou, Chongqing, Calcutta, Beijing, and Bangkok, have not yet been able to formulate effective and efficient AQMPs to manage their deteriorating air environment, particularly in urban areas (Gulia *et al.,* 2015). However, countries such as the United States, the United Kingdom and Australia have effectively managed to develop and implement AQMPs at different scales in accordance with their regulatory management framework. Some trends from megacities in these countries show that urban air quality does show signs of improvement as a result of effective implementation of AQMPs (EEA, 2008; Gulia *et al.,* 2015; Gulia *et al.,* 2020; Hasheminassab *et al.* 2014; Naiker *et al.,* 2012; Sivertsen & Bartonova, 2012; Tonne *et al.,* 2008;).

Despite many interventions already undertaken by the government of South Africa, the problems associated with air pollution are far from being resolved, particularly with the observed levels of PM and ozone in areas declared as hotspots (Feig *et al.,* 2019; Govender & Sivakumar, 2019; Roomaney *et al.,* 2022; Tshehla & Wright, 2019). In addition, since the promulgation of NEM:AQA in 2004, not all spheres of government such as some provincial, district and local municipalities have developed their air quality management plans as required by Chapter 3 of the act, with 34 of 44 district municipalities, 7 out of 8 metropolitan municipalities, and 7 out of 9 provinces having developed AQMPs in 2020 (DFFE, 2021; Tshehla & Wright, 2019). Given that the status quo has not changed despite the various government interventions, it is quite clear that there could be underlying challenges in the effectiveness of the current existing government instruments, including the AQMPs (Altieri & Keen, 2019; DFFE, 2021; Engelbrecht & Van der Walt 2007; Engelbrecht & Van der Walt 2012; Feig *et al.,* 2019; Govender and Sivakumar, 2019; Henneman *et al.,* 2016; Naiker, 2007; Naiker *et al.,* 2012; Roomaney *et al.,* 2022; Sheik *et al.,* 2020; Tshehla & Wright, 2019). This research therefore aims to evaluate the effectiveness of AQMPs in South Africa.

1.3 Research aim and objectives

The aim of this research is:

To evaluate the effectiveness of air quality management plans (AQMPs) as a governance instrument in South Africa.

This research has four research objectives to achieve the research aim, namely:

- Research Objective 1: To critically reflect on the current air quality management planning measures within the air quality governance and management system in South Africa;
- Research Objective 2: To identify and justify a method to evaluate the effectiveness of the AQMPs in South Africa;
- Research Objective 3: To develop performance evaluation criteria against which the effectiveness of AQMPs can be evaluated;
- Research Objective 4: To apply the performance evaluation criteria of selected AQMPs in South Africa.

1.4 Structure and outline of the thesis

This thesis comprised six phases that are unpacked in seven chapters as shown in Figure 1-1 below:

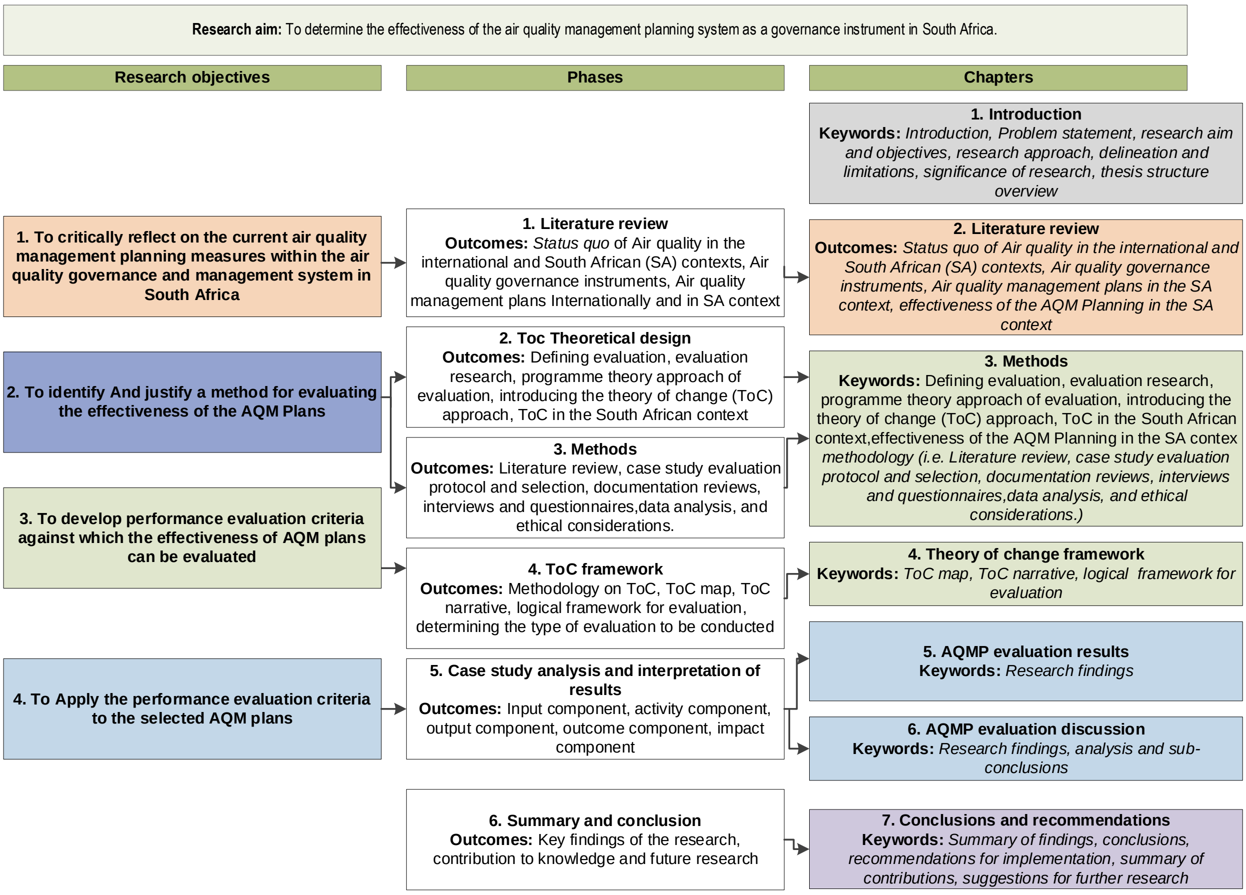

Figure 1-1 Thesis overview and layout

1.4.1 Chapter 1

Chapter 1 of this study offers a brief overview of air quality status and governance in South Africa. This chapter also discusses air quality management plans, and gives the problem statement, aims and objectives of the research.

1.4.2 Chapter 2

Chapter 2 documents Phase 1 and investigates the status quo of air quality in the international and South African (SA) contexts, conceptualisation of air quality management and governance instruments in terms of the four environmental management approaches in South Africa. The chapter also introduces air quality management plans (AQMPs) from international and local contexts as well as the status of AQMPs development in South Africa. The chapter further introduces the steps involved in the development of AQMPs internationally and locally.

1.4.3 Chapter 3

Chapter 3 documents Phases 2 and 3. Phase 2 is the methodological design and approach, which focuses on introducing the concept of evaluation and evaluation research, programme theory, as well as theory of change. This is a section that provided the justification of using programme theory of evaluation specifically ToC a suitable method for evaluating AQMPs in South Africa. Lastly, effectiveness in the context of air quality management planning in South Africa is defined.

Phase 3 offers a literature review of ToC, a case study evaluation protocol, documentation evaluation, interview process, ethical considerations, and limitations to the research. Here selected case studies are evaluated through literature review, interviews, questionnaires, and document evaluations.

1.4.4 Chapter 4

Chapter 4 is the ToC framework chapter, which discusses in detail the developed ToC map, ToC narrative, logical framework for evaluating the AQMP in South Africa and to determine the type of evaluation to be conducted. This is done during Phase 4 of the thesis in Figure 1-1.

1.4.5 Chapter 5 and 6

Phase 5 includes the results (Chapter 5) and discussion (Chapter 6). Chapter 5 gives an analysis of the data collected from selected case studies. The key findings are discussed to reach preliminary conclusions. Chapter 6 interprets the results against the available literature.

1.4.6 Chapter 7

Lastly, Chapter 7 concludes Phase 7 by providing a summary of findings, conclusions, recommendations for implementation, summary of contributions and suggestions for further research.

1.5 Delineation and limitations

1.5.1 Delineation

This study only focuses on the evaluation of AQMP effectiveness within the South African context. This is based on the reasoning that despite having one of the most mature and complex air quality management legal frameworks, South Africa is still facing serious air pollution challenges, especially in those areas that have been declared as priority areas (Mukwevho *et al.,* 2022; Nel & Alberts, 2018; September, 2012; Tshehla & Wright, 2019). In addition, according to the Department of Forestry, Fisheries and Environment (DFFE, 2021a), since the promulgation of NEM:AQA in 2004, not all municipalities and provinces have successfully developed and implemented AQMPs (DFFE, 2021a; Tshehla & Wright, 2019). Given this lack of AQMP development and implementation, a better understanding is required of the underlying challenges. The evaluation of AQMP using a specific programme evaluation instrument has not been done in the South African context, which then makes it a good case study for both local and global lessons.

1.5.2 Limitations

There are some limitations in the application of the ToC approach to AQMP evaluation. These include some of the aims and objectives of AQMPs being found difficult to measure and in some case not quantifiable. In addition, the success of an AQMP in achieving its objectives or having an impact can sometimes only be determined over a long term.

Similar to Alberts (2020), Moreoane *et al.* (2021), and Moolman *et al.* (2022), this study used only one reviewer to evaluate the nine case studies against the set KPIs. The reviewer has been working in the field of environmental management including air quality governance for over a decade. He has experience in academic supervision of postgraduate students who the evaluated quality and effectiveness of various environmental and air quality policy instruments in South Africa.

Moreover, while case studies can provide rich insights into a particular topic or issue, there are several limitations to this research approach, such as replication and generalisation from a low number of case studies. However, this study applied a “replication logic” instead of “sample logic,” which enables the researcher to predict similar results or contrasting results by using the same evaluation criteria within a specific context (Yin, 2018). Similar to Alberts (2020), this research attempted to make context-specific conclusions that could be expected to be replicated under similar conditions or within similar contexts or sectors rather than making broad generalisations.

1.6 Conclusion

This introduction briefly discussed air quality statutes globally and locally. It subsequently offered a problem statement, research aim and research objectives. The chapter continued with an overview of the research approach, a delineation and consideration of limitations, and a cursory view at the structure of the thesis. This chapter provides a clear justification that the study will make which include evaluating the effectiveness of AQMPs (as central policy instrument as a critical first step in gaining a better understanding of the performance of the overall national air quality governance system. The next chapter (Chapter 2) presents a literature review. The aim of the literature review is to share the existing knowledge around air quality governance and explain the theoretical concepts related to the management of air quality in the international and South African contexts. The chapter also conceptualises air quality governance instruments in South Africa and introduces air quality management plans.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter provides a critical reflection on the literature on air quality governance and specifically AQMPs, from an international and national perspective. The AQMP development and implementation process internationally and locally is discussed in detail. Due to the focus on South Africa, the chapter discusses the different governance instruments relating to air quality management in the South African context in some depth. This chapter also introduces the concepts of evaluation, evaluation research, effectiveness in evaluation research, programme theory approach of evaluation, introducing the ToC approach, and the ToC justification in the South African context.

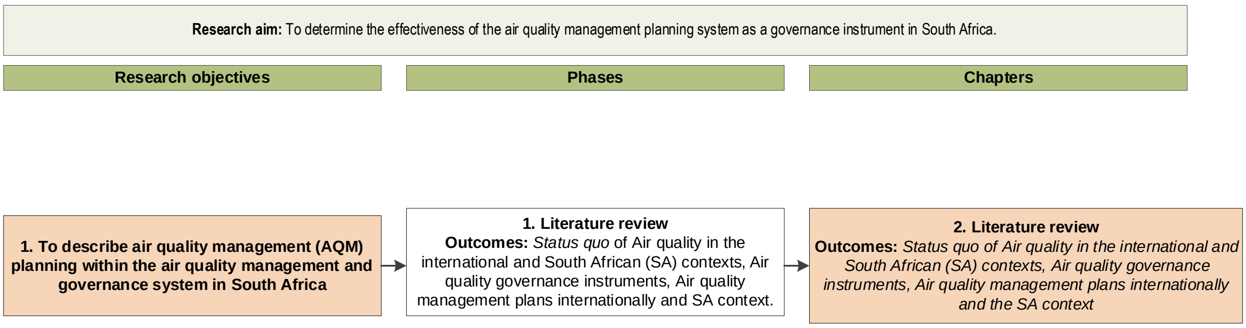

Figure 2-1 Layout of Chapter 2 (literature review)

2.2 Air pollution in the international context

Air pollution is defined as mixture of particulate components or matter, heterogenous gases, organic and inorganic compounds in the air (Calderón-Garcidueñas *et al.,* 2015). Human activities cause unnatural emissions and exacerbate natural emissions of substances into the atmosphere (Babatola, 2018; Cohen *et al.,* 2017; Kuklinska *et al.,* 2015; Miranda *et al.,* 2015; Roomaney *et al.,* 2022; Sinha, 2018).

Some of the earlier events that created an awareness of air pollution were the London's Great Smog of 1952 and the Los Angeles photochemical smog in the late 1950s, which lead to the development of the relevant legislations in those countries. It was on 12 December 1952 when people in London woke up to a still deadly fog which was a mixture of deep fog and dense pollution from burning coal (Laskin, 2006). This deadly fog is reported to have caused around 4 000 deaths in two weeks and over 8 000 over the next 10 weeks (Wilkins, 1954). It is reported that at the time that children could not stop coughing and those who went outside were smeared with oily soot and a black mucus on their skin and clothes (Laskin, 2006). Wilkins (1954) found that mortalities were as a result of chronic bronchitis and emphysema, exacerbated by pollutants like SO_2 and possibly SO_3 and PM. It was this event that changed the world's perception of air pollution and revolutionised the history of environmental legislation (Laskin, 2006).

Another separate event occurred around the same time in the Los Angeles (LA). A photochemical smog in the late 1950s led to the development of US's Clean Air Act of 1963. Seinfield (2004) describes photochemical smog as a mixture of O_3 and other compounds produced from chemical reactions between primary pollutants. This happens due to sunlight and is accelerated at higher temperatures. Despite the fact that stratospheric O_3 does protect living organisms from UV radiation, O_3 at ground level at higher concentrations can have a negative impact on the environment and human health (Seinfield, 2004). The LA smog air pollution challenge did not necessarily result from the primary pollutants themselves, but rather from the products of these chemical reactions (Tiao *et al.,* 1975). It caused a haze that reduced visibility, increased O_3 and health issues such as eye and lung irritations. These severe events revealed the need to manage air quality in general.

Because air pollution is a mixture of several gases, particulate matter and other compounds, the main pollutants that most researchers focus on due to their health effects are particulate matter (PM), O_3, CO, NO_X, and SO_2 (Babatola, 2018; Dugard & Alcaro, 2013; Henneman *et al.,* 2016; Lee *et al.,* 2018; Mustafic *et al.,* 2012; Roomaney *et al.,* 2022; Sinha, 2018). Particulate matter consists of solid and liquid particles and has different morphological, chemical, physical, and thermodynamic properties (Arias-Pérez *et al.,* 2020). It is classified according to aerodynamic diameter sizes into course particles PM_{10} (< 10μm), fine particles $PM_{2.5}$ (<2.5 μm) and ultrafine particulates $PM_{0.1}$ (< 0.1 μm) (César 2012; Yang *et al.,* 2020). The size and composition of PM is dependent on its source. Air borne PM_{10} is usually emitted from vehicular or windblown soil and dust, while $PM_{2.5}$ is commonly emitted from the burning of fossil fuel such as motor road traffic, power plants, industrial and residential heating using oil, coal, or wood (Lee *et al.,* 2018). The smaller the size of PM, the easier it enters the air sacs in the human lungs, where they may have negative health effects (Turalioğlu, 2005).

Recent studies show that exposure to $PM_{2.5}$ globally have decreased slightly from the year 2000 to 2019, with 65% of cities still having increased levels (Sicard *et al.,* 2023; Southerland *et al.,* 2022). Most reductions were observed in the Eastern US, Europe, Southeast China, and Japan, while the Middle East, sub-Saharan Africa, and South Asia experienced increased levels (Sicard *et al.,* 2023; Southerland *et al.,* 2022).

Sulphur dioxide as a gaseous pollutant is usually released into the air during the burning of fossil fuels containing sulphur, mostly from power plants, and it is one of the most common air pollutants locally and globally (Lee *et al.,* 2018; Rall, 1974; Turalioğlu, 2005). During the sunlight or or by the catalytic effect of certain particulates in the atmosphere, SO_2 can play a role in the formation of other compounds such as sulphuric acid, sulphate aerosols and photochemical oxidants (Rall, 1974; Turalioğlu, 2005). SO_2 in the atmosphere then becomes a source from which more toxic compounds can be generated from (Rall, 1974). SO_2 emission trends differ in every region (Jion *et al.,* 2023). According to Denby *et al.* (2010), there has been a decrease in SO_2 annual mean concentrations in most parts of Europe during the period between 1996 and 2005. In addition, a recent study shows that SO_2 concentration trends have been increasing in the Indian subcontinent (South Asia) during the years 2003 to 2009, followed by a small decline from 2016 onwards. This can be attributed to the implementation of new norms for coal-based power generation (Chitua *et al.,* 2022). Jion *et al.* (2023) found that as a result of anthropogenic activities such as urbanisation, industrialisation and economic expansion, SO_2 and NO_2 concentration levels have increased in Asian countries such as Bangladesh, China, Pakistan, Nepal, Malaysia, Iran, Kuwait, India, and Japan, followed by a decline due to the COVID-19 lockdown.

Oxides of nitrogen (NO_X) are common pollutants that play a vital role in the formation of photochemical smog through reactions with other compounds (Knelson & Lee, 1977). Oxides of nitrogen are mostly emitted from vehicles during road traffic, residential heating, power generation and industrial sources (Lee *et al.,* 2018). Despite the fact that there is naturally existing NO_X in the air, human activities are found to be a significant contributor to NO_X into the atmosphere, mostly through high temperature combustion processes (Knelson & Lee, 1977). Moreover, according to Knelson and Lee (1977), nitrous oxide (N_2O), nitric oxide (NO), and nitrogen dioxide (NO_2) are the most important gases in the atmosphere due to their biological significance for air pollution. These compounds exist in gaseous form under normal conditions, but may also occur in particulate forms of aerosols of nitric acid and its salts in ammonium nitrate (Knelson & Lee, 1977). Itahashi *et al.* (2019) found that NOx pollution in China has been increasing since 2005 and peaked in 2011, followed by a decline of around 3% per year to 2016. The study further shows that NOx emissions in India continuously increased over the same period by around 1 to 6% per year. According to Sicard *et al.* (2023), NO_2 increased globally from 2006 to 2019 in 71% of cities, with increases in exposures in regions such as sub-Saharan Africa, Middle East, and South Asia due to socioeconomic development, while improvements were observed in the global north such as North America and Europe. In addition, some of the biggest improvements in NO_2 exposure reduction were observed in Eastern China in both time periods 2000–2009 and 2010–2019 (Sicard *et al.,* 2023).

The complex photochemical reactions of NO_X and volatile organic compounds (VOCs) result in the formation of ozone (O_3) (Brunekreef & Holgate, 2002). As an oxidising agent, O_3 also plays an important role in converting NO into NO_2 in the atmosphere (Brunekreef & Holgate, 2002).

Ozone is also considered as one of the important air pollutants due to its adverse effects on human health, air quality, climate change, and the biophysical environment (Akimoto, 2003; Finlayson-Pitts & Pitts, 1997). A study by Cooper *et al.* (2014) shows that tropospheric O_3 trends have been different from region to region from 1990 to 2000. Trends in Western Europe showed an increase in the 1990s, which was followed by a decline in 2000. The eastern US tropospheric O_3 concentrations varied in accordance with seasons, with low concentrations in summer and high concentrations in winter, while in the western US it was higher in spring season (Cooper *et al.,* 2014). A study also revealed a general increase in O_3 in the free troposphere in the Northern and Southern hemispheres since beginning of 1995 or earlier (Cooper *et al.,* 2020). At a global level, exposure to O_3 has shown to increase as a result of lower titration O_3 by NO (Sicard *et al.,* 2023). Sicard *et al.* (2023) also found that the mitigation of precursor pollutants resulted in a decline in O_3 concentrations in North America, Northern Europe, and Southeast China between 2000 and 2019. Equatorial Africa, South Korea, and India, on the other hand, have seen an increase in O_3 concentrations. It is thus clear that more effort should be made in these regions, including reliable risk and exposure assessments and effective emission control policies (Sicard *et al.,* 2023).

Another important air pollutant is carbon monoxide (CO), which occurs naturally in the environment but is human-induced through the combustion of fossil fuels (Vreman *et al.,* 1995). This gas is generated from the incomplete combustion of fossils fuels. Exposure to this gas can lead to CO poisoning, leading to cellular hypoxia (Ernst & Zibrak, 1998).

All these pollutants have a great impact on health and the environment or are precursors to adverse effects. Particulate matter has greatest health impact, while O_3 has both health and environmental impact. SO_2 and NO_x are precursors to PM, and CO and NOx are precursors to O_3. Addition, other pollutants have been observed on the smaller local scale. There are now managed as hazardous air pollutants. Examples include lead and benzene. Lead pollution, caused by its introduction to gasoline by Thomas Midgley Jr in the 1920s, has had a major effect on human health (Edelmann, 2016). However, through rigorous air quality management, the problem of airborne lead pollution has almost been irradicated worldwide.

Air pollution exposure is one of the leading contributors to the global burden of diseases (Lim *et al.,* 2012; GBD 2015; Risk Factors Collaborators, 2016). In 2015, air pollution accounted for 6.4 million mortalities globally. Of these, 2.8 million deaths were from household air pollution and 4.2 million from ambient air pollution (Cohen *et al.,* 2017; GBD 2015; Risk Factors Collaborators, 2016)). In addition, Chowdhury (2020) indicates that premature deaths from exposure to ambient $PM_{2.5}$ and O_3 increased by about 30% and 17% respectively from 2000 to 2015. The World Health

Organization further argues that approximately 92% of the world's population is living in areas where air quality levels exceed WHO limits (WHO, 2016).

Air pollution can cause or exacerbate lower respiratory infections such as asthma, bronchitis, ischemic heart diseases (IHD), stroke, lung cancer, diabetes, and chronic obstructive pulmonary disease (COPD) (Burnett *et al.,* 2018; Dockery *et al.,* 1993; Hansell *et al.,* 2016; Jerrett *et al.,* 2009; Li *et al.,* 2018; Lelieveld *et al.,* 2019; Stanaway *et al*., 2018; Yin *et al.,* 2017). Particulate matter ($PM_{2.5}$) and pollutants like NO_2 and SO_2 can irritate the airways and lead to inflammation, coughing, wheezing, and difficulty breathing and exposure to such pollutants increases the risk of cardiovascular diseases such as heart attacks, strokes, diabetes, and high blood pressure (Arias-Pérez *et al.,* 2020; Brunekreef & Holgate 2002; Tunicliffe *et al.,* 2001; Yang B., *et al.,* 2020; Yang L., *et al.,* 2020). Fine particles and toxic gases can enter the bloodstream through the lungs, triggering inflammation, damaging blood vessels, and promoting the formation of blood clots (; Wang & Tang 2021; Xie *et al.,* 2021).

Moreover, a recent study shows that only 0.18% of the global land area and 0.001% of the global population were found to be exposed to annual $PM_{2.5}$ concentrations lower than the WHO limit of 5 μg/m^3 in 2019, making it the fourth leading global risk factor for premature mortality (Murray *et al.,* 2020; Yu *et al.,* 2023). Southerland *et al.* (2022) argue that despite a decrease in global urban $PM_{2.5}$ concentrations between the years 2000 and 2019, about 86% of people living in urban areas were exposed to levels that exceeded the WHO's 2005 guideline of 10 μg/m^3, leading to 1.8 million mortalities in 2019. Regional averages of $PM_{2.5}$ related mortalities increased in all regions, with the exception of Europe and the Americas. This is due to population dynamics, age, and disease rates. However, some cities experienced a decrease in $PM_{2.5}$ concentrations due to age dynamic shifts and non-communicable diseases (Southerland *et al.,* 2022). Another study also suggests that greenhouse gasses (GHG), which induced climate change, is likely to yield an increase in $PM_{2.5}$ and associated premature mortality (Park *et al.,* 2020). These estimates highlight the urgent need to address air pollution and its adverse effects on public health through effective policies and interventions to reduce emissions, promote cleaner sources of energy, improve indoor air quality, and protect vulnerable populations. It is crucial to continue monitoring and addressing the impacts of air pollution on health to safeguard public health and promote sustainable development.

There is a strong link between the level of economic development and the state of air quality and health effects (Carson *et al.,* 1997; Farzin & Bond 2006; Parrish *et al.,* 2016; Shikwambana *et al.,* 2021). Industrialisation, urbanisation, regulatory policies, and socioeconomic factors affect air pollution and the emission of pollutants into the atmosphere. Many developing economies (mostly in the Western Pacific and South-East Asia regions) have been experiencing a high air pollution impact due to the heavy industries and air pollution hotspots (Babatola, 2018). Butt *et al.* (2017) argue that the global $PM_{2.5}$ concentrations increased by 37.5% over the period 1960 to 2009. This period was dominated by increases from China and India due to economic expansions and growth in emissions. Air pollutants such as O_3 have been linked with a decrease in yield of wheat crops in China, which could affect future food production (Feng *et al.,* 2021).

However, developed nations like the UK, Europe and the US have seen a significant decrease in air pollution as technologies and policies improved and the focus on mitigation increased. Recent studies suggest an improvement in some of the air quality parameters, such as $PM_{2.5}$ and PM_{10} concentrations in countries such as China, Korea, Japan, Spain, UK and Europe, particularly at regional or city level (Colette *et al.,* 2020; De la Campa *et al.,* 2018; Ito *et al.,* 2021; Munir *et al.,* 2021; Sicard *et al.,* 2021). At local scale, some cities, including Paris, Sao Paulo, Mexico City and New York have managed to address their vehicular emissions by implementing various regulatory means focusing on circulation restriction, fuel initiatives, technological advancements such as emission abatement technology, as well as fiscal incentive approaches in targeting fuel and technology initiatives (De la Campa *et al*., 2018; Molina *et al.,* 2019; Slovic & Ribeiro, 2018).

The impact of human activities on air quality became apparent on a global scale during the COVID-19 pandemic when large reductions in air pollution were observed all over the world (Berman & Ebisu, 2020; Cardito *et al.,* 2023; Gulia *et al.,* 2021; Ko *et al.,* 2023; Travaglio *et al.,* 2021; Zhao *et al.,* 2023). The rate of observed climate change has reignited the need to curb the human activities that emit pollutants into the atmosphere. The potential to find co-benefits in managing air quality and climate change has never been more pertinent (de Oliveira *et al.,* 2013; Harlan & Ruddell, 2011; Mir *et al.,* 2022; Thambiran & Diab 2011a, 2011b). The correlation between air pollutants increases and human health has since also triggered policy initiatives aimed at improving air quality in many of those countries (Sheik *et al.,* 2020).

2.3 Air pollution in the South African context

South Africa is a middle-income country with high levels of poverty and inequality where many people rely on fossil fuels for cooking and heating indoors (Shezi & Wright, 2018). Furthermore, as a developing economy and the second-largest economy in Africa, it is home to high energy-intensive industries and this has led to high emissions per capita of GHG from the predominantly coal-fired power industry (Klausbruckner *et al.,* 2016). Some of the biggest contributors to air pollution in the country are electricity generation, industrial processes, domestic energy use, vehicular exhaust emissions, dust storms, unpaved roads, smokestacks waste and agriculture (Scorgie *et al.,* 2004; Tshehla & Write, 2019). South Africa has a coal-heavy economy (80% of electricity) (CSIR, 2023).

Some of the key sectors contributing to South Africa's GDP include agriculture, forestry and fishing, industry, services finance, transport, manufacturing, and mining and quarrying (Statistics South Africa, 2021). Furthermore, according to Statistics South Africa, the population in South Africa was estimated at 60.6 million by the end of June 2022, ranking fifth on the African continent (Statistics South Africa, 2022). South Africa still has major inequality issues, which adds pressure to service delivery, resulting in poorly build houses, poorly planned settlements and a lot of informal areas (Francis & Webster, 2019). South Africa has seen rapid population growth, leading to increased poverty which translates to use the of dirty fuel (coal, wood, paraffin and dung) in households and informal waste burning (Language *et al.,* 2016; Pauw *et al.,* 2022).

In terms of energy production, South Africa is one of the top generators of electricity on the African continent. It had 54 GW of electricity capacity in 2022 from all sources, of which 80% of was from coal (CSIR, 2023). Studies also show that these power plants among other anthropogenic activities do contribute to the emission of pollutants such as SO_2, and NO_X in areas such as the HPA (Chidhindi *et al.,* 2019; Eurididou *et al.,* 2022; Morosele & Langerman, 2020). Power stations are emitting SO_2 at levels three to six times more than the MES limit (Langerman *et al.,* 2023). These coal-fired power plants were not built with modern control technologies. Many still have electrostatic precipitators (ESP) (95–98%), while some have fabric filter plants (99%), and only Medupi and Kusile having flue gas desulphurisation (FGD) abatement designed to remove SO_2 from the flue gases before they are released into the atmosphere (Nkambule & Blignaut 2017; Singleton, 2010). The Medupi power station is also fitted with a Pulse jet fabric filter plant (PJFF) for the reduction of particulate emissions and low NOx burners to assist in reducing NOx emissions (Singleton, 2010; Strickroth *et al.,* 2020). However, the effectiveness of these retrofit measures and their impact on SO_2 emissions and air quality would need to be assessed over time.

The poor local ambient air quality has become a major concern due to its negative health effects that especially affects poorer communities who reside close to polluting industries and who rely on dirty fuel burning for household use (Buthelezi *et al.,* 2019; Dugard & Alcaro, 2013; Klausbruckner *et al.,* 2016; Matandirotya *et al.,* 2019; Matandirotya *et al.,* 2022; Roomaney *et al.,* 2022; Shirinde *et al.,* 2014). This is common in urban areas with a high population density, industries and traffic as well as in rural areas without electricity (Bradshaw *et al.,* 2003; Langerman *et al.,* 2018; Norman *et al.,* 2007).

In terms of air pollution, South Africa is the world's 14^{th} largest emitter of GHGs and CO_2, which was 4% to the global contribution and 40% of Africa's emissions in 2011. These emissions are predominantly due to a heavy reliance on fossil fuel such as coal (Adom, 2015; Pradhan & Mbohwa, 2014). Particulate matter is currently bad in South Africa, especially in dense, low-income areas and during cold seasons. Ambient PM concentrations can reach dangerous high levels in some of South Africa's air pollution hotspots such as the Vaal Triangle Airshed Priority Area (VTAPA), Highveld Priority Area (HPA) and their associated townships such as Soweto and KwaZamokuhle (Feig *et al.,* 2019; Govender & Sivakumar 2019; Matandirotya *et al.,* 2022; Moletsane *et al.,* 2021; Roomaney *et al.,* 2022, Scorgie *et al.,* 2004). Roomaney *et al.* (2022) show that about 51 million South Africans (97%) were exposed to harmful concentrations of $PM_{2.5}$ (exceeding 10 µg/m^3), while 35 million (67%) were exposed to concentrations higher than the NAAQs limits (20 µg/m3) in 2012. Trends show that $PM_{2.5}$ pollution varies depending on strong temporal and seasonal factors. Concentrations usually increase during winter periods and during the early hours of the day and the early hours of the evening. This is attributed to natural and anthropogenic activities such as domestic fuel burning, indoor combustion, as well as wind-blown dust (de Lange *et al.,* 2019). In addition, several studies found that during these winter periods, $PM_{2.5}$ exceeds NAAQS daily and annual emission limits in various regions of South Africa (Adesina *et al.,* 2020; Cairncross, 2016; Govender & Sivakumar, 2019, Moletsane *et al.,* 2021). However, Govender and Sivakumar (2019) also found a decrease in annual $PM_{2.5}$ concentrations in the Diepkloof and Sebokeng townships from 2007 to 2017.

Although there is no complete spatial representation of SO_2 emissions at a country scale, studies show that the highest SO_2 levels are concentrated in the HPA (Garland *et al.,* 2017; Martins *et al.,* 2007; Sangeetha & Sivakumar, 2019). However, recent studies have shown that SO_2 is generally high in most of South Africa's industrial and low-income urban settlements, especially during the winter season, but it usually does not exceed the NAAQS threshold of 50 µg/m^3 (Matandirotya *et al.,* 2022; Morakinyo *et al.,* 2020). Some exceedances however do sometimes occur for SO_2 in HPA due to seasonal variations, with emissions mostly from power plants and industrial sources (Josipovic *et al.,* 2009). Swarts *et al.* (2020) analysed a 21-year passive-sampled dataset for atmospheric SO_2, NO_2 and O_3 and found that SO_2 showed seasonal patterns that are influenced by various factors such as occurrences of air masses passing, as well as increased biomass burning January and February. Rooney *et al.* (2022) argue that even at low levels of exposure, ambient air pollution can still pose adverse health risks. Furthermore, an earlier study shows that rainwater in Skukuza in the Kruger National Park was found to be acidic, with the average precipitation pH of 4.72, which can be attributed to SO_2 emissions from the HPA (Mphepya *et al.,* 2006).

In South Africa, especially the HPA, human activities have disturbed the natural nitrogen cycle (Clain *et al.,* 2009; Collet *et al.,* 2010). However, studies have found that although NOx is high in hot spots areas like HPA, especially in winter, it does not exceed MES (Collet *et al.,* 2010; Josipovic *et al.,* 2009). Collet *et al.* (2010) argue that the increase in NO, NO_2 and NO_3

concentrations have yielded a net positive balance of nitrogen and that the overall amount of nitrogen deposited per year in the HPA had values between 6.7 kg N/ha per year and 13.1 kg N/ha per year, which is lower than the prescribed critical load value for grasslands of 15 kg N/ha per year.

Tropospheric O_3 concentrations in various regions of South Africa have been on the rise and remains high. They exceed standards in the northern part of the country during some parts of the year (Bencherif *et al.,* 2020; Diab *et al.,* 2003; Clain *et al.,* 2009; Govender & Sivakumar 2019; Josipovic *et al.,* 2009; Thompson *et al.,* 2012; Thompson *et al.,* 2014). Ozone precursors such as NOx and VOCs do play a role in the amount of O_3 present, and in areas such as VTAPA, anthropogenic activities such as vehicular emissions from high traffic congestions do contribute to the emissions of NOx and VOC (Govender & Sivakumar, 2019). In order to mitigate O3 concentrations in South Africa, there should be stringent controls on emissions of either NOx and VOCs (Laban *et al.,* 2015).

Similar to the rest of the world, air pollution trends in South Africa's Mpumalanga area showed a strong decrease in pollutants such as CO, NOx and PM during the first two weeks of the 2020 COVID-19 lockdown and a strong increase after lockdown (Venter & Lourens, 2021).

However, South Africa has implemented emissions regulations for various industrial sectors, including the Minimum Emission Standards (MES) for air pollutants, which include SO_2, PM, CO, NO_X, etc. These regulations aim to limit the emissions of these air pollutants from industrial sources. Compliance with these regulations and enforcement of emission limits may positively affect emissions trends in South Africa.

Despite many interventions and amidst the plethora of instruments, some of which have been in existence for decades such AQMPs and AELs, trends show that air quality in South Africa is deteriorating, especially in those areas that have been declared as priority areas (Feig *et al.,* 2019; September, 2012; Tshehla & Wright, 2019). Muyemeki *et al.* (2022) further predict that without any strict policy interventions, air quality in South Africa is luckily to get worse in the future and to contribute more to the health burden as a result of the current rate of urbanisation, population growth, and economic development.

It is evident that air pollution is a substantial health burden in South Africa and efforts to mitigate air pollution and promote clean air are crucial to protect public health (Altieri & Keen, 2019; Henneman *et al.,* 2016; Roomaney *et al.,* 2022; Sheik *et al.,* 2020). It is also important to note that estimating the exact health impacts of air pollution is complex and involves various factors, including the type and level of pollutants, duration of exposure, individual susceptibility, and other environmental and socioeconomic factors. The health effects of air pollution in South Africa include cardiovascular and respiratory diseases such as asthma, chronic obstructive pulmonary disease (COPD), and respiratory infections. These are among the top three fatal diseases in South Africa (Altieri & Keen, 2019; Roomaney *et al.,* 2022). Similar to other regions globally, $PM_{2.5}$ and O_3 concentrations in South Africa are found to have increased between 2000 and 2012, which saw South African population being exposed to $PM_{2.5}$ concentrations that exceeded the WHO guidelines of 10 µg/m^3 annually (Roomaney *et al.,* 2022). As a result, $PM_{2.5}$ exposure was linked to 19 507 deaths, while O_3 exposure was linked to 1 734 deaths in the year 2012, with the Gauteng province having the greatest number of deaths (Roomaney *et al.,* 2022).

Air pollution is a critical health issue affecting people worldwide, and South Africa is no exception. Ambient air pollution is a significant health risk in the country, and addressing the problem requires both short- and long-term interventions. Short-term interventions include the enforcement of NAAQS and industry MES, while long-term interventions can include measures to manage pollutants from sources such as the burning of fossil fuels for industrial and domestic uses, power generation, and transports, and the replacement of these with clean renewable energy sources (Roomaney *et al.,* 2022). The following section provides an overview of some of air quality management and governance interventions for both international and local context.

2.4 Air quality management and governance internationally

In response to the effects of air pollution, governments have been working with research institutions, industry and civil society to introduce efficient management measures (Ma *et al.,* 2019). Many countries, including China, the US and the European Union (EU) have implemented a series of national control policies to reduce air pollution emissions (Kuklinska *et al.,* 2015; Ma *et al.,* 2019; Sheikh 2020; Wang *et al.,* 2014). On a smaller scale or at the local level, several European cities have developed policy instruments, of which AQMPs are principal key delivery framework for air quality management. These plans include emission abatement measures designed and implemented by EU Member States (MS) in accordance with the Framework Directive 96/62/EC on ambient air quality assessment and management (Miranda *et al.,* 2015). However, Member States do not always meet the requirements of the directive especially when it does not fit their legal and administrative structures and contradicts with economic growth (Borzel, 2000; Nagl *et al.,* 2016)

2.5 Conceptualising air quality management and governance in South Africa

Nel and Du Plessis (2003) define environmental governance as the collection of legislative, executive and administrative functions, processes and instruments used by any organ of state to ensure sustainable behaviour by all as far as the governance of activities, products, services, processes, and tools are concerned. As a response to the air pollution challenges, many international and regional governments, including the South African government, have developed various policies since the 1960s that have over time introduced various regulating instruments to inform air quality governance decision-making (Emilsson *et al.,* 2004; Scorgie *et al.,* 2004; Engelbrecht & Van der Walt, 2007; Engelbrecht & Van der Walt, 2012; Naiker, 2007; Naiker *et al.* 2012). Moreover, various other air quality management approaches and instruments have been introduced by industry and civil society to improve their performance and protect their interests. The result has been a highly complex air quality management and governance context, and despite a plethora of these instruments, there is no integrated framework and/or conceptualisation of these instruments. Mukwevho *et al*. (2022) have attempted a conceptualisation by identifying existing air quality management and governance instruments and classifying them in terms of broader environmental management approaches into a) command and control-based instruments, b) incentive and disincentive or fiscal-based instruments, c) agreement-based instruments and d) civil-based instruments (Mukwevho *et al.,* 2022; Nel & Alberts, 2018; Nel & Du Plessis, 2001; Nel & Wessels, 2010). Furthermore, Nel and Wessels (2010) argue that in all these approaches of governing instruments, there is not a single category or instrument that offers a one-size-fits-all solution to environmental challenges, meaning that every instrument or category of tools has strengths and weaknesses when it comes to enforcement performance. Furthermore, some of these instruments will have similar characteristics, even though they belong to different categories. For this reason, the adoption of a hybrid approach is gaining increasing popularity. It entails that organisations adopt a combination of one or more tools to address one specific environmental issue. The adoption and use of many of these instruments in a hybrid manner is often specified as conditions of environmental authorisations (Nel & Du Plessis, 2001; Nel & Wessels, 2010). Furthermore, all these instruments form part of the concept of integrated environmental management (IEM). IEM is focused on aligning fragmented and disjointed environmental governance processes which cut across different spheres of government (Nel & Du Plessis, 2003). Nel and Du Plessis (2003) further explain IEM as meaning the “adoption of NEMA principles and tools by other organs of state in line with the duty of co-operative governance and IEM as meaning the adoption of a holistic and integrative perspective of planning and decision processes by considering numerous parameters to inform the decision-making processes”.

2.5.1 Command and control-based instruments

Command and control-based instruments (CaC) in environmental management refer to instruments that set regulations, legislation, and environmental standards to achieve environmental goals (Kostka, 2016). These laws and regulations are set by governmental authorities to regulate the social and developmental factors in the environment to minimise the impact on the receiving environment (Malloy, 2010). The command-and-control approach manages industries by holding all companies to the same environmental laws. For this reason, it often faces criticism from various industries and is described as inflexible due to its strict regulations to achieve development goals (Kirschke & Newig, 2017; Stavins, 2000).

Also, there is a debate regarding the effectiveness of this approach when compared to other less forceful approaches, such as self-regulation, since it is perceived as a less economically damaging approach to development (Sinclair, 1997). Compliance can be a significant concern when it comes to environmental policies (Borzel, 2000). When laws and regulations are clear and well-defined, it becomes easier for individuals, organizations, and governmental bodies to understand and adhere to them. Clear rules provide specific guidance on what actions are required or prohibited, reducing ambiguity and interpretation issues. However, environmental policies can sometimes be complex and involve multiple layers of regulations which often result in lack of transparency, public participation, and accountability which can make compliance challenging (Makrickiene et al., 2019).

The CaC instruments governing air quality are embedded in different parts of the South African legal framework. It starts with section 24 of the Constitution, which is regarded as the supreme law in the country that informs all other legislation as shown in Figure 2-2. The constitution makes provision for citizens' right to an environment that is not harmful to their health or well-being. Following the Constitution is the National Environmental Management Act, 107 of 1998 (NEMA), which provides for cooperative environmental governance, and which defines the principles for decision making on matters affecting the environment. NEMA provides that reasonable legislative (CaC) and other measures (fiscal- and civil-based) be implemented to address environmental issues, including air quality.

Most of the CaC instruments governing air quality in South Africa are based on the NEM:AQA, which is the main sector-specific legislation for managing and governing air quality as an environmental media. Some of the CaC instruments that are stipulated in NEM:AQA legislation include the 2017 National Framework for Air Quality Management (NFAQM), national ambient air quality standards, air quality management plans, and air quality management measures (which include instruments such as priority areas, environmental impact assessments (EIA) and atmospheric emission licensing (AEL), controlled emitters, controlled fuels, pollution prevention plans, and measures relating to dust, noise and odours). It is thus a mandate that this Act be efficiently and effectively implemented by all relevant spheres of government in dealing with air quality management issues in South Africa. The main objective of NEM:AQA is:

"To protect the environment by providing reasonable measures for the protection and enhancement of the quality of air; the prevention of air pollution and ecological degradation; and securing ecologically sustainable development while promoting justifiable economic and social development, and to give effect to section 24(b) of the Constitution".

However, before the promulgation of NEM:AQA in 2004, air quality matters were regulated by the Atmospheric Pollution Prevention Act, 45 of 1965 (APPA), which mainly focused on regulating certain industrial processes (Scorgie, 2012). The APPA became obsolete in 1994 when new roles and responsibilities were assigned to the new government powers were delegated to lower levels or spheres of government (Engelbrecht & Kornelius, 2021).

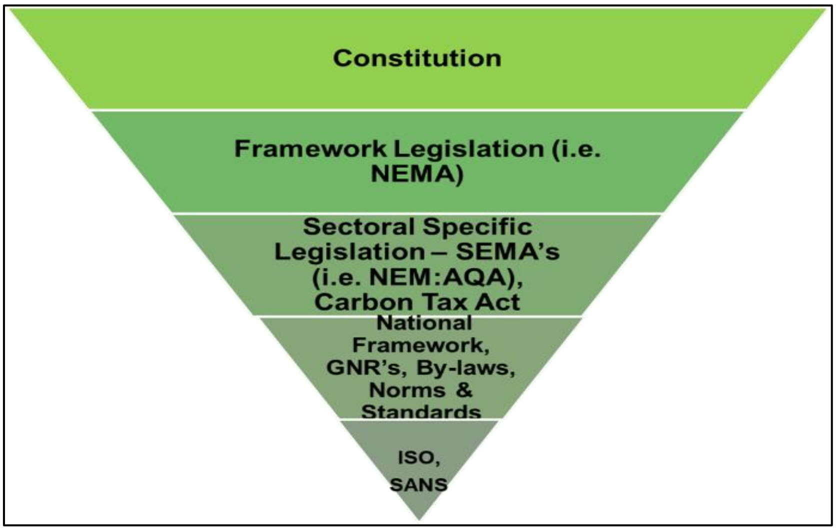

Figure 2-2 Air quality legal framework in South Africa

The fourth level of governance as shown in Figure 2-2 includes national AQMPs described in the 2017 NFAQM in the Republic of South Africa, which is a key policy document that articulates different CaC measures in the country. Other key instruments in this category include gazetted notices mandated by NEM:AQA, such as the national ambient air quality standards (NAAQS), the declaration of priority airshed areas, minimum emission standards and municipal air quality management by-laws (Engelbrecht & Kornelius, 2021; Euripidou *et al.,* 2022). According to Engelbrecht and Kornelius (2021), municipalities are required by section 13(a) of the Municipal Systems Act and section 11(1) of NEM:AQA to develop and implement air quality by-laws. The last tier of air quality governance is the adoption of specific voluntary or best practice guiding documents and standards such as the International Organisation for Standardisation (ISO) or South African National Standards (SANS). Examples of such documents include standards outlining emission measurement methods and analysis such as ISO 7934:1989; ISO 7935; ISO 9096; ISO 10155; ISO 10396; ISO 10780; ISO 11632; ISO 12141 and ISO 14164, which are required in terms of *Government Gazette* 36973 number 831: Declaration of small boilers as controlled emitters. There are many other pieces of national legislation that also directly or indirectly regulate air quality matters in South Africa (Mukwevho *et al.,* 2022; DEA 2018).

2.5.2 Fiscal-based instruments

The fiscal-based instruments, also known as market-based instruments, focus more on the economic perspective of environmental management and entail using taxes, subsidies, and permits to regulate organisations and the general public's activities and their impact on the environment (Pirard, 2012; Wessels & Mkhari, 2007). These instruments add economic value to the environment, which causes organisations and consumers to consider more environmentally friendly and cost-effective measures in their operations and products (Munda *et al.,* 1994; Stavins, 2000). Previous studies have shown that companies are more willing to partake in environmental initiatives to achieve their goals regarding this approach and are willing to alter certain aspects of their business practices to meet these goals (Frondel *et al.,* 2008). This method does, however, receive considerable criticism due to environmental services not necessarily meeting the economic value given to them in taxes and subsidies (Pirard, 2012).

There are several strengths and weaknesses associated with fiscal-based instruments. Some of the strengths of this approach are that these instruments are found to be more friendly than the traditional CaC instruments to organisations and individuals in that they allow an opportunity for them to swiftly respond to matters in a manner that offers financial incentives and disincentives (Toxopeüs & Kotzé, 2017). This was observed in the US where air pollution was reduced significantly beyond their legal regulatory requirement due to the provision of greater financial incentives to industry (Lurmann *et al.,* 2015). This approach usually influences consumer behaviour by manipulating the costs of goods and services, and in so doing encouraging cleaner production and efforts to bring a balance between environmental quality and the value of goods and services (Goulder, 2005). Other strengths of this approach include cost reductions. Organisations or individuals can meet their pollution and energy reduction targets at lower cost rather than just directly complying with legal requirements (Goulder, 2005). This approach also encourages innovative incentives where polluting organisations start looking at alternative technological interventions. Some of the weaknesses of this approach are that these approaches may not always be effective in organisations with enough financial means to pollute and degrade the environment and only pay charges afterwards. Furthermore, the implementation of some of these instruments can be complex and difficult and may require accurate information on aggregate marginal abatement costs and how various agents work with these costs (Henderson, 2010).

Furthermore, according to the National Treasury (2006), the environment and its challenges are the first to be ignored in everyday market activities when a country's market fails. The government of South Africa has come up with various environmental policy mechanisms to rectify such environmental market failures. These are regulated mostly by CaC instruments such as standards, prohibiting the use of some goods or technologies, liability payments (such as the mining rehabilitation fund) and non-tradable permit systems (National Treasury, 2006).

In South Africa, it is evident that many of the fiscal-based instruments exist as a hybrid with other approaches, especially CaC instruments as shown in Table 2-1 (Mukwevho *et al.,* 2022). Also shown in Table 2-1 are a few of the stand-alone instruments which include projects such as the clean development mechanism (CDM) and green infrastructure projects with the purpose of reducing emissions in developing cities and encouraging green building developments through market mechanisms and incentives (Mukwevho *et al.,* 2022).

Table 2-1 Fiscal-based instruments for air quality management with relevant examples

<table>
<tr><th>Fiscal-based Instrument</th><th>Example</th></tr>
<tr><td>Incentives and awards</td><td rowspan="22">Clean Development Mechanism (CDM) projects e.g. Beatrix mine methane project for electricity generation.
General Fuel Levy (petrol, diesel, biodiesel), Aviation Fuel Levy.
Carbon emission tax for vehicles that produce more than 120g/km and are taxed at a rate of R75 + VAT for every g/km in excess of the 120g/km threshold.
Green procurement strategies for the City of Cape Town and Nelson Mandela Bay metropolitan municipalities.
RECSA is the association of Voluntary REC market participants in South Africa. All active producers, traders and consumers of RECs in South Africa are automatically members of RECSA.</td></tr>
<tr><td>Information disclosure programmes</td></tr>
<tr><td>Demand-side management</td></tr>
<tr><td>Disincentives</td></tr>
<tr><td>Tradable Renewable Energy Certificate (TREC)/ Tradable/marketable permits</td></tr>
<tr><td>Depository return schemes</td></tr>
<tr><td>Security deposits</td></tr>
<tr><td>Air Quality charges/levies</td></tr>
<tr><td>Emission Trading Schemes/ Cap and Trade Instruments including restrictions</td></tr>
<tr><td>Pricing policies</td></tr>
<tr><td>Differential indirect taxes</td></tr>
<tr><td>Tax concessions</td></tr>
<tr><td>Subsidies (investment, research and development, activity)</td></tr>
<tr><td>Product charges/taxes</td></tr>
<tr><td>Resource charges/taxes</td></tr>
<tr><td>Emission charges</td></tr>
<tr><td>Process charges/taxes</td></tr>
<tr><td>Two-tier tariffs</td></tr>
<tr><td>Deposit-refund system</td></tr>
<tr><td>Green purchasing</td></tr>
<tr><td>User fees</td></tr>
<tr><td>National environmental fund/account</td></tr>
</table>

2.5.3 Agreement-based instruments

Agreement-based instruments (also known as voluntary agreements) are collaborative arrangements between firms, regulators, and other interested and affected parties in which firms voluntarily commit to actions that improve the natural environment (Delmas & Terlaak, 2001).

Parties are not legally obliged to participate in such agreements, and it is entirely up to the organisation get involved voluntarily (Karamanos, 2001). Agreements can be used by organisations as strategic tools to adhere to their compliance obligations, develop new environmental air quality competencies ahead of the competition, and communicate their responsible environmental air quality performance to their customers or any other interested and/or affected party (Delmas & Terlaak, 2001). According to Nel and Wessels (2010), the voluntary adoption of agreements means that performance is sometimes never verified. Some are regularly verified by independent and competent third parties. Such verifiers could be either entirely independent, such as accredited certification bodies providing assurance of conformity or even enforcement agencies themselves, public watchdog bodies, or enforcement surrogates appointed by the regulated (Nel & Wessels, 2010).

According to Borkey *et al.* (1998), there are four different types of voluntary approaches, these being unilateral commitments, private agreements, negotiated agreements, and public voluntary programmes. Unilateral commitments are based on environmental improvement programmes that are developed and implemented by organisations themselves and communicated to their interested and affected parties such as employees, shareholders, clients, competent authorities, and communities (Borkey *et al.,* 1998). In these unilateral commitments, organisations can define their environmental air quality objectives and indicators, and they can include the country's air quality compliance obligations. Private agreements are contracts between the organisations and those individuals who are affected by its emissions (workers, local inhabitants, neighbouring firms, etc.) or their representatives (community organisations, environmental associations, trade unions, business associations). The contract stipulates the company's commitments to addressing air quality-related matters, usually through an environmental management programme. Negotiated agreements are contracts between the public (local, national, or regional) authorities and industry. They contain objectives and targets, including a schedule to achieve them. Public voluntary programmes entail participating organisations agreeing to standards that have been published by public bodies such as environmental agencies. These standards outline the conditions of individual members, including the provisions the organisations have to adhere to, as well as the monitoring criteria and the evaluation of the results (Borkey *et al.,* 1998).

Agreement-based instruments can be divided into self-regulation and co-regulation (Farina, 2001). Self-regulation instruments allow private organisations to select their own targets, while with co-regulation the targets and methods of achieving them are developed through interaction with the government. The adoption of self-regulation instruments may be entirely voluntary, meaning that no-one ever verifies performance, while co-regulation implies that independent and competent third parties regularly verify performance. Verifiers could be either entirely independent, such as accredited certification bodies, or even enforcement agencies themselves. The verifiers could also be public watchdog bodies or enforcement surrogates appointed by the regulated (Nel & Wessels, 2010). A good example of co-regulation is the agreements that organisations have with government on the collective efforts to minimise air quality impacts. These goals are put in AQMP implementation plans and are monitored. A South Afrcan example of a co-regulation agreement is the partnership between the International Business Machines Corporation (IBM) with the Council for Scientific and Industrial Research (CSIR) and the municipality of the City of Johannesburg to curb air pollution in the city by analysing historical and real-time data from environmental monitoring stations across the Gauteng province. The objective was to gain greater insight into the nature and causes of air pollution and model the effectiveness of intervention strategies. In this project, scientists are using historical and real-time data from environmental monitoring stations and machine learning and cognitive models to gain insight about air pollution, ground-level ozone, and air quality to model the effectiveness of intervention strategies (IBM 2016).

The three key benefits of agreements-based instruments are: (a) to encourage a proactive cooperative approach from the industry to reduce conflicts between regulators and industry; (b) they allow greater flexibility and freedom to find cost-effective solutions that are tailored to specific conditions, and (c) the ability to meet environmental targets more quickly due to decreased negotiation and implementation lags.

The primary advantage of agreements-based instruments is that they encourage good working relations between the private sector and the public and/or the government through the commitment to enhancing environmental management performance (Skjærseth, 2000). These voluntary efforts promote continual improvement, and shared responsibilities and reduce conflicts between various role players (Sergerson & Miceli, 1998). Agreement-based instruments are also found to be cost-effective and flexible in that they allow for individual organisations to decide on their own strategies and mechanisms for reducing environmental impacts (Skjærseth, 2000). They encourage organisations to explore new and cost-effective technological advanced abatement technologies and strategies that can be adopted and implemented (Skjærseth, 2000). Many organisations prefer voluntary agreements to avoid the high costs of penalties associated with the traditional directive methods (Seekoe, 2017).

However, one of the disadvantages of this approach includes misinterpretation by organisations and authorities, which results in mistrust of their performance (Seekoe, 2017). Unlike CaC instruments, agreement-based instruments can lead to poor performance due to a lack of sanctioning of companies that do not comply with their own arrangements (Skjærseth, 2000). In addition, organisations have the flexibility to choose to manipulate and change their own agreements, which leads to ineffectiveness.

The most used agreement-based instruments in South Africa and internationally are the ISO series guidelines developed by the International Organisation for Standardization (ISO) (see Figure 2-3). These standards are adopted by many private organisations and governments internationally as best practice guidelines for management of air quality matters. The ISO 14000 series of standards provide a framework for organisations, enabling a coordinated approach to addressing various environmental challenges, including air quality. ISO standards enable organisations to implement various instruments in combination. This can be seen in the commonly used environmental management systems standard (ISO 14001:2015) that requires the involvement of relevant interested and affected parties. It is primarily a civil-based approach that determines their needs and adopts them. This standard further requires organisations to identify all the relevant environmental legal and other requirements (primarily a command-and-control approach) (Mukwevho *et al*., 2022).

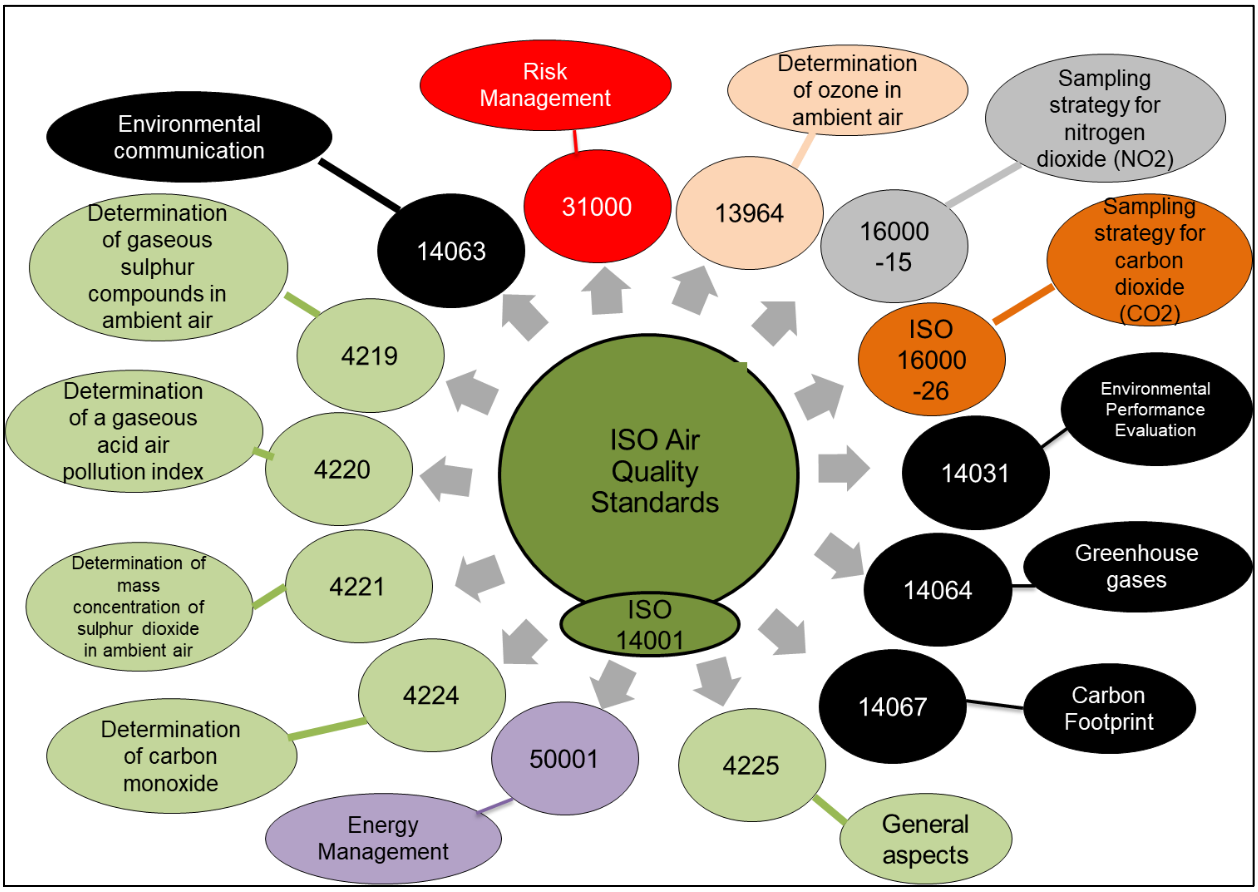

Figure 2-3 Some of the air quality ISO standards that may be adopted by companies and governments in South Africa

Furthermore, certain specific projects are initiated as part of agreement-based instruments. These include for example the carbon disclosure project (CDP), an initiative in which the South African top 100 companies that are listed on the Johannesburg Stock Exchange (JSE) are required to disclose information on carbon emission, including their carbon mitigation measures (Mukwevho *et al.*, 2022). This has resulted in companies exerting influence on their suppliers by requiring carbon emissions performance with the aim of enhancing environmental performance. The CDP was launched in South Africa in November 2007, and by 2009 many companies had shown significant and valuable improvement. As a result of this project, an increased number of companies started to voluntarily disclose their emission reduction targets, to implement emissions mitigation measures, and to influence other companies within their sphere of influence.

2.5.4 Civil-based instruments

Civil-based instruments are implemented to empower civil society to become involved with stakeholders in environmental governance by encouraging them to become active participants in decisions that may affect the environment and people's health and well-being (Toxopeüs & Kotzé, 2017). Through these instruments, all of society, particularly the most vulnerable to environmental injustice, are given an opportunity to raise their environmental-related concerns about the ways in which they may be affected by the decisions taken by the government and private participants. These instruments aim to educate society to help improve their relationship with their environment (Keen *et al.,* 2005). This social learning approach mainly aims to create opportunities for education about the environment by building partnerships and programmes to teach ethics to stimulate the action of the people to build a sustainable future (Keen *et al.,* 2005). A good example includes an awareness campaign such *Basa Njengo Magogo*, which is aimed at educating townships in South Africa on coal combustion. The idea is that the fire burns from the top down, improving the combustion of the coal through increased oxygen flow created by an updraft through the fire.

In South Africa, however, the civil-based approach is often difficult to implement, mainly due to a lack of formal education in most communities, limiting the potential of environmental education to a few people (Wessels & Mkhari, 2007). Also, air quality issues are very costly and complex, which makes civil instruments difficult to implement.

Various sections in NEMA require a public participation process, particularly those activities that require environmental authorisations (i.e., AEL) before commencement. This is used to help incorporate public concerns to help regulate justice in development projects (Viljoen, 2007). Other examples in South Africa include carbon sequestration campaigns such as planting trees and rooftop garden campaigns; air quality monitoring campaigns such as the bucket brigade;

education and awareness campaigns such as indoor air pollution campaigns (e.g., *Basa Njengo Magogo*); watchdog role and empowerment through access to information campaigns such as the South Durban Community Environmental Alliance campaign (Le Roux *et al.,* 2009).

Like market-based instruments, civil-based instruments are also designed as hybrids with other approaches, particularly the CaC approach. As shown in Table 2-2, several air quality-related civil-based instruments in South Africa rely heavily on access to information, justice campaigns, awareness, and carbon sequestration campaigns. Non-government organisations such as the Centre for Environmental Rights (CER) also play a significant role in the implementation of civil-based instruments in South Africa. The CER is comprised of a group of activist lawyers who assist communities and civil society organisations to realise their constitutional right to a healthy environment by advocating and litigating for environmental justice.

Table 2-2 Civil-based instruments for air quality management with relevant examples

Civil-based instrument	Examples
Education	• *Basa Njengo Magogo* project; • South Durban Community Environmental Alliance campaign; • Tree planting and rooftop gardens campaigns (e.g., Arbor Week); • Centre for Environmental Rights (CER); • GroundWork and the Vukani Environmental Justice Movement v Government case for the Highveld Priority Area (HPA); • Richards Bay Clean Air Association (RBCAA) • The case of Tergniet and Toekoms Action Group v Outeniqua Kreosootpale (Pty) Ltd; • Uzani Environmental Advocacy CC and BP Case; • Labelling schemes – such as energy efficiency labels on electrical appliances or organic farming produce; • Information disclosure programmes – such as the Toxic Release Inventory in the United States or Indonesia's PROPER initiative; • Rating and ranking – where the environmental performance of a firm is ranked or rated according to certain criteria and publicly made available through the stock exchange.
Public awareness	
Carbon sequestration	
Public participation	
Improved access to information: – Requests for more information – Statutory record-keeping and reporting	
Air quality monitoring committees/forums	
Increased *locus standi*	
Environmental justice organisations	
Class action, improved access to courts	
Private prosecution	
Beneficial cost awards	
Protection of workers	
Protection of whistle-blowers	
Green rights	
Eco-labelling	
Public waste and pollution inventories	
Information disclosure programmes	

2.5.5 Hybrid approach

Nel and Wessels (2010) argue that in all the governing instruments, there is not a single instrument that offers a one-size-fits-all solution to environmental challenges, meaning that every instrument has strengths and weaknesses when it comes to performance. Some of these instruments have similar characteristics even though they belong to different categories of environmental management approaches. The adoption of a hybridised approach, which is the integrated use of all the approaches to ensure sustainable governing efforts, is increasingly gaining popularity as organisations adopt a combination of one or more instruments to address specific environmental issues (Nel & Alberts, 2018). Internationally, the application of more than one approach as part of a suite of instruments to address air quality challenges is recommended for effective air quality management. This is referred to as the “redundancy effect”. This redundancy effect argues that multiple instruments provide a better chance of success while also providing checks and balances by allowing some instruments to either rectify the problem or to generate alternative solutions should one of them fail (Kirschke & Newig, 2017; Landau, 1969; Nel & Alberts, 2018; Nel & Du Plessis, 2001; Taylor, 1984). The adoption and use of these instruments in a hybridised manner are also often specified as conditions in environmental authorisations (Nel & Du Plessis, 2001; Nel & Wessels, 2010). Furthermore, another key aspect in adopting and using any suite of instruments is selecting them carefully to optimise synergy and avoid instruments working against each other, as well as to prevent injudicious and fruitless expenditure (Nel & Alberts, 2018). It is thus important to state that separating these different approaches into classes is artificial or not realistic in practice because most, if not all instruments are hybridised in their application. Figure 2-4 provides some examples of existing hybridised instruments relating to air quality management and governance in South Africa.

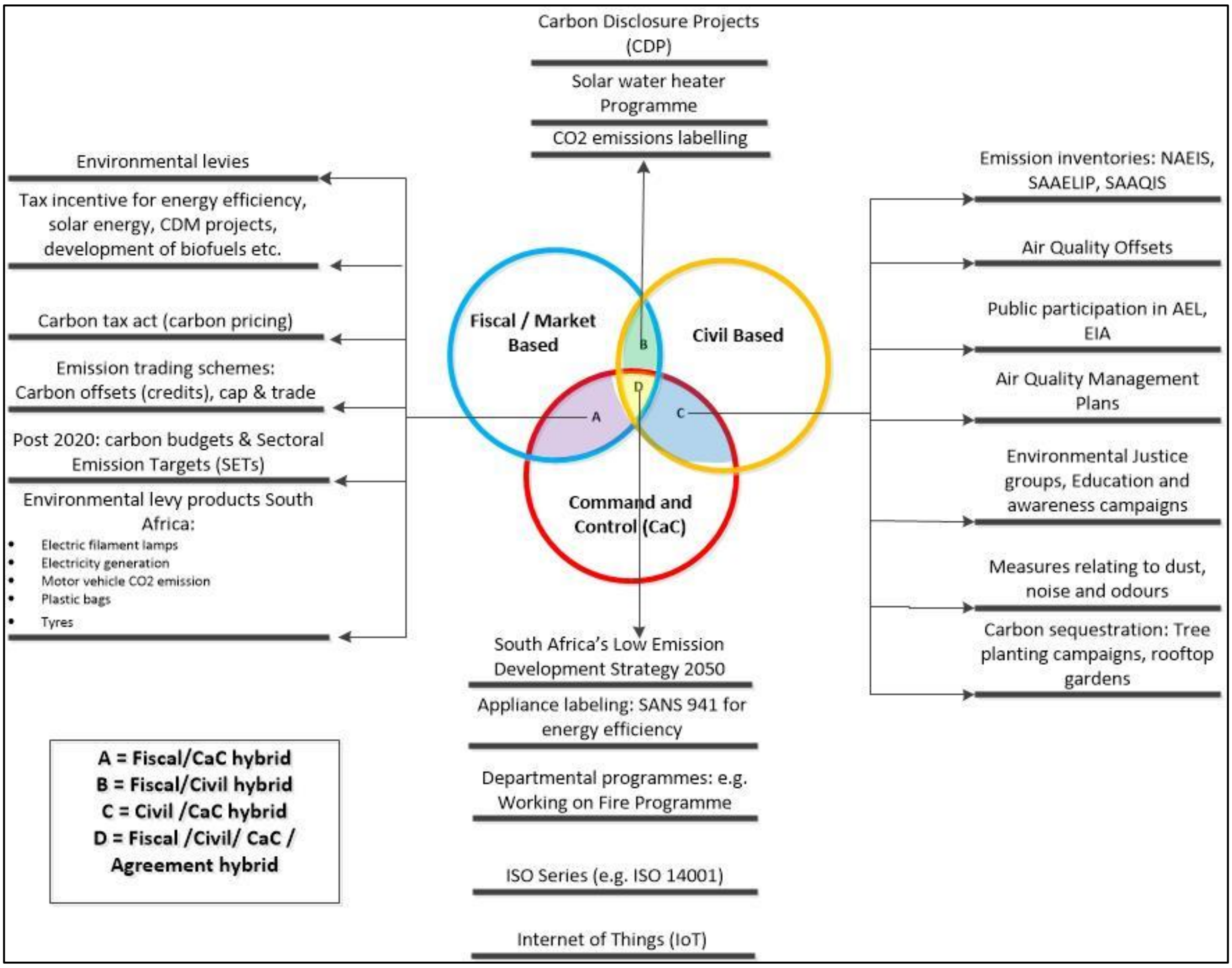

Figure 2-4 Hybrid air quality governance and management instruments

2.6 AQMP internationally

As a means to regulate air pollution and related impacts, governments in many countries such as the US and the EU have been working in collaboration with research institutions to develop mitigation strategies through legislation and policy implementation to regulate and manage activities that contribute to air pollution (Kuklinska *et al.,* 2015; Ma *et al.,* 2021; Mukwevho *et al.,* 2020; Sheikh 2020).

One of these policy instruments for air pollution is the development and implementation of AQMPs. These plans are internationally defined as strategic instruments that describe past trends and the current state of air quality in a defined geographic administrative unit (typically a city or region), and stipulate goals and objectives and describes short- and long-term strategies, policies and controls to improve air quality in a city or region (Sivertsen & Bartonova, 2012; DEA, 2012). Sivertsen and Bartonova (2012) state that in Europe and North America, AQMP is defined as a tool that describes the present state and what could be done to ensure clean air in a city or region. It stipulates the goals and objectives for a region and describes short- and long-term policies and controls to improve air quality. These plans typically include a combination of regulatory measures, technological improvements, and public awareness campaigns aimed at reducing emissions from various sources, improving air quality monitoring, and mitigating the impacts of air pollution. AQMPs are typically developed in areas where air quality does not meet the air quality standards set by national or regional environmental regulatory agencies. AQMPs typically include a comprehensive assessment of the sources and causes of air pollution in the area, as well as an evaluation of the health and environmental effects of poor air quality. Based on this assessment, AQMPs outline strategies, measures and actions to be taken to improve air quality and bring it into compliance with regulatory standards (Gulia *et al.,* 2015; Lieu & Treyz, 1992; Miranda *et al*., 2015; Moreoane *et al.,* 2021; Park & Bae, 2006; Sivertsen & Bartonova, 2012).

Different countries use different terms to describe AQMPs, including air quality plans (AQP) (EU member states), urban air quality management plan (UAQMPs) (e.g., India), air pollution prevention and control action plan (the action plan) (e.g., China), all depending on the spatial scale of a region. They vary from national level to city level and site-specific level (Engelbrecht & van der Walt 2007; Feng *et al.,* 2019; Gokhale & Khare, 2007; Gulia *et al.,* 2015; Lieu & Treyz, 1992; Miranda *et al*., 2015; Moreoane *et al.,* 2021; Park & Bae, 2006; Sivertsen & Bartonova, 2012). An AQMP therefore provides measures, strategies or interventions that will achieve air quality goals and objectives of a particular geographical area and for it to succeed, it requires involvement of various stakeholders from government, business, industry and NGOs (Sivertsen & Bartonova, 2012). An AQMP is considered an important instrument in that it seeks to implement any country's obligations with respect to air pollution reduction, protection of the environment, and compliance with international agreements.

There are generally six steps that are followed in the development and implementation of AQMP, both locally (DEA, 2018; Naiker *et al.,* 2012) and internationally (Sivertsen & Bartonova, 2012). These steps are: 1) goal setting; 2) baseline air quality assessment; 3) air quality management system (AQMS); 4) intervention strategies; 5) action plans implementation; and 6) evaluation and follow up as shown in Figure 2-5.

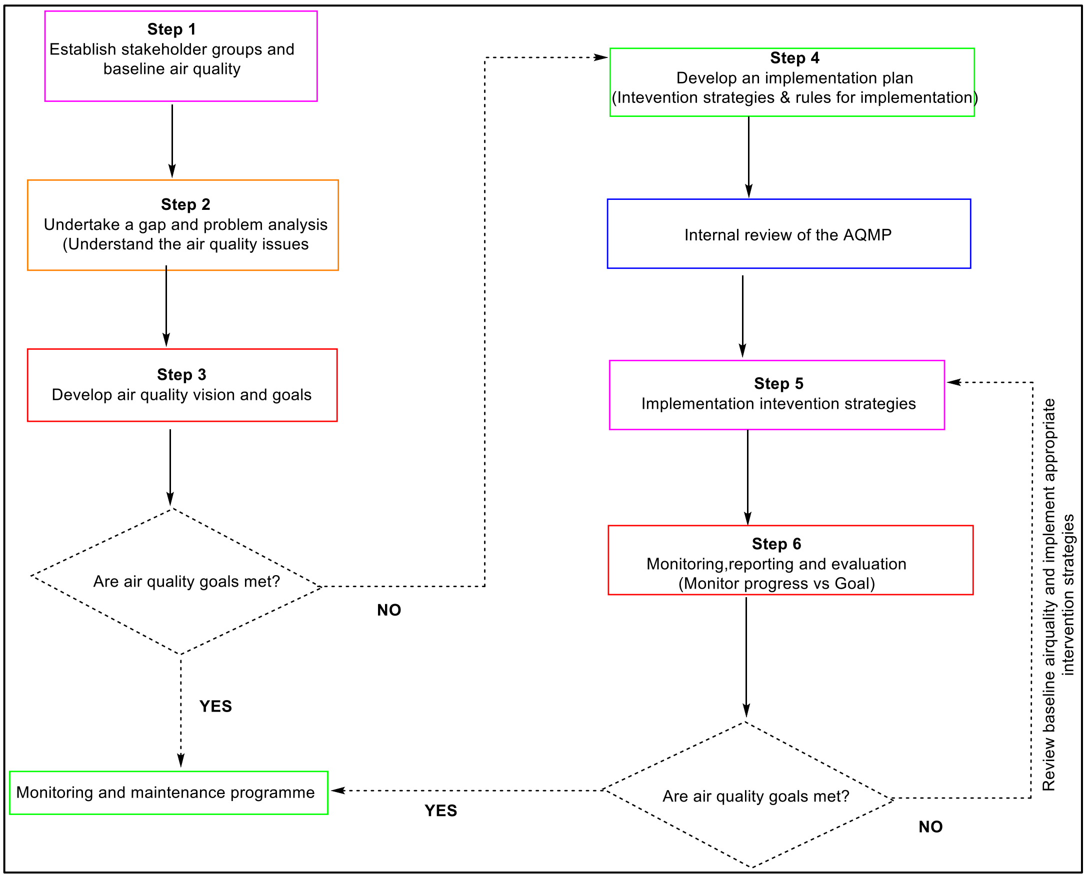

Figure 2-5 AQMP development and implementation process (DEA, 2012)

2.6.1 Air quality goal setting

Air quality goal setting or objectives are the primary elements of any AQMP. They provide the main overarching goals relating to policy or legislation (Gulia *et al.,* 2015; Sivertsen & Bartonova, 2012). The development of these goals must be done with a comprehensive involvement of stakeholders across different spheres (Longhurst *et al.,* 1996). Goal setting may include among other things the identification of primary and secondary pollutants of concern, evaluating urban or local challenges such as air quality and impact from industries, assessing regional issues (such as acid rain, regional, ozone and transboundary problems), global issues (such as greenhouse gases and persistent organic pollutants) and indoor exposure (Sivertsen & Bartonova, 2012). In addition, It is also important that in order to develop effective, measurable goals and objectives SMART criteria (specific, measurable, achievable, realistic, and timeous) should be applied (Moreoane *et al.,* 2021).

2.6.2 Baseline air quality assessment

Baseline air quality assessment is a method to gather information data about the past and current status of a particular geographic area to assess the temporal variability and trends (Sivertsen &

Bartonova, 2012). A baseline assessment helps determine if there is a need for any additional studies (DEA, 2012). Based on existing knowledge of ambient air levels, the assessment should identify sources of emissions, pollutants and areas of concern, as well as areas in the background not directly affected (DEA, 2012; Sivertsen & Bartonova, 2012). A baseline assessment offers important information that becomes an input in modelling the pollution of an area and to simulate their dispersion traits (Moreoane *et al*. 2021).

2.6.2.1 Emission inventories

The identification of sources of emissions is known as an emission inventories. It is an important basis for the planning process and have been conducted since the 1960s in the UK and the US (Garnett, 1967; Marsh & Foster, 1967, Sivertsen & Bartonova, 2012; Sutherland, 2005). Emission inventories are conducted to identify the sources and also to assess their direct or indirect impact on the ambient air quality and to provide the basis to establish mitigation measures to reduce air pollution (Southerland, 2005). Developing a past, present and future emission inventory for any area of concern is important for knowledge that can be used for the management of the atmospheric environment at both local and global scale (Ohara *et al.,* 2007). Emission inventories can be used to track progress on the implementation of intervention strategies (Derwent *et al.,* 1995).

According to Sivertsen and Bartonova (2012), the following should be taken into account when developing an emission inventory: 1) source identification at different spheres; 2) data collection on production, consumption and emissions from different sources, emission modelling for evaluating source data input into dispersion models; and 3) trends evaluations in emissions based on regulatory and economic scenarios.

2.6.2.2 Air quality monitoring

Air quality monitoring is one of the key aspects of the AQMP that provides information to decision makers (Gulia *et al.,* 2020). It generates data on the trends for current air quality and helps evaluate the effectiveness of policy implementation interventions (Gulia *et al.,* 2015). Monitoring as a tool helps reduce uncertainties when reading the intensity of the emission to be mitigated, their areas and whether the interventions or actions are working or not (Gulia *et al.,* 2020). Another key aspect in a monitoring programme is the development of an air quality monitoring network (AQMN) (Sivertsen, 2008). An air quality monitoring network is developed and implemented based on specific air quality objectives (Sivertsen, 2008). A good AQMP can only be effectively developed and implemented based on good quality monitoring data from a comprehensive AQMN (Gulia *et al.,* 2020). An AQMN must be composed of monitoring stations that are built to meet certain specifications. Furthermore, an integrated AQMN uses different monitoring techniques, including a conventional manual method and continuous real-time and sensor-based monitoring stations (Gulia *et al.,* 2020). Sivertsen and Bartonova (2012) further stress that an AQMN or system should include: procedures for quality assurance (QA) and quality control (QC); data dissemination measures; accurate and useful meteorological data for modelling; sources of pollutants data at various scales and potential affected receptors; methods for air quality assessment and the use of statistics for reporting requirements including trend analysis to check compliance to goals and legal requirements; and methods to determine specific problems such as severe exposures and hot spots areas. In addition, having confidence in the air quality management systems provides quality assurance of any data analysis conducted (DEAT, 2008).

Many different monitoring networks have been developed for different reasons in counties all over the world, as shown in Table 2-3 (Gulia *et al.,* 2015). Many of these countries, especially low- and middle-income countries, have these monitoring networks in place mainly to monitor compliance with their legal requirements, such as their national ambient air quality standards.

Table 2-3 Air quality monitoring networks from various countries (Gulia *et al.,* 2015)

Countries	AQMN	Automatic / Manual	Pollutants Monitored	Available online
US	(i) State and local air monitoring stations (SLAMS), (ii) National air monitoring stations (NAMS), (iii) Special purpose monitor station (SPMS) for very specific or short-term monitoring goals and, (iv) Photochemical assessment monitoring station (PAMS).	Both	CO, PB, NO_2, O_3, PM, SO_2	www.airnow.gov
UK	Rural (R), traffic (T), industrial (I) and background (B). Automatic Rural and Urban Network (ARUN) is the largest monitoring network.	Both	NO_X, SO_2, O_3, CO, and PM (PM_{10} and $PM_{2.5}$)	www.uk-air.defra.gov.uk/network
EU	Categorised based on compliance, exposure assessment, online monitoring (episode), and operational monitoring (adjacent to specific source)	Both	NO_X, NO_2, O_3, CO, PM (PM_{10} and $PM_{2.5}$), Benzene	www.eea.europa.eu/data-and-

Countries	AQMN	Automatic / Manual	Pollutants Monitored	Available online
				maps/data/ airbase
Australia	Urban and regional based on population >25000. Monitoring is not done if previous measurements or screening studies have shown that specific pollutant levels would be consistently below the NAAQS	Both	CO, NO_2, O3, SO_2, and PM_{10} and $PM_{2.5}$	www.environmetnx.nsw.gov.au/aqms
British Columbia	Continuous (hourly), non-continuous (24 hourly), and mobile (episodic).	Both	CO, NO_2, O_3, $PM_{2.5}$, PM_{10} SO_2	www.envistaweb.env.gov.bc.ca
Mexico	Manual monitoring stations started in 1972. Automatic air quality monitoring network established in the 1980s. Air quality data are shared through national information system.	Both	O_3, CO, NO_2, $PM_{2.5}$, PM_{10} SO_2	http/sinaica2.inecc.gob.mx/maic/rmart
South Africa	The South African Air Quality Information System (SAAQIS)	Manual	CO, NO_2, PM_{10} SO_2	www.saaqis.org.za
China	The Chinese National Environmental Monitoring Center (CNEMC)	Both	CO, NO_2, O_3, $PM_{2.5}$, PM_{10} SO_2	www.aqicn.org
India	National Ambient Air Quality Programme (NAAQM)	Both	CO, SPM, NO_X, PM_{10} SO_2	http://164.100.43.188/cpcbnew

Gulia *et al.* (2020) further indicate that many low- and middle-income countries' air quality monitoring systems are still developing and thus still face several challenges such as data quality, sufficient and well-skilled technical human resources for maintenance of monitoring equipment, as well as no clear regulatory guidelines for quality assurance (QA) and quality control (QC). Another challenge facing most AQMNs is issues around resource availability such as funds to establish a network and costs for management and reporting of data (Gulia *et al.,* 2020).

2.6.2.3 Modelling air quality

Air quality models are mathematical instruments to predict the dispersion and estimation of pollutants in the atmosphere in a specific geographic area (Chang & Hanna, 2004; Sivertsen & Bartonova, 2012). Several types of models exist for the quantification of ambient air quality including, dispersion models, impact models, economic models, cost/benefit analyses (Sivertsen & Bartonova, 2012). Models employed in the development of AQMPs differ from simplified versions covering a few aspects of emission abatement analysis scenarios to more complicated types that include optimisation methods that take into consideration cost-effectiveness measures (Miranda *et al.,* 2015). These models integrate meteorological and mathematical approaches to narrate the interactions between emissions, meteorology, deposition, chemical formation, concentration, etc. (Chang & Hanna, 2004; Cheng, 2013). Air quality models therefore play an important role in providing information to identify if pollutants are not exceeding the National Ambient Air Quality Standards (NAAQS) (USEPA, 2007). Through modelling the movement and pathways of air pollutants and the chemical and physical processes in plumes enables researchers more accurately analyse air pollutants in different locations (Lee *et al.,* 2014; Li *et al.,* 2021).

According to Sivertsen and Bartonova (2012), modelling includes three basic steps, namely 1) finding a model that will cover all aspects of air quality assessment; 2) checking that local and regional scale models for transport, dispersion and transformation are available and tested/ against measurement data; and 3) implementing the models to determine key sources, root cause analysis of emission and exposure, future predictions and impact assessment, as well as effectiveness evaluation of intervention/mitigation strategies and identification of optimal abatement strategies to meet the set air quality objectives.

Some of the most commonly used dispersion models range from small and medium scale models such as ISC3, AERMOD, ADMS, or CALPUFF, complex comprehensive regional scale models such as NAQPMS, CAMX, WRF-CHEM, CMAQ, through to global scale air quality models such as GEOS-CHEM (Li *et al.,* 2021). However, according to the US Environmental Protection Agency (EPA) classification, the most frequently adopted and endorsed models which are mainly dispersion models (e.g., AERMOD, CALINE3, CAL3QHC/CAL3QHCR, CTDMPLUS, OCD., ADAM, ADMS3, CALPUFF, etc.), photochemical models (e.g. AERSCREEN, RTDM3.2, COMPLEX1,, SCREEN3, TSCREEN, VALLEY, CTSCREEN, VISCREEN, CMAQ, CAMx, REMSAD, UAM-V) and receptor models (e.g., CMB, Unmix, PMF) (Cimorelli *et al.,* 2005; EPA, 2023; Li *et al.,* 2021). Once modelling of the baseline assessment has been conducted, the next step becomes the development of intervention strategies discussed in the next sub-section.

2.6.3 Intervention strategies

Intervention strategies are actions and mitigation measures developed after the baseline air quality assessment to reduce further environmental impact (Gulia *et al.,* 2015; Miranda *et al.,* 2015; Sivertsen & Bartonova, 2012). Once the emission sources have been identified and quantified, intervention or control strategies can be established and evaluated, either in combination or individually (Gulia *et al.,* 2018). Sivertsen and Bartonova (2012) argue that developing intervention strategies must include the evaluation of mitigation measures, including technical, economic, political feasibility and costs; conducting cost-benefit analyses for the options, which then informs cost-effective intervention strategies; the establishment of an implementation plan that covers budgeting and timelines; compliance and enforcement of relevant legal requirements to implement the strategies. Moreoane *et al.* (2021), however, found that intervention strategies that have to be implemented by government organisations directly encountered challenges relating to funds availability for implementation of the strategies. On example is South Africa's first-generation Vaal Triangle Airshed Priority Area (VTAPA) AQMP.

One of the most critical steps in developing intervention strategies is the cost-efficiency analysis to identify which intervention strategies should be prioritised for implementation (WHO 2013). Priority intervention strategies or measures are those considered to have lower implementation costs with high effectivity (Miranda *et al*., 2015). A cost-benefit analysis (CBA) is one of the most commonly used tools to identify appropriate strategies that will realistically mitigate air pollution in an AQMP (Sivertsen & Bartonova, 2012). A cost-benefit analysis is a holistic task that aims to determine the financial costs and benefits of intervention strategies to be implemented for air pollution reduction. In addition, this task requires thorough knowledge of the entire causal relationship of each step in the AQMP planning, starting from emissions sources and costs of abatements all the way to pollutant pathways and their effect on the environment and human health. The determination of non-monetary interventions should also be explored (Sivertsen & Bartonova, 2012). There are many other tools to identify priority intervention strategies, although CBA has been found to be the most favourable for use in practice.

2.6.4 Plan implementation

An implementation plan or strategy provides details on how the intervention strategies will be implemented, monitored and how the enforcement of legal requirements will be done (Sivertsen & Bartonova, 2012). The effective implementation of the strategies in the implementation plan are considered to be associated with the reduction of air pollution in the atmosphere and improvement in ambient air quality (DEAT, 2009). This means that the AQMP should be implementable, quantifiable (either quantitatively or qualitatively), clear and truthful, and provide reporting requirements such as dates and programmes (Moreoane *et al.,* 2021; Sivertsen & Bartonova, 2012).

2.6.5 Evaluation and follow-up

Sivertsen and Bartonova (2012) stress that in evaluating the implementation of the plan, the following may need to be considered: developing or identifying knowledgeable institutions to provide training and provision of instruments; assessing the effectiveness of control measures; the application of various evaluation techniques, including source surveillance, ambient air concentration monitoring downwind from the sources, evaluating and modifying control plans and short term, and medium- and long-term mitigation measures.

2.6.6 AQMP effectiveness

The effectiveness of air quality management policy instruments such as AQMPs can vary depending on a number of factors, such as the comprehensiveness of the plan, the level of implementation, the cooperation and engagement of various stakeholders, limited data and monitoring infrastructure, technological and financial constraints, legal and regulatory challenges, lack of political will and commitment, and climate change considerations (Bradley & Bowler, 1982; Engelbrecht & Van der Walt, 2007; Feng. *et al.,* 2019; Gao *et al.,* 2019; Gollata & Newig, 2017; Gulia *et al.,* 2015; Henneman *et al.,* 2017; Jorquera, 2021; Mohlala, 2020; Naiker *et al.,* 2012; Sivertsen & Bartonova, 2012; Tshehla & Wright, 2019; Van Erp *et al.,* 2008; Wang *et al.,* 2014).

Many of the cities in low- and middle-income countries such Shanghai, New Delhi, Mumbai, Guangzhou, Chongqing, Calcutta, Beijing, and Bangkok have not yet been able to formulate effective and efficient AQMPs to manage their deteriorating air environment, particularly in urban areas (Gulia *et al.,* 2015). Some of the reasons for this lack of development and implementation of AQMPs include the complex and multi-sectoral nature of everyday air polluting activities, the increase in ambient PM and NO_2 concentrations as a result of rapid urbanisation, the inadequate actions of governments due to poor information and weak understanding of the air pollution problems, and the lack of institutional capacity and coordination among government agencies in the various sectors contributing to air pollution (Gulia *et al.,* 2015; KEI, 2002; Murray *et al.,* 2006; Naiker *et al.,* 2012; Sivertsen & Bartonova, 2012). Developing and implementing AQMPs also often require technical expertise, financial resources, and operational capacity (Beattie *et al.,* 2000; Engelbrecht & Van der Walt 2007; Naiker *et al.,* 2012). Many countries, particularly developing ones, may face challenges in terms of poor regulator and stakeholder commitment and participation, weak legal frameworks and poor of air quality data and emission inventories, and limited capacity and resources for AQMP development and implementation (Engelbrecht & Van der Walt, 2007; Gulia *et al.,* 2015; Gulia *et al.,* 2020; Naiker *et al.,* 2012).

In contrast, some countries have seen good air quality improvements as a result of effective implementation of AQMPs (EEA, 2008; Gulia *et al.,* 2015; Gulia *et al.,* 2020; Hasheminassab *et al.,* 2014; Sivertsen & Bartonova, 2012; Tonne *et al.,* 2008). According to Gulia *et al.* (2015), the success of any AQMP depends on the reliability of key aspects such as objectives, monitoring network, emission inventories, modelling, implementation strategies and stakeholder engagements. Most of the developed countries such as the US, UK, Australia have effectively managed to develop and implement AQMPs at different scales in accordance with their regulatory management framework (Gulia *et al.,* 2015; Gulia *et al.,* 2020; Hasheminassab *et al.,* 2014; Sivertsen & Bartonova, 2012; EEA, 2008; Tonne *et al.,* 2008). Some trends emanating from megacities in some developed countries show that urban air quality does show signs of improvement as a result of proper implementation of AQMPs (EEA, 2008; Gulia *et al.,* 2015; Gulia *et al.,* 2020; Hasheminassab *et al.,* 2014; Naiker *et al.,* 2012, Sivertsen & Bartonova, 2012; Tonne *et al.,* 2008). This was seen in the European Environment Agency (EEA) countries where the emission reduction from vehicular exhausts from 1990 to 2009 has been reported to be around 54% for SO_2, 27% for NO_X, 16% for PM_{10} and 21% for $PM_{2.5}$ (Gulia *et al.,* 2015). Also, in New South Wales (NSW) in Australia, road transport is the single largest source of NO_X emissions as it contributes more than 71% of total emissions. However, the hourly average NO_2 concentrations have shown a declining trend from 1980 to 2009 and this reduction may be due to the implementation of and AQMP in that area maintaining cleaner fuel standards (Gulia *et al.,* 2015). Significant reductions of NO_2 were observed in Cardiff and Norwich cities after a successful implementation of an UAQMP (Moorcroft & Door, 2013). Correira *et al.* (2013) found that efficient and effective implementation resulted in the reduction of $PM_{2.5}$, which led to an increase in life expectancy in 545 counties in the USA. In addition, the development and implementation of effective policy measures for air quality improvement require strong political will and commitment from governments and policy makers (Guttikunda *et al.,* 2014). China provides a good example where 338 cities from 2013 to 2017 saw remarkable decline in key pollutants such as $PM_{2.5}$, PM_{10}, and SO_2 through effective implementation of their air pollution prevention and control action plan policy. This emphasises the great political will of the Chinese government to reduce air pollution as one of the mechanisms (Feng, *et al.,* 2019).

Furthermore, the Greater London Authority has successfully implemented various initiatives emanating from their AQMP such as congestion and road user charging schemes to mitigate vehicular emissions in defined zones (EEA, 2008). These initiatives have shown some effectiveness in reducing air pollution from road transport of CO_2, NO_X and PM_{10} concentrations by 16.4%, 13.4% and 6.9% respectively (EEA, 2008; Tonne *et al.,* 2008; Tonne *et al.,* 2010). A recent study by Jorquera (2021) found a significant reduction of $PM_{2.5}$ from -0.5 (μg/m^3)/year to -4 (μg/m^3)/year in Santiago and Coyhaique, cities in Chile, because of ongoing implementation of AQMP.

2.7 AQMP in the South African context

The definition and process of air quality management planning in South Africa are similar to those described by Sivertsen and Bartonova (2012) for Europe and North America. According to the Department of Environmental Affairs' (DEA) 2011 status quo report (now called Department of Forestry, Fisheries and the Environment (DFFE)):

> *"An AQMP describes the current state of air quality in an area, how it has been changing over recent years, and what could be done to ensure clean air quality in a region. It provides goals and objectives for a region and prescribes short- and long-term policies and controls to improve air quality".*

According to Naiker *et al.* (2012), AQMPs are aimed at supporting government departments in planning to implement NEM:AQA, which entails mitigations measures and the provision of funding. Furthermore, according to section 15 of the NEM:AQA, each national department, province, and municipality must prepare an AQMP, which is the document that sets out what will be done to achieve the requirements of NEM:AQA and the air quality standards. Section 17 further indicates that those organs of the state that prepare the AQMP must also report on the implementation of the plan, including information on: 1) air quality management initiatives undertaken during the reporting period; 2) the level of compliance with ambient air quality standards; 3) measures taken to secure compliance with those standards; 4) compliance with any priority area air quality management plans applicable; and 5) air quality monitoring activities. The aim of an AQMP is to give effect to the objectives of NEM:AQA, which also ultimately seeks to give effect to section 24 of the Constitution of the Republic of South Africa as shown in Figure 2-2. Furthermore, through the NFAQM, the AQMP aims to develop and implement intervention strategies to address issues of pollution at a regional level so as to comply with the NAAQS as contemplated in section 9 of NEM:AQA.

Moreover, the NFAQM provides technical guidance to meet the objectives of NEM:AQA (DEA, 2018). Air quality management plans are outlined in Chapter 5 of the NFAQM with direction for the development and implementation of AQMPs provided in the *Manual for Air Quality Management Planning* (herein referred to as the Manual) (DEA, 2012). This means the development of the AQMPs by the various spheres of government must be guided by the process stipulated in the Manual, published in 2012 to establish best practice guidelines on the definition of objectives, strategies, plans, and procedures for the different spheres of government to meet the requirements of the NEM:AQA on air quality management planning and reporting (DEA, 2012). According to the Manual, six steps must be taken in the process of developing AQMPs. These steps are: (1) the establishment of stakeholder groups, defining the boundaries of the AQMP geographic area and the establishment of a baseline; (2) gap and problem analysis; (3) establish air quality goals; (4) develop interventions and a plan to achieve air quality objectives; (5) implementation of the intervention strategies and (6) monitoring, reporting and evaluation. The AQMP development and implementation in this study therefore refers to the process incorporating the six steps from development to implementation of an AQMP as a policy instrument as shown in Figure 2-5.

According to Naiker *et al.* (2012), once the AQMP has been developed, the national and provincial environmental departments must incorporate the AQMP into environmental management plans (EMPs) and environmental implementation plans (DEA, 2012, Naiker *et al.,* 2012). Municipalities are required in terms of Chapter 5 of the Municipal Systems Act to include an AQMP in their strategic planning document and the Integrated Development Plan (IDP). In addition, the implementation of the intervention strategies is done via a number of instruments stipulated in the NEM:AQA, including emission standards for listed activities, an air quality officer (AQO) appointment within each environmental authority, controlled emitters and fuels designation, and regulations (Naiker *et al.,* 2012).

A few studies have been done on AQMPs since the promulgation of the NEM:AQA in South Africa (Engelbrecht & Van der Walt, 2007; Engelbrecht & Van der Walt, 2012; Moreoane *et al.,* 2021; Naiker, 2007; Naiker *et al.,* 2012; Scorgie, 2012; Scott, 2010; Thambiran & Diab, 2010, 2011; Tshehla & Wright, 2019). Earlier studies provided an overview of the transitional arrangements of air quality legal framework from the APPA to NEM:AQA, including an outline of the new requirements for AQMP development and implementation (Engelbrecht & Van der Walt, 2007; Naiker, 2007; Naiker *et al.,* 2012; Scorgie, 2012; Scott, 2010; Thambiran & Diab, 2010; 2011).

Engelbrecht and Van der Walt (2007) developed a framework guideline for AQMP documenting and implementation for municipalities. This study also found several shortcomings related to the AQMP development and implementation process, including a lack of awareness on AQMP matters, slow progress on appointing quality officers, poor air quality management infrastructure and lack of technical capacity, including skills; and poor budgetary provisions. In addition, the study also found at that time, 82% of municipalities had not even began drafting their AQMPs, even two years after the promulgation of NEM:AQA (Engelbrecht & Van der Walt, 2007). Since then, the government has made some good progress in attempting to address challenges around the AQMP development and implementation. Efforts included the development of a technical guiding document for the development of an AQMP in 2008, updated in 2012 (herein referred to as the Manual). However, despite these efforts by government, Scogie (2012) identified several challenges even a few years later during the development process of some metropolitan municipalities' AQMPs. These challenges included no relevant air quality management policy frameworks and poor executive commitment; inadequate resources, especially human resources; poor cooperative governance; poor information dissemination and public consultation; and poor integration of the AQMP with other sector planning such as land use, energy and transportation (Scogie, 2012).

A recent government report and study in 2019 indicated that not all district municipalities have had their AQMPs in place. In 2021, the two provinces of KwaZulu-Natal and Mpumalanga were also still under development as shown in Figure 2-6 and Figure 2-7 (DFFE, 2021; Tshehla & Wright, 2019). Tshehla and Wright (2019) argue that the fact that the status quo had not changed in the three declared priority areas, bares evidence that there are still challenges in developing the AQMPs that actually deliver impact as intended. A more recent study found the following shortfalls in their review of the quality of the Vaal Triangle Airshed Priority Area AQMPs: (1) the description of the socio-economic status; (2) the identification of international agreements; (3) the assessment of regional and greenhouse impacts; (4) the description of urban population extension and urban agglomeration boundary; (5) the complaints data; as well as (6) funding (Moreoane *et al.,* 2021).

Despite having some of the most robust and complex air quality legislation in Africa, South Africa is still facing serious air quality challenges, especially in those areas that have been declared as priority areas (September, 2012; Thambiran & Diab, 2011a; Tshehla & Wright, 2019). Since the promulgation of NEM:AQA in 2004, all but two of the nine provinces of South Africa have developed an AQMP and, at a municipality level, 34 of 44 district municipalities and seven out of eight metropolitan municipalities have developed AQMPs as required by the act (DFFE, 2021; Tshehla & Wright, 2019). Given this lack of AQMP development and implementation, a better understanding is required of the underlying challenges. This is typically achieved through policy instrument evaluations and identifying constraints in their effectiveness, including underlying assumptions that underpin the design and implementation of the policy instrument (Alberts *et al.,* 2021; Mason & Barnes, 2007; Vogel, 2012).

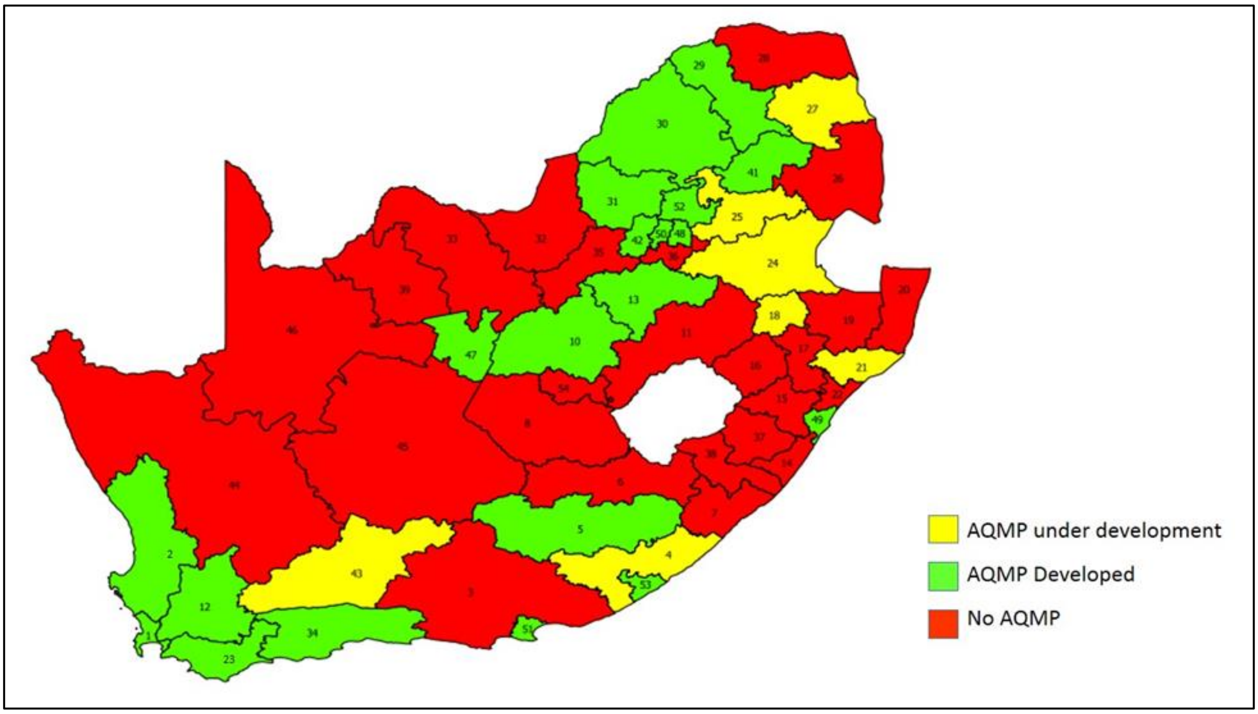

Figure 2-6 Development progress of AQMPs in South African district municipalities (South African Air Quality Information System (SAAQAIS) database)

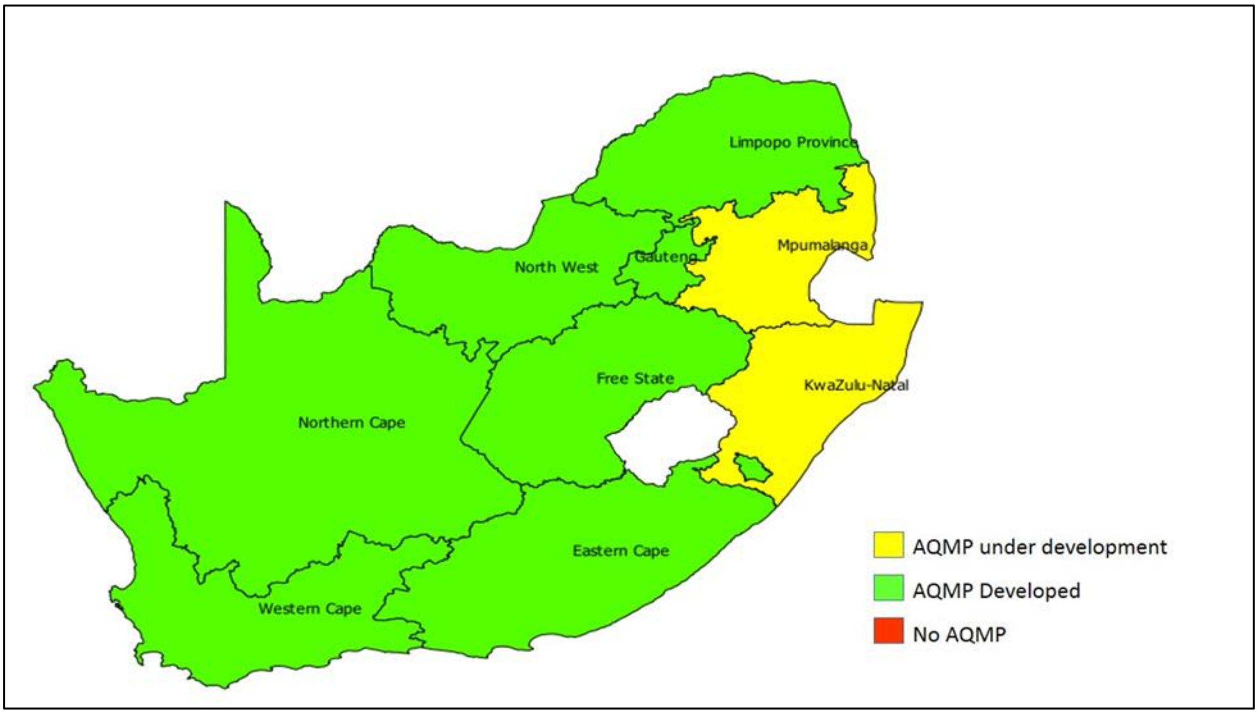

Figure 2-7 Development progress of the AQMPs at provincial level (SAAQIS database)

With AQMPs having been a requirement since 2004 in South Africa through NEM:AQA, this study provides an opportunity to evaluate AQMP effectiveness to provide policy makers with recommendations for improvement towards better air quality management and governance.

2.8 Chapter summary

This chapter has discussed various concepts relating to air quality management and governance in South Africa, as well as internationally. Section 2.2 described the current air pollution status quo from both local and international contexts. Section 2.3 provided a brief introduction to air quality management and governance from an international perspective. Section 2.3 provided a comprehensive conceptualisation of air quality management and governance instruments in South Africa. This conceptualisation unpacked the four environmental management approaches (i.e. command and control, fiscal-based, civil-based, voluntary based as well as hybrid based approaches) and further listed some of the existing air quality instruments within each approach. This section has resulted in a peer-reviewed publication at the national Clean Air Journal. Section 2.5 introduced the AQMP concept from international literature which provided a detailed specification of the steps involved in the process of developing and implementing AQMPs. Section 2.6 further provides a detailed discussion of AQMP from a South African context. Several concepts that have been discussed in this chapter will also form part of Chapter 4 as part of the development of the programme theoretical approach.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter explains Phases 2 and 3, which address Objective 2 to identify a method for evaluating the effectiveness of AQMPs of this research as highlighted in Figure 3-1. Phase 2 describes the definitions of evaluation, evaluation research, programme theory approach of evaluation, introducing the theory of change (ToC) approach, and the ToC in the South African context. Phase 3 then deals with the methodology devised for data collection and analysis. The outcomes are the literature review, case study evaluation protocol, interview questionnaire process, ethics considerations, and limitations to the research.

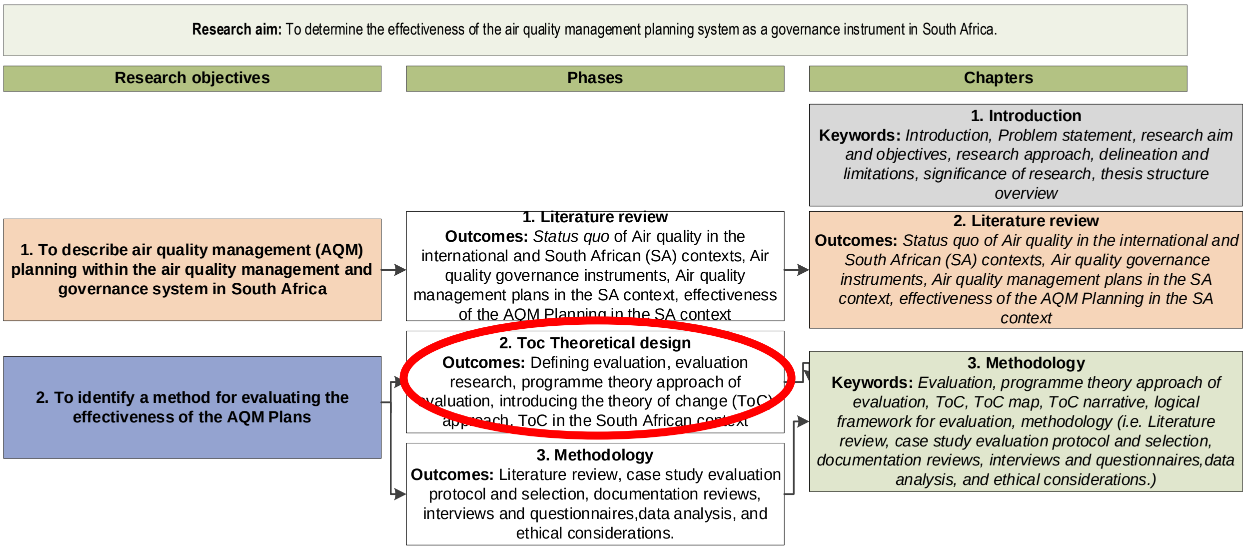

Figure 3-1 Research structure showing Objective 2 as it links with Phase 2 and Chapter 3 on methodology

3.2 Evaluating air quality policy instruments

In order to evaluate or understand whether a policy instrument is working or not, the fundamental question one needs to ask is how effective that policy is in achieving its intended objectives (Alberts, 2020; Alberts *et al.,* 2021; Loomis & Dziedzic, 2018; Pope *et al.,* 2018; Retief, 2007; Shakil *et al.,* 2015; Wang *et al.,* 2014). For this reason, this study has adopted the application of evaluation research as a method of evaluating the AQMP. Clark (1999) stresses that one of the primary purposes of evaluation research is not necessarily to discover new knowledge, but to study the effectiveness with which existing knowledge is used to inform and guide practical action (see below).

3.2.1 Defining evaluation

According to Rossi and Wright (1984), evaluation research came to the fore in the mid-1960s as an applied social scientific activity during the Great Society programmes. They further explain that this type of research developed after the discovery among law makers and public administrators that evaluations could be done through an ordered logical thought process using social scientific research methods. These methods yield more valid and reliable outcomes with less subjectivity and judgement when compared to other previously used approaches (Rossi & Wright, 1984). In addition, evaluation research checks the effects of policies and programmes on their targets against the objectives they are meant to achieve. Using specific objective and systematic methods, evaluation research evaluates the extent to which objectives have been achieved and focus on the factors that are associated with successful or unsuccessful outcomes (Weis, 1993).

Clark (1999) explains that an evaluation scrutinises a programme/process from various perspectives and checks the causal relationships between activities and outcomes. Programme evaluation is therefore a theory-based exercise that also recognises the significance of other components of a programme or intervention, and based on this, researchers can make future predictions of the programme outcomes. Bulmer and Warwick (1993) support programme evaluation by deducing that it is the most scientific concept of applied social research.

3.2.2 Evaluation in South Africa

The South African government published the National Evaluation Policy Framework (NEPF) in November 2011 and 2019. Its main purpose was to promote quality evaluations that can be used for learning to improve the effectiveness and impact of government by reflecting on what is working and what is not working and revising interventions accordingly (DPME, 2011; 2019). This NEPF was developed by the South African government mainly to address the issue that evaluation was inconsistently applied across government entities. It was also not found to be informing decision-making processes such as planning, policy making and budgeting, and as a results they were missing the opportunity to improve the relevance, effectiveness, efficiency, impact and sustainability of government’s interventions (DPME, 2011). Furthermore DPME (2011) states that the main objective of the national framework is to promote quality evaluations which can be applied to gather knowledge to improve the effectiveness and impact of government by determining processes and activities that are functioning and not functioning followed by revising interventions accordingly. The NEPF aims to ensure that reliable and objective evidence from evaluation is applied in planning, budgeting, organisational improvement, policy review, and project management to enhance performance.

The evaluations adopted by the South African government are based on the base model, which links inputs to the activities, outputs, outcomes and impacts of an intervention. These can be used to assess and manage the performance of that intervention (DPME 2011; 2019). According to the NEPF of South Africa, the types of evaluations are design evaluation, implementation evaluation, impact evaluation, and outcome, all of which are defined in Table 3-1 (DPME 2011; 2019).

Table 3-1 Defining the evaluation types used in this study (DPME, 2019)

Evaluation type	Definition	Timing
Design evaluation	*"Used to analyse the theory of change, internal logic and consistency of the programme, either before a programme starts, or during implementation to see whether the theory of change appears to be relevant and working. This is quick to do and uses only secondary information and should be used for all new programmes. It also assesses the quality of the indicators and the assumptions underpinning the theory of change."*	In the first year after an intervention has been designed, and possibly later.
Implementation evaluation	*"Aims to evaluate whether an intervention's operational mechanisms support achievement of the objectives or not and understand why. Looks at activities, outputs, and outcomes, use of resources and the causal links. It builds on existing monitoring systems and is applied during programme operation to improve the efficiency and efficacy of operational processes. It also assesses the quality of the indicators and assumptions. This can be rapid, primarily using secondary data, or in-depth with extensive field work"*	Once or several times during the intervention.
Outcome evaluation	*"Should measure the degree to which the programme is having an effect on the target population's wellbeing and/or behaviours. Outcome evaluations help determine whether or not the intended benefits of a programme are actually achieved (i.e., whether or not the programme is able to meet its intended purpose)."*	After the programme has made contact with at least one person or group in the target population.

Evaluation type	Definition	Timing
Impact evaluation	*"Seeks to measure changes in outcomes (and the well-being of the target population) that are attributable to a specific intervention. Its purpose is to inform high-level officials on the extent to which an intervention should be continued or not, and if there are any potential modifications needed. This kind of evaluation is implemented on a case-by-case basis" (DPME, 2011).*	Designed early on, baseline implemented early, impact checked at key stages, e.g., after 3/5 years.

3.3 Programme theory approach of evaluation

According to Weiss (1998), programme theory is the instrument that investigates the causal relationships between the delivery of the programme and the emergence of the outcomes of interest. The purpose of a programme theory is to discover the theoretical sensibility of a programme and to provide a basis for evaluating relatively uncontrolled programmes (Sharp, 2011). Various terminologies are found to describe programme theory of evaluation, including programme theory, theory-based, theory-driven, and programme theory evaluation, etc. (Rogers, 2000). Programme theory describes how a policy is known to contribute to a chain of results that bring about the expected or actual impacts. The effects can be positive or negative. Programme theory can also reveal other factors that contribute to adverse impacts, such as context and other projects and programmes. Friedman (2001) elaborates that programme theories are developed for various functions, such as explanatory functions (i.e., explaining events or behaviour), predictive functions (i.e., inferring future events or outcomes), and normative/control functions (i.e., identifying actions that should be taken so that outcomes can be made to occur).

One of the main justifications in using the programme theory of evaluation is that it provides clarity on the actual intentions of a programme. This provides the bases on which an evaluation can be done based on the quality of those intentions (Bickman & Peterson, 1990). In addition, a programme theory provides a conceptual basis for reviewing and improving existing programmes and also supplements logical reasoning on new programmes (Bickman, 1987; Lipsey, 2000). It is therefore true that a well evaluated and successful programme theory enables policy makers to implement similar concepts to other applicable programmes (Bickman, 1987).

3.4 Introduction to theory of change (ToC) approach

A series of theory-based evaluation programmes have been developed internationally over the past 30 years (Hansen & Vedung, 2010). Many terms are used to describe the programme theory of evaluation, including theory-based, theory-driven, theory-oriented, theory-anchored, theory of change, intervention theory, outcomes hierarchies, programme theory, intervening mechanism, theoretically relevant, logic modelling and programme logic (Rogers, 2008). All these evaluation programmes, however, have one common interest, and that is to apply logical thinking to reconstruct a causal model based on several sources to unpack how a specific intervention (programme) is intended to achieve its outputs and outcomes based on its inputs and activities (Stame, 2004; Rogers, 2008). Evaluation research under the term theory of change evaluation has been applied previously in assessing the effects of various social programmes and has also recently been applied to governmental programmes including important evaluations of job training programmes, compensatory education, mental health centres, community health services, community action, law enforcement, corrections, and other government interventions (Alberts *et al.,* 2021; Amundsen & D'Amico, 2019; Archibald *et al*., 2016; Biggs *et al.,* 2017; Connell & Kubisch, 1998; Jackson, 2013; Thornton *et al.,* 2017; Weiss, 1993)

This study adopts the term theory of change (ToC) for its theory-based evaluation of AQMPs as defined by Biggs *et al.* (2017). It is viewed here as an instrument that supports decision making by identifying the causal relationships and sequences of the events required for a programme to reach its intended outcomes and describing the key assumptions in each step of the process. Theory of change exposes the assumptions about what and how things should happen in a specific programme and tests the validity of such assumptions (Amundsen & D'Amico, 2019; Connell and Kubisch 1998). Connell and Kubisch (1998) further describe ToC as a systematic and cumulative study of the links between activities, outcomes, and contexts of a programme by specifying how activities will lead to interim and longer-term outcomes. It identifies the contextual conditions that may affect them. These linkages can be expressed in a hierarchical structure showing how each component informs the other, which ultimately determines the type of evaluation to be conducted (DPME 2011; 2019).

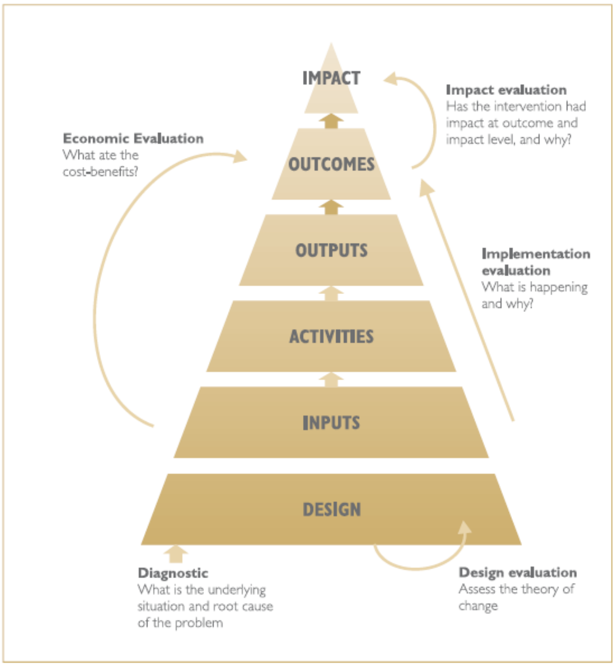

Figure 3-2 Different types of evaluation as adopted by the DPME in South Africa

Many of the current programme theories of evaluation focus on developing a model of the logic implicit in programme design (Friedman *et al.,* 2001). Such logic models explain how programme inputs and activities are intended to create the desired outcomes. A well-developed, logical model provides a useful framework for identifying measurable short- and long-term outcomes. Theory of change uses three components to describe the programme, namely the programme activities or inputs, the intended outcomes or outputs, and the mechanisms through which the intended outcomes are achieved (Sharpe, 2011).

If the critical inputs are clearly defined, then the components of the programme will also be well defined. How these components are delivered is described as well. In addition, critical inputs should define the strength or amount of treatment required to induce the outcome (Sidani & Sechrest, 1999). Lastly, the critical inputs should outline the required aspects that are important in producing the expected outcomes (Lipsey, 1993). The output should specify the nature, expected timing, side effects, and pattern of change, as well as interrelationships among outcomes. The output/outcomes can be broken into immediate, intermediate, and long-term effects (Funnell, 2000).

Moreover, Allen *et al.* (2017) define the different components of ToC as follows: the inputs are the required resources (such as money, staff, equipment, and infrastructure). Activities are the interventions and actions that have to be undertaken to achieve specified outputs. Outputs are the tangible results. Outcomes can be split into intermediate (short-term and medium-term) and long-term outcomes and are usually specified in terms of sequential preconditions. Short-term outcomes are the changes in individuals and groups, such as including enhancements to knowledge, understanding, perceptions, attitudes, and behaviours. Medium-term outcomes result in changed skills and practices, such as changed behaviours to accomplish results or capabilities. Long-term outcomes would result in desired goals such as an increased ecosystem and human health, which can be assessed over multiple value areas, including social, cultural, economic, and environmental areas (Allen *et al.,* 2017). A design component is also included in some cases to address the contextual design of the policy or programme (DPME, 2011).

The NEPF stipulates that evaluation processes should explain the logic model or theory of change of the any plan, in other words, the causal mechanisms between the activities, outputs, outcomes and impacts (DPME, 2011). Causal linkages are therefore a fundamental aspect of the scientific methodology, which can prove complicated when working with complex programmes (Romero & Puts, 2018). Applying the ToC approach to a complex programme such as AQMP and scrutinising the causal links between the different components of the programme can therefore shed light on the key assumptions that underpin the potential outcomes of the programme. This is done through agreements with relevant stakeholders and practitioners in that field so that they can unpack a complex programme by identifying and testing the validity of the assumptions related to that programme or intervention (Allen *et al.,* 2017; Connell & Kubisch, 1998). Many other programmes have been explored previously, especially in EIAs, and no study to date has applied ToC to explores the causal relationships of a complex programme such as AQMP in South Africa.

3.5 Theory of change justification in the South African context

This study argues that there are strong indications that ToC is an appropriate methodology for evaluating AQMPs in South Africa. Firstly, AQMPs as a policy instrument for addressing air quality issues in South Africa have been understudied in the academic space, and no study to date has been done to evaluate the effectiveness of these plans specifically using the ToC approach. Similar studies found internationally were related to the effectiveness of air quality regulations (Bradley & Bowler, 2002) and air quality interventions (Van Erp *et al.,* 2008). Secondly, as described in Section 2.9 and 2.10, programme theory (ToC) is the approach formally prescribed by the South African government for policy evaluations and monitoring and has increasingly been used by many other governments, multi-lateral development agencies, civil society agencies international NGO’s including the UK and United Nations (DPME, 2011; Vogel, 2012). Thirdly, South Africa has robust air quality legislation, but despite this the air quality has not improved (Mukwevho *et al.,* 2022; Tshehla & Wright, 2019). For this reason, the application of the ToC approach in evaluating AQMPs is in line with the country’s national strategy for conducting policy evaluations.

3.6 Defining the effectiveness for AQMP evaluation

Clark (1999) stresses that one of the primary purposes of evaluation research is not necessarily to discover new knowledge, but to study the effectiveness with which existing knowledge is used to inform and guide practical action. In this regard, the fundamental question evaluation research asks is how effective the programme is in meeting its objectives and intended outcomes and by testing the effectiveness of such programmes against their own objectives. This not only validates the objectives and intended outcomes but also verifies the true nature of such programmes.

Effectiveness studies to examine environmental impact assessments (EIAs) have been conducted since the 1990s and have recently emerged as a subfield in scientific literature due to the multidimensional nature of the term “effective” (Alberts, 2020; Loomis & Dziedzic, 2018). According to a literature review conducted by Loomis and Dziedzic (2018), many authors agree that EIA effectiveness is multidimensional and plural in nature, which requires a holistic approach. In contrast, effectiveness studies in air quality governance and management instruments (including AQMPs) have not been examined in the same depth in which EIAs have both globally and locally. Only a few studies have been limited to the effectiveness relating to air quality regulations and air quality interventions (Bradley & Bowler, 1982; Gao *et al.,* 2019; Gollata & Newig, 2017; Goyal *et al.,* 2019, Henneman *et al.,* 2017; Jorquera, 2021; Li & Chen, 2018, Tshehla & Write, 2019; Van Erp *et al.,* 2008; Wang *et al.,* 2014).

To date, no study has applied the evaluation research approach (ToC specifically) to evaluate the effectiveness of air quality governance and management instruments in South Africa, and for this reason, this study aims to evaluate effectiveness of AQMPs using ToC approach of evaluation. AQMPs are a central tool aimed to assist government departments in planning NEM:AQA implementation, including control measures and financial provision (Naiker *et al.,* 2012). Similar to EIA effectiveness evaluations, a holistic approach to AQMP evaluations is required to bring about multidimensional thinking for more substantive solutions to the challenges encountered with AQMP development and the implementation process. It can also enhance further research to discover even better solutions for air quality governance. It is therefore important to define and conceptualise the term “effectiveness” as it relates to AQMP evaluation.

This study suggests that effectiveness evaluation means to assess whether the AQMP works as intended and achieves its outcomes. The AQMP objectives are as stipulated in chapter 3 section 16 of NEM:AQA: to improve air quality; to identify and reduce the negative impact on human health and the environment of poor air quality; to address the effects of emissions from the use of fossil fuels in residential applications; to address the effects of emissions from industrial sources; to address the effects of emissions from any point or non-point source of air pollution; to implement the Republic’s obligations in respect of international agreements; and to give effect to best practice in air quality management. In essence, AQMPs should help government departments plan for the implementation of the NEM:AQA requirements, including mitigation measures and making funds available (Naiker *et al.,* 2012). In addition, as described in the NFAQM, the AQMPs provide logical outlines of the strategies and the resource needs for the implementation of the interventions or for meeting specific targets (DEA, 2018). Such objectives and targets aim to reduce air pollution in a defined area and to identify and mitigate the negative effect on human health and the environment. Through these objectives, AQMPs become one of the important tools for the realisation of the broader NEM:AQA objectives, which include air pollution prevention and ecological degradation, securing ecologically sustainable development while promoting justifiable economic and social development. Through AQMPs as one of the mechanisms, NEM:AQA must ultimately give effect to section 24 of the Constitution of the Republic of South Africa by enhancing the quality of ambient air for the sake of securing an environment that is not harmful to the health and well-being of people (DEA, 2018).

In effectiveness evaluations, the key logic is that the plan should provide guidelines to achieve its actual intended outcomes, any deviation from this is likely to result in poor implementation (Baer, 1997). In determining effectiveness, this study applies the implementation, impact, and economic evaluation types to evaluate AQMPs in South Africa as per the DPME guidelines.

The ToC method is conceptualised around a results-based pyramid that has been adapted for the evaluation of AQMP development and the implementation process from the government’s national evaluation policy frameworks (DPME, 2011; Alberts *et al.,* 2021). The pyramid shows the conceptualisation of the six ToC evaluation components and provides key questions emanating from these components relating to the AQMP development and implementation as shown in Figure 3-3 below. These key questions were then used as a basis that guided the development of a ToC map, a related causal narrative, and the identification of critical assumptions.

In addition, based on the manner in which AQMPs should achieve their aims in South Africa as set out in NEM:AQA, this study focuses on the design, implementation, outcome, and impact evaluation types described in Table 3-1 as prescribed in the NPEF. This is because of their relevancy and applicability towards the evaluation of AQMP development and the implementation process.

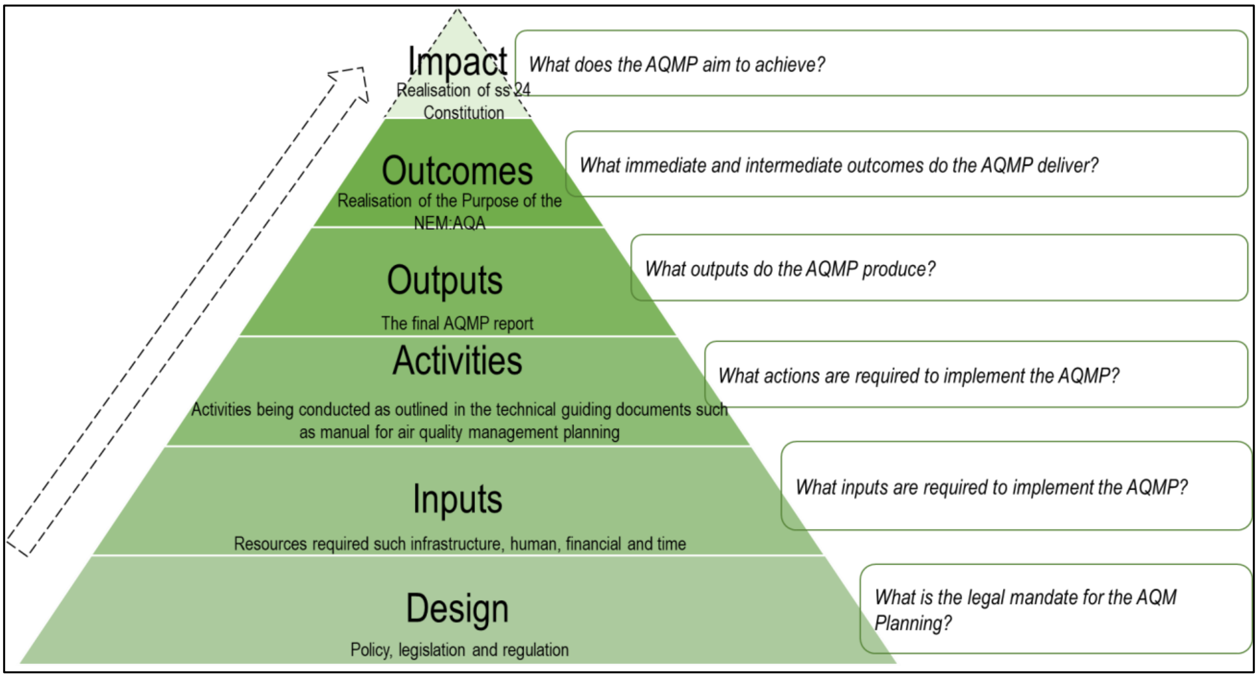

Figure 3-3 ToC results-based pyramid for the AQMP development and implementation (adapted from the DPME, 2011, 2019; Alberts *et al.,* 2021)

The nature of any research problem must determine the methodology the researcher adopts (Levy, 2006). The section below outlines the methodology used to collect and analyse data.

3.7 Methods

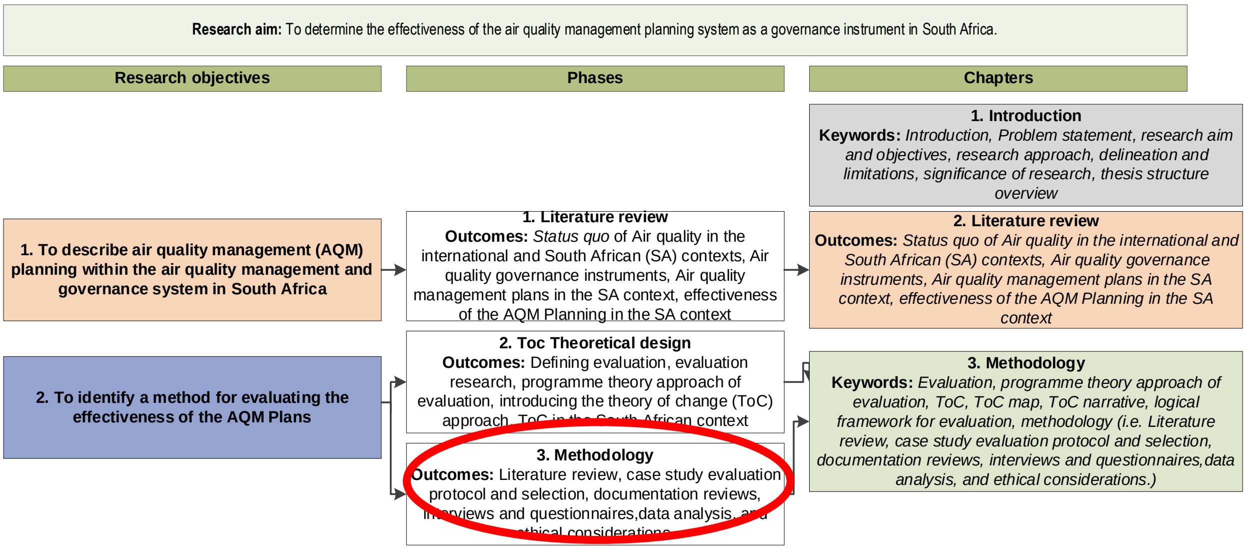

Figure 3-4 Thesis structure showing Phase 3 and Chapter 3

Like any other ToC's developed in literature, the development of a ToC for AQMP development and implementation would require developers and stakeholders to work together to clearly define the programme as a sequence of inputs, activities and outputs that lead to the desired outcomes and effects (Morra Imas & Rist, 2009; Weiss, 1995). In addition, developing a ToC requires stakeholders to identify their key assumptions to explain the change process they have mapped out as discussed (Anderson, 2005). This study went through the ethics approval process prior to any interaction any with stakeholder as discussed in section 3.10 below.

Research objective 3 of this study is to develop performance evaluation criteria against which the effectiveness of AQMPs can be evaluated. This study followed a method similar to that of Alberts *et al.* (2019) and Moolman *et al.* (2022) and adapted it to the AQMP development and implementation system in South Africa. This section describes the seven steps followed to develop the ToC map, ToC narrative and ToC logical framework for AQMPs as further discussed in Chapter 4. The steps are as follows (see Table 3-2):

- **Step 1:** South African Specialist Workshop: The very first ToC conceptual map (see Figure 4-2) and key assumptions were developed in a workshop with five internal specialists at the North-West University (NWU) who are well-established in the application of ToC methodology to various sectors of environmental management. The initial conceptual ToC map was developed by brainstorming how the AQMP development and implementation process works as required by the legal framework of South Africa. Each step of the AQMP process was critically analysed, broken down and aligned with the six components of the ToC approach (i.e., design, inputs, activities, output, outcome and impact). Once the map had been agreed upon, the key underlying assumptions were identified for each of the six components. The AQMP ToC map and key assumptions were identified and developed by brainstorming based on the specialists' understanding of the South African air quality management and overall environmental legal framework. These participants were expert researchers and consultants in the application of ToC approach and other methodologies to policy evaluations in different disciplines of environmental sciences and management, including EIAs, environmental auditing, water quality, and waste management. Together they had a combined experience of more than 50 years in the field of environmental management and sciences (Alberts, 2020; Alberts *et al.,* 2019; Alberts *et al.,* 2021; Moolman *et al.,* 2022; Retief 2008; Retief *et al.,* 2022).

- **Step 2:** Academics, consultants and industry practitioners' workshop: Following the internal specialist workshop, three separate workshops were held during which the conceptual ToC map and the key assumptions were presented to different consultants and practitioners, including scientists, researchers, and practitioners in the industry (consulting firms, state owned entities, mining, etc.) as shown in detail in Appendix 1. The following workshops were held: (1) Academics workshop with two senior lectures from well recognised institutions in South Africa, (2) Specialist/consultant workshop with five senior environmental consultants from private consulting firms, (3) Industry workshop with five environmental practitioners/officers from well recognised organisations. The attendees were asked questions from the pyramid and were also asked whether they agreed with the assumptions presented to them and if they had anything to add. These participants were selected based on their knowledge, experience and/or involvement in some part of AQMP development and/or the implementation process, either from a research, consultation, or monitoring and compliance point of view. The comments and additional assumptions from these workshops were then used to further refine the ToC map and assumptions. Some of the comments and assumptions raised in these workshops included issues related to the implementation of the AQMPs.
- **Step 3:** Regulator workshop: Following the consultants' and practitioners' workshops, the ToC map and assumptions were presented to regulators represented by 11 government officials for refinement and to obtain a regulator's inputs. Representatives from various spheres of government were invited, including national, provincial and local departments and municipalities (including DFFE, GDARD, City of Johannesburg; Gauteng provincial government, Knysna local municipality, LEDET). Each of these officials had experience in the development and/or implementation of an AQMP as a regulator and many of the

comments and assumptions raised in the workshop included concerns about the transparency of the AQMP legal framework and issues related to development and implementation.

- **Step 4:** General stakeholder discussions: These engagements were conducted following the input from the previous workshops. Participants in these discussions included three members of non-profit organisations (i.e., Vaal Environmental Justice Group (VEJA) and Vukani Environmental Justice Movement in Action). These organisations are active and influential environmental justice organisations in the VATAPA and HPA, which are among the air quality priority areas in South Africa.
- **Step 5:** International specialist input: To ensure a broader perspective on the history of air quality legislation in South Africa and from a global point of view, a meeting was held with an ex-government official who had been involved in the initial development of air quality legislation and guidelines in South Africa and is now based abroad. He provided some background on the development of NEM:AQA. This provided valuable context for fine-tuning the design component of the ToC as it relates to the manner in which the South African air quality legislation is structured and its intent for AQMP development and implementation.
- **Step 6:** The National Association for Clean Air (NACA) Conference. The ToC assumptions and the map were submitted as a paper and presented at the NACA conference on 6–9 October 2021. Several comments and questions were used to further refine the ToC map and assumptions. The paper was also accepted and formed part of the conference papers published online (Mukwevho & Burger, 2021).
- **Step 7:** UK Air quality professional perspective. In October 2022 a meeting was held with air quality official from the Newcastle-under-Lyme Borough Council to discuss the assumptions and to get a UK perspective on the effectiveness of a UK's air quality action plans.

On completion of the above seven steps, the following were developed and identified: a ToC map and 15 key assumptions underpinning the AQMP development and implementation (see Chapter 4). It is important to mention that more than 15 assumptions were raised during discussions at the various workshops. The notes were coded by the researcher and sorted into 15 key assumptions based on their similarities and meaning. Although these are not the only assumptions that underpin the AQMP development and implementation process, the researcher through the outcomes of the workshops is confident that the 15 key assumptions are the most important ones that could determine the effectiveness of this process. This process is reached a saturation point where no other new information was arising from the discussions and therefore the subjectivity was eliminated.

Table 3-2 Workshops conducted with various stakeholders between June 2021 and October 2022.

Workshops	Workshop type and purpose	Stakeholders	Organisation
Step 1	South African specialist workshop	5x NWU academic staff members	North-West University
Step 2.1	Academia workshops	2x senior lecturers	1x University of Cape Town; 1x University of Johannesburg
Step 2.2	Specialist/consultant workshops	5x senior consultants	3x Airshed Planning Professionals (Pty) Ltd; 1x Davhana Geotech Solutions (Pty) Ltd); 1x Xilalelo Project Managers
Step 2.3	Industry workshops	5 x industry environmental practitioners/officers	Eskom Holdings SOC Ltd; Anglo American Platinum
Step 3	Regulator workshops	11x government officials	DFFE; GDARD; City of Johannesburg; Gauteng provincial government; Knysna local municipality; LEDET
Step 4	NPO discussions	(Vaal Environmental Justice Group (VEJA); members and Vukani Environmental Justice Movement in Action	VEJA and Vukani Environmental Justice Movement in Action
Step 5	International specialist inputs: Broader perspective on the history of air quality legislation in South Africa and global point of view.	Ex-government official now based abroad	None

Workshops	Workshop type and purpose	Stakeholders	Organisation
Step 6	NACA conference presentation: 06 October 2021	Over 100 participants	Academia, government officials, industry etc.
Step 7	UK perspectives on the assumption and effectiveness of air quality policy instruments like air quality action plan, with specific reference to UK's air quality action plans	An official in the Environmental Health – Newcastle-under-Lyme Borough Council	Newcastle-under-Lyme Borough Council

3.8 Data collection methods

Connell and Kubisch (1998) argue that ToC is not an evaluation method of its own, but rather relies on other qualitative and quantitative methodologies for data collection and analysis. Using the developed ToC framework, a qualitative mixed method was used to evaluate the effectiveness of the selected air quality management plans in South Africa, including a literature review, case study evaluations, interviews and questionnaires. According to Jones *et al*. (2012), the ToC components should be specific, measurable, attainable, relevant and time bound (SMART). The qualitative methods described below were used to evaluate whether the components of the developed ToC are SMART and based on the assumptions, evaluation questions and KIPs developed from the logical framework.

Several AQMP case studies were identified and selected using the purposive sampling method (discussed in sections below), with relevant supporting information from the relevant authorities and the SAAQIS database and other websites. Once all the case studies and supporting documentation had been collected, a mixed method (i.e., documentation review and evaluations, questionnaires and interviews) was used based on the logical framework of evaluation for further data collection and analysis. Case study evaluation, literature review, documentation evaluation, questionnaires and interview processes are discussed in detail in the sections below.

3.8.1 Literature review

A literature review is an evidence-based in-depth search and analysis of a specific subject or topic (Winchester & Salji, 2016). It is a great way to generate research findings to provide evidence at a higher level and to identify gaps for which further research is required. As such it creates an important platform for building conceptual models (Snyder, 2019). Winchester & Salji (2016) state that a literature review must be informative, with a personal objective summary of information that gives a consistent view that incorporates different findings, including established and current knowledge. As a research method, a literature review should logically summarise the findings from previous research on a topic and reach a conclusion on how accurate and complete that knowledge is (Knopf, 2006).

In this study, a literature review offers a synthesis of concepts from existing studies as a detailed introductory background to the study topic to address research objectives. One of the objectives of the study is to describe and conceptualise air quality management planning instruments in South Africa (research objective 1). A literature review as a research method is more relevant than ever to address this specific research objective. Furthermore, Snyder (2019) argues that a literature review can also give an overview of areas in which the research is distinct and interdisciplinary, and this was found to be the case in this study where different approaches and instruments relating to the management of air quality in South Africa were identified and conceptualised in Chapter 2. Furthermore, research objective 3, which is to identify a method for evaluating the effectiveness of the AQMPs, also largely relied on a literature review as a methodology to describe the research design of the study.

3.8.2 Case study evaluation protocol

As discussed earlier, empirical evaluative studies focused on evaluating the appropriateness of an intervention and on asking whether the outputs and outcomes of interventions are justified by their inputs and processes (Keen & Packwood, 1995). Such interventions usually raise complex questions that must be addressed in complex situations, and case study evaluations are valuable in such instances (Keen & Packwood, 1995). Case study research enables the exploration and understanding of a complex issue. The value of case study approach is determined by the nature and complexity of the intervention being evaluated (Keen & Packwood, 1995; Zainal, 2007). The development of a case study review protocol is helpful in all circumstances, but essential for multiple case study evaluations (Yin, 2018). The protocol provides the methodologies, processes and general rules needed for data gathering and the analysis further provides the basis for the validity and reliability of eventual results (Yin, 2018).

Furthermore, there is no single method effective enough to address all the key aspects of an intervention. Case studies usually use several quantitative and qualitative methods, depending on the complexity of the intervention (Keen & Packwood, 1995). Case study research allows the researcher to gather more data beyond quantitative statistical results, which can bring a greater understanding of matters such as the behavioural aspects and perspectives of role players (Zainal, 2007). The key aspect of case study research is the use of multiple methods to obtain valid results. Using both quantitative and qualitative data in case study research enables both the process and outcome of an intervention to be analysed by complete observation, reconstruction and analysis of the case studies being evaluated (Tellis, 1997). However, Keen and Packwood (1995) argue that qualitative methods are more valuable than quantitative methods in case studies where an intervention is being analysed in detail for its success or failure, where the general context will affect the outcome, or where researchers asking the questions will have no control over events.

In this study, an AQMP quality review package developed by Moreone *et al.* (2021) was adapted for the evaluation of selected case studies. This adapted review package specifically evaluated the completeness and quality of the selected AQMP reports that form part of the implementation evaluation. KPIs 4.1 to 4.20 shown in the logical framework (Table 4-1) were used to evaluate this aspect in the selected case studies. This review package enabled this study to test whether the selected case studies conformed or not to the relevant procedural requirements stipulated in the legislation (i.e., NEM:AQA), the NFAQM, as well as the substance quality requirements stipulated in the Manual during the development of the plans.

3.8.3 Case study selection

Case study research often faces criticism in that it lacks robustness as a research method, so prior to selecting case studies to be investigated, it is important to master the design of the case studies for evaluation (Zainal, 2007). According to Yin (2018), there are two types of case study designs, namely single and multiple case studies. The choice between a single-case and multiple-case design all depends on the issue in question (Zainal, 2007). A multiple-case design can be selected in situations with multiple sources of evidence through replication rather than sampling logic (Zainal, 2007). A multiple-case study design was adopted in this study since the research aimed to evaluate the effectiveness of air quality management plans across the different regions and spheres of the South African government as shown in Table 3-3 below (i.e., provincial, district and metropolitan and local municipalities, as well as priority areas AQMPs). In addition, the study also evaluated the different system components of air quality management planning such as inputs, activities, outputs and outcomes (i.e., specific embedded components), and for this reason a multiple embedded case study design was adopted.

Since NEM:AQA requires air quality management plans to be developed at different levels and spheres of government, the selection of case studies to be evaluated in this study was done to ensure that the research covers all the government spheres of the entire AQMP development and implementation in South Africa. For this reason, this evaluation covered the AQMPs from the following spheres of government to get a full picture of air quality management planning in South Africa:

- Priority area AQMP (WBPA)
- Provincial AQMPs
- District municipalities AQMPs
- Metropolitan municipality AQMPs
- Local municipality AQMPs

It is often difficult to determine how many case studies one should select for evaluation to get a fair representation. Flyvbjerg (2006) distinguishes between two strategies of selecting samples or cases (i.e., random selection and information-oriented selection). Random selection (further subdivided into random and stratified samples) is conducted to avoid systematic biases in sample selection in which the sample's size is decisive for generalisation. However, Flyvbjerg (2006) also argues that selecting case studies based on random sampling or representative sampling may not be an appropriate strategy when the objective is to obtain the greatest amount of information on a specific programme. This is because the typical or average case often does not contain sufficient information. Extreme cases, on the other hand, often reveal more information because they expose various role players and different perspectives on the situation studied (Flyvbjerg, 2006).

To evaluate AQMPs in South Africa, this study adopted the information-oriented selection strategy to maximise the use of information from small samples. The selection of cases was based on the expectations about their information content. The information-oriented selection strategy is further divided into four subcategories, one being the selection of "maximum variation cases". This was adopted in this study to gather information about "the significance of various circumstances for case process and outcome (e.g., three to four cases that are very different on one dimension: size, form of organisation, location, budget)" (Flyvbjerg, 2006, pp. 230). Eisenhardt (1989) argues that there is no absolute number in case selection and therefore a number between four and ten case studies usually meet the purpose. However, it is often challenging to develop complex theory with fewer than four cases, and empirical justification is likely to be subjected to criticism. On the other hand, it easily becomes challenging to manage a greater volume of data if it becomes ten cases or more (Eisenhardt, 1989).

In this study, two case studies were selected for each sphere of government (provincial, district/local, metropolitan, and local municipality). As for the priority area AQMPs, only three declared priority areas existed at the time of the evaluation, and therefore one case study (i.e., Waterberg-Bojanala) was sampled. The reason for selecting one priority area for evaluation is that the HPA AQMP did not meet this study's selection criteria in that it was not developed in accordance with the Manual and a similar study on quality evaluation has been done for the VTAPA AQMP. A total number of nine cases were selected for evaluation, which is in line with the reasoning of Eisenhardt (1989). Information on these cases was obtained from relevant government departments, municipalities, environmental authorities, AQOs and websites. The number of the cases sampled for evaluation across all the government spheres was purposively based on strict adherence to the following criteria:

- The air quality management planning process should have been in accordance with sections 15 and 16 of the Air Quality Act of 2004.
- The planning must have been informed or done in accordance with the *Manual for Air Quality Management Planning* in South Africa as developed by the DEA.
- The AQMP had to have been completed and implemented.
- All the supporting documentation on the case had to be available (e.g., baseline assessment, implementation plans, etc.).
- All the required documentation had to be accessible for evaluation.

The study aimed as far as possible to select case studies from across government spheres to get a well-represented national profile of case studies. The next section describes the other data-gathering methods for the case study evaluations, namely document evaluation, semi-structured interviews and questionnaires.

Table 3-3 Total number of case studies collected across all the government spheres

AQMP collections				
Provincial	**Metros**	**District**	**Local**	**Priority Areas**
2	2	2	2	1
Gauteng (GP)	City of Johannesburg (CoJ)			
Western Cape		West-Coast District Municipality (WCDM)	Langeberg Municipality (LLM)	
Limpopo (LP)				Waterberg-Bojanala Priority Area (WBPA)
North-West				
Mpumalanga			Steve Tshwete Local Municipality (STLM)	
Eastern Cape	Buffalo City (BCMM)			
Northern Cape		John Taolo Gaetsewe District Municipality (JTGDM)		

3.8.4 Document review

Bowen (2009) describes document analysis/review as a structured way of reviewing or evaluating printed or electronic documents. Document analysis requires data to be analysed and interpreted to construct meaningful concepts, develop understanding, and expand empirical knowledge (Corbin & Strauss, 2008).

Document evaluation in this research forms an integral part of data analysis, particularly in reviewing some of the ToC components (i.e., inputs, activity, outputs, and outcome components). For this reason, document availability was one of the key criteria used in selecting case studies. Furthermore, the documentation evaluated in this study varied from AQMP reports, baseline assessment reports, to implementation plans and more, depending on the way the AQMP development and implementation for each selected case study had been undertaken.

In addition, documentation evaluation in this study followed that of Alberts (2020), where key performance indicators are developed for the evaluation of selected case studies. This was done on the documentation evaluation sheet (see Annex B), which also includes a comments section for the justification of the selected score. The following criteria were adapted from Alberts (2020) for scoring the documents:

- A = conformance – meaning the fulfilment of a KPI;
- B = partly conformed – fulfilment of a KPI but not completely;
- NC = non-conformance – non-fulfilment of a KPI;
- NA = not applicable to the scope.
- NE = Not Evaluated

Alberts (2020) argues that although these criteria may not outline specified quantifiable parameters or thresholds with limits, they do achieve the objective because in the end, the overall performance was purely based on an informed qualitative judgment to tell a story against the ToC inner logic. Furthermore, the test of whether all the identified underlying assumptions conformed, partially conformed, or did not conform, was based on the assumption that conformance to more key performance indicators implies better performance.

In addition, there is no specific legal requirement or guidelines outlining skills and competencies requirements of consultants/specialists and officials in South Africa for developing and implementing AQMPs. As a result, this study adopted the training needs outcomes identified by Engelbrecht and Van der Walt (2007) to evaluate the skills and competencies of the air quality officials of the selected case studies. The training needs were identified in an earlier study 16 years ago as the skills that were lacking among AQOs in South Africa (Engelbrecht & Van der

Walt, 2007). The following skills were identified as gaps: legislative framework, air pollution and its characteristics, engineering control, atmospheric chemistry, air pollution meteorology, air pollution risk assessment, air quality management principles, air pollution modelling, air pollution monitoring, identification and emission quantification, and air quality management planning. This study therefore also evaluated whether there have been any improvements to date on the skills and competencies of AQOs against the same training needs identified by Engelbrecht and Van der Walt (2007).

Furthermore, this study adopted the South African Council for Natural Scientific Professions' (SACNASP) requirements for the evaluation of consultants/specialists. The South African Council for Natural Scientific Professions is a regulatory body in terms of the Natural Scientific Professions Act, 27 of 2003, which requires natural scientists to be registered to practice in one or more of the various fields of practice. Its main purpose is to ensure a high level of ethical practice and professionalism among natural scientists in South Africa. The skills and competencies of the consultants/specialist involved in the development of the selected case studies were then evaluated using documentation reviews and an internet search of the relevant individuals to check if they conformed to the SACNASP requirements listed as KPIs 2.1–2.3 in Table 4-1 of the logical framework. The following requirements for registration with SACNASP were used as part of the evaluation in this study:

- A recognised four-year Bachelor of Science degree; Bachelor of Science (Hons); or Postgraduate Diploma; or equivalent qualification at NQF level 8 and three years appropriate work experience in the field of practice applied for; or
- A recognised Master's of Science; Master's of Technology; Master's of Agricultural Science; Master's of Applied Sciences; or equivalent qualification at NQF level 9 and two years of appropriate work experience in the field of practice applied for; or
- A recognised doctoral qualification at NQF Level 10 and one year of appropriate work experience in the field of practice applied for; or
- Ten years natural science experience in the field of practice without any formal qualification, but with recognition of prior learning (RPL).

3.8.5 Interviews and questionnaires

Questionnaires and interviews are mostly used together in mixed-method studies (Harris & Brown, 2010). Questionnaires can be used to identify patterns from bigger sample populations, while qualitative interviews bring a rigorous understanding of participant attitudes, reasoning, and actions (Kendall, 2008). The main advantage of mixed-method research is that data obtained using various methods can supplement each other and thus improve the quality of individual methods (Harris & Brown, 2010). Pairing structured interviews with structured questionnaires can also improve the methodological reliability (Antaki & Rapley, 1996).

This study suggests that in the absence of comprehensive scientifically measured air quality data for all the selected case studies, the perspectives of various stakeholders can be a useful source of information towards understanding the AQMP effectiveness in South Africa. Stakeholder perspectives may bring insights into the real issues faced in the development and implementation of these plans and provide the best response measures to pollution challenges based on policy design and implementation (Okumar & Yebooh, 2020). Like Okumar and Yebooh (2020), this study acknowledges that although these perspectives are not a representation of the whole population, they do provide insight into whether AQMPs as a policy instrument are supported as well measures that can be taken towards change. Interviews and questionnaires were important to this study since they offer an effective method to collect data for some of the ToC components such as design, outcomes and impacts. Furthermore, this study adopted the content analysis methodology for analysing data from interviews and questionnaires. This is discussed later in the data analysis section.

3.8.5.1 Interviews

In many instances, qualitative data are collected through both interviews and questionnaires, with interviews being the most effective method to bring narrative data that allow researchers to investigate people's views in greater depth (Kvale, 1994; Alshenqeeti, 2014). Interviewing is defined as a systematic way of talking and listening to people, enabling researchers not only to analyse words and gather detailed views of informants, but also allowing interviewees to express their thoughts and feelings (De la Croix *et al*., 2018; Lune & Berg, 2017). Meyers and Newman (2007) note that there are many types of qualitative interviews, including structured interviews, unstructured or semi-structured interviews, and group interviews. For structured interviews, a complete script is prepared in advance and followed, not allowing for improvisation or follow-up questions. Such interviews are usually used in situations where the interviews are not done by the researcher. Unstructured or semi-structured interviews consist of an incomplete script. The researcher may prepare some questions beforehand but allows some flexibility of improvisation. The interviewer is the researcher or part of the team. In group interviews, two or more people are interviewed at the same time by one or more interviewers, and this type of interview can be structured or unstructured.

In addition to document reviews, this study conducted open-ended semi-structured interviews (see Annex C) with eight of the nine air quality officials (excluding the Steve Tshwete AQMP) as a supplement and verification to document review. The interviews using Annex C with the eight

AQOs were conducted strictly to verify some of the gaps that could not be addressed from document reviews. The researcher made use of Zoom and MS Teams and interviews were recorded. The interview questions were based on the evaluation questions and KPIs generated from the ToC logical framework (see Table 4-1 and Annex B). The interviews were conducted anonymously to promote the participation among the interviewees and to encourage honest responses to the questions posed (Saunders *et al*., 2015).

3.8.5.2 Questionnaires

A questionnaire is a document consisting of questions and other information developed to collect information that is suitable for analysis. It is mostly used in survey research, experiments and other types of observations (Acharya, 2010; Babbie, 1992). Questionnaires are very important in qualitative studies and are easy to administer for data collection. According to Acharya (2010) there are two kinds of questionnaires: structured and unstructured. Structured questionnaires include a pre-coded sequence of questions based on a defined pattern. They usually have fewer discrepancies, are easy to administer and provide consistency in data collection and management (Acharya, 2010). Unstructured questionnaires consist of open-ended and opinion-type questions. They may not be interrogative questions and usually require a reviewer to interpret and make sense of the responses (Acharya, 2010). Although questionnaires are sometimes seen as more objective and capable of yielding sensible information, there are also many factors that can affect the results. These include faulty questionnaire design; errors in sampling and poor response rates; biased questionnaire design and wording; respondent unreliability; ignorance; misunderstanding; errors in coding, processing, and statistical analysis; and faulty interpretation of results (Oppenheim, 1992).

In this study, additional data were collected using the questionnaire in Annex D to determine the skills and competencies of the air quality officers in the input component of the ToC. This questionnaire was sent to the relevant air quality official responsible for implementing the selected case studies' AQMPs. This study acknowledges that there is no specific legislated regulatory body or programme in South Africa that provides a standardised minimum set of requirements for consultants or government officials for their involvement in the development and implementation of AQMPs. For this reason, this study adopted the "training needs outcomes" protocol identified by Engelbrecht and Van der Walt (2007), outlining the key technical skills air quality officers need to close the gap between existing knowledge and expected skill (also see Annex D). This "training needs outcomes" protocol was sent out as a questionnaire to the responsible air quality officers (AQO) of the nine selected case studies.

Regarding the design, outcomes and impacts components of the ToC, structured and unstructured questionnaire were also used to collect qualitative data. An initial open-ended questionnaire was sent out between August and November 2021 using email, to which less than 10 responses were received. A second revised questionnaire that included a basic Likert-type scale and comment box was sent out between August and October 2022 using email as well Google Forms platforms (see Annex E). A total of 42 responses were received from different stakeholder groups. The questionnaire contained ten questions on KPIs 1.1 and 1.2 for the design component, KPIs 5.2, 5.3, 5.4 for the outcomes component and KPI 6.1 for the impact component (see annex E). Four categories of participants were identified, and the recipients were selected based on the following:

- Government officials/responsible authority i.e., those who have experience in the developing and implementing at least one AQMP.
- Consultants/specialists i.e., those responsible for developing the AQMP. In most cases, external consultants have conducted an AQMP.
- Industry i.e., those whose who form part of the MSRG/ITT groups who have been involved in the development and implementation process of an AQMP.
- Public/civil society/NGOs i.e., those whose who form part of the MSRG/ITT groups and were involved in the development and implementation process of at least one AQMP.

3.9 Data analysis

For the case study evaluation, the data were analysed and discussed according to the four main categories as outlined in section 3.8.4 above: (A = conformance – meaning fulfilment of a KPI; B = partly conformed – fulfilment of a KPI but not completely; NC = Non-conformance – non-fulfilment of a KPI; NA = not applicable to the scope) (Alberts, 2020). The data showing the performance areas of each case study were recorded on a meta-matrix spreadsheet in Annex F. In the meta-matrix spreadsheet, both the individual and cross-case study analyses were done. The individual case study analysis was done to determine how each case study performed against the KPIs and cross case study analysis was done to determine how the AQMPs at different spheres of government performed. The scores for each category were colour coded to provide a clear understanding of the outcomes to identify areas of good, partial or non-conformance i.e., A = green, B = amber, NC = red, and NA = grey (see Annex E). Furthermore, there was no formal methodology applied in the interpretation of the data from the verification interviews conducted with the eight AQO as the responses were use to verify whether the case studies conformed (in accordance to the above-mentioned categories) to the relevant KPI.

According to Sgier (2012), there are two main categories of basic qualitative data analysis methods. One of these is content-based analysis, which uses thematic analysis and interpretive analysis such as discourse analysis. Content analysis is a method to make reasonable deductions that can be replicated from data or information into their context of use (Krippendorff, 1989). This technique is used to determine and record the attitudes, views, perceptions, and the interests of stakeholders either as individuals or in groups (Drisko & Maschi, 2016). Content analysis examines what the data says, followed by arranging the outcome information into themes, categories, or codes emanating from the key questions posed by the research (Bowen, 2009; Sgier, 2012). Furthermore, there are three approaches to content analysis, which are conventional, directed, or summative, and all these approaches are applied by analysing logic or meaning from data content (Hsieh & Shannon, 2005). Conventional content analysis is mostly applied in a study design aiming to describe a phenomenon by analysing or observing the emotional reactions of respondents. Such a design is often applicable when there is limited existing research literature on a phenomenon (Fox *et al*., 2015; Hsieh & Shannon, 2005).

Due to the limitation of existing literature relating to AQMPs in South Africa, this study followed the conventional content analysis technique in analysing the response data collected from stakeholders for KPIs in the design, outcomes and impact components of the ToC framework. The method was adopted because the key focus was to understand the perspectives of stakeholders on the effectiveness of AQMP development and implementation in South Africa.

In this analysis, ten KPIs emanating from the ToC map and the assumptions were categorised from A to J. The comments and responses from questionnaires and interviews were then further categorised into themes within each category or KPI (Fox *et al*., 2015; RIISKJÆR *et al.,* 2012). A total of 42 respondents participated across the four stakeholder groups, i.e., officials (n=11), consultants (n=11), industry (n=10), and civil society (n=10). The researcher first thoroughly scrutinised all the comments in an attempt to get a general feel for the content of each response. This was followed by developing themes for each of the identified meanings, after which a working definition for each theme was given. This was done to provide a more accurate interpretation of each specific meaning relative to other categories (Fox *et al*., 2015).

In addition, interviews and questionnaire data obtained from stakeholders was integrated during the interpretation of the results. The reason for this was to provide a comprehensive and nuanced understanding of the research topic. This integration allows researchers to gather rich data from multiple perspectives, enhancing the depth and validity of their findings. Furthermore, integrating interviews and questionnaires allows for triangulation, which involves the use of multiple data sources to validate and corroborate findings. By comparing and contrasting data from interviews and questionnaires, researchers can establish greater confidence in the accuracy and reliability of their results. Interviews offered in-depth exploration of participants thoughts, experiences, and emotions, allowing researchers to capture detailed and nuanced information. Questionnaires, on the other hand, provide a broader view by reaching a larger sample, allowing researcher to identify trends, patterns, common themes and commonalities across a wider population.

3.10 Ethics considerations

Following the research ethics guidelines established by North-West University (NWU) in 2018, research endeavours must adhere to fundamental principles and be consistently upheld by the responsible researcher. Additionally, ethical deliberation is imperative and should be clearly outlined throughout the course of the research activities. The Scientific Committee of the Environmental Management Research Group (EMRG) within the Unit for Environmental Sciences and Management evaluated the research proposal for this study. In addition, the ethics approval process of the North-West University's Faculty of Natural and Agricultural Sciences Ethics Committee (ethics number: NWU-0620-20-A9) has categorised the nature of this research as minimal risk to animals or human participants.

3.11 Chapter summary

This chapter addressed Objectives 2 and 3 of this study in two phases (Phase 2 and 3). Objective 2 was dealt with in Phase 2, which introduced the research design. During this phase, the chapter discussed evaluation, evaluation research, effectiveness in evaluation research, programme theory approach of evaluation, introducing the theory of change (ToC), and the ToC justification in the South African context. Objective 3 was addressed in Phases 2 and 3, where Phase 2 describes the ToC methodological approach in which the outcomes are the methodological design of the ToC, the ToC map, ToC narrative, logical framework for evaluation, and the type of evaluation to be conducted. Phase 3 then dealt with methods applied in data collection and analysis, of which the outcomes are literature review, case study evaluation protocol, interview and questionnaire process as well as the ethics considerations.

CHAPTER 4: THE THEORY OF CHANGE FRAMEWORK

4.1 Introduction

This chapter provides the ToC framework pertaining to the AQMP development and implementation process. The framework provides a thoroughly explored view of the AQMP process in South Africa, from its development phase to implementation until it achieves its intended outcomes. It unpacks the causal links between the design, inputs, activities, output, outcome and impact evaluation components from the results-based pyramid (Alberts, 2020).

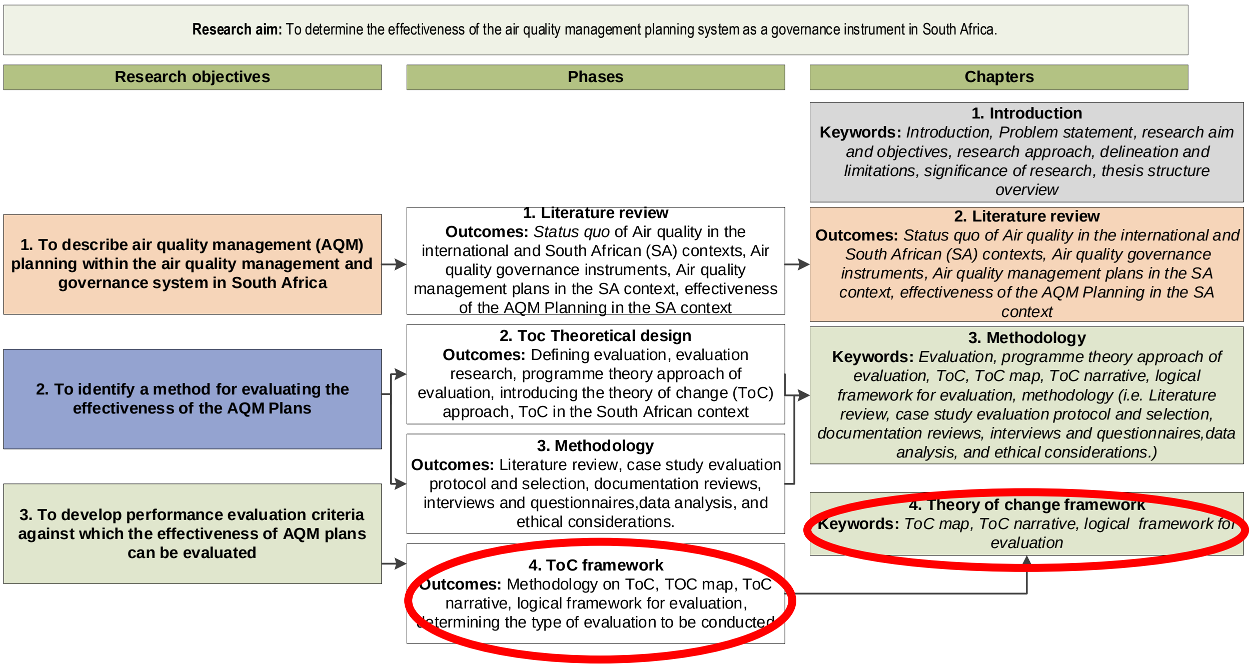

Figure 4-1 ToC structure shows that Objective 3 is addressed in Chapter 4 Phase 3.

4.2 Theory of change (ToC) map

A ToC can be explained using different methods, such as plain narrative description, causal loop diagrams, logic models and results chains (Senge, 1990; Knowlton & Phillips, 2012). This section provides and describes the ToC map (Figure 4-2) developed in this research as part of the workshops with various stakeholders as further informed by the literature review conducted. The initial design of the ToC map was based on experts' understanding of the AQMP development and implementation process in South Africa. The map explores the causal links between the six components of the ToC approach (i.e., design, input, activities, output, outcomes and impact) and each component is discussed in the narrative in Section 4-5. Figure 4-2 shows that there are six components that are linked as shown by the black dotted arrows. The red dotted circles indicate the 15 key assumptions relating to the AQMP development and implementation process in South Africa.

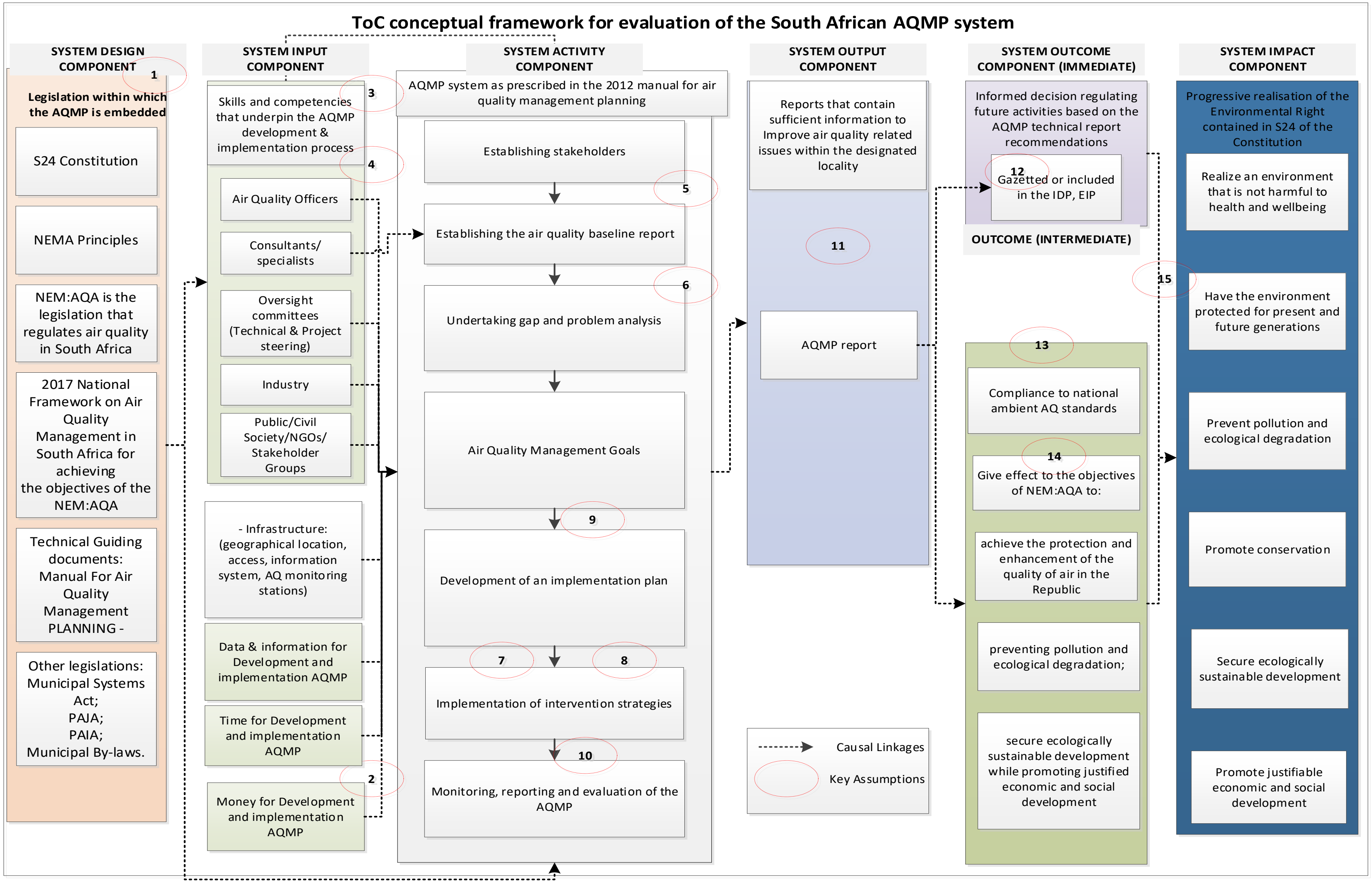

Figure 4-2 ToC map for AQMP development and implementation in South Africa

4.3 Theory of change narrative

According to Connell and Kubisch 1998, a key aspect in building a valid ToC model to evaluate any programme is the clear description of the narratives and other evidence to assist those involved in the thought process to easily connect between the different components of the ToC map. A ToC narrative provides a framework based on which to tell the story of the programme as it is implemented to reflect on what it is achieving and how that relates to the assumptions and rationale guiding its design (Mason & Barnes, 2007). The ToC narrative and ongoing approach to the development of ToCs allow us to identify issues for further clarification over time or through further data collection.

The ToC narrative gives a description of the six stages or components of the ToC map. These components are: design; input; activity; output; outcome and impact. The outcome component is further divided into immediate and intermediate sections.

The ToC narrative described in this section relates to the AQMP development and implementation process in South Africa and should be generally clear and understood by different stakeholders working in any field. In the end, the ToC narrative, map and evaluation framework must provide an inner logic on how an AQMP as a policy instrument works or is supposed to work in South Africa. Following the identification of assumptions, evaluation questions and KPIs were generated for each assumption. These are discussed in Section 4.6.

4.3.1 AQMP design component

This component describes the relevant pieces of the law that inform the design, development and implementation of the AQMP in South Africa. In this case, the legal and other requirements that inform the AQMP start from section 24 of the Constitution, which then translates into the NEMA framework legislation. After the NEMA as the framework legislation comes the air quality sector-specific legislation known as the NEM:QA as discussed in Chapter 2. The NFAQM is the next document that is regarded as the national AQMP for South Africa. Other related key pieces of legislation and regulations that are directly or indirectly linked with the management of air quality in South Africa are the next tier after the NFAQM. Furthermore, the design component also comprises technical guidance documents for the development and implementation of the AQMPs, such as the *Manual for Air Quality Management Planning,* which is referred to as the Manual in this study.

4.3.1.1 The Constitution

Section 24 of the Constitution of the Republic of South Africa provides that the government must use legislative and other means to ensure the human right to the progressive realisation of an environment that is not harmful to health and wellbeing. Air quality should be improved to progressively ensure that ambient air is not harmful to health and well-being by preventing pollution (including air pollution) and ecological degradation. Section 24(b) requires the enhancement of ambient air, which will enable an environment that is not harmful to the people of South Africa (Scorgie, 2012).

4.3.1.2 National Environmental Management Act, 107 of 1998 (NEMA)

NEMA is a framework legislation in South Africa. Its purpose is to provide for cooperative environmental governance and for principles for decision-making on environmental matters (DEA, 2018). Some of the key principles in this act that relate to air quality matters include the polluter pays principle, pollution prevention or minimisation, as well as the promotion of participation of all interested and affected parties in environmental governance. Furthermore, the NEMA regulations outline the EIA process, including the public participation that must be followed during the application atmospheric emissions licences for the listed activities in terms of NEM:AQA.

4.3.1.3 National Environmental Management: Air Quality, Act 39 of 2004 (NEM:AQA)

Air quality management plans are required in terms chapters 3 and 4 of NEM:AQA. As discussed in Chapter 2 of this thesis, NEM:AQA requires that each national department, province, and municipality must prepare an AQMP. This is the document that sets out what will be done to achieve the prescribed requirements of NEM:AQA and the air quality standard. The objectives of this act are:

a) *"To protect the environment by providing reasonable measures for–*

   (i) *the protection and enhancement of the quality of air in the Republic;*

   (ii) *the prevention of air pollution and ecological degradation; and*

   (iii) *securing ecologically sustainable development while promoting justifiable economic and social development; and*

b) *To give effect to section 24(b) of the Constitution in order to enhance the quality of ambient air for the sake of securing an environment that is not harmful to the health and well-being of people."*

4.3.1.4 National Framework for Air Quality Management in the Republic of South Africa (NFAQM)

In addition to the air quality management plans prescribed by NEM:AQA, a further detailed description of the development and implementation of AQMPs are outlined in the 2017 NFAQM in the Republic of South Africa, which was developed by then the Department of Environmental Affairs. The NFAQM is considered as the national air quality management plan for the republic and its mandate is to achieve the objectives of NEM:AQA by providing mechanisms, systems and procedures for the management of air quality in a holistic and integrated manner. This includes the provision of guiding norms and standards relating to all technical aspects of air quality management.

4.3.1.5 Technical guiding documents: Manual for air quality management planning

The NFAQM further provides that the development of AQMPs by the various spheres of government must be done in accordance with the process stipulated in the Manual published in 2008 and 2012. The manual for the AQMP development in South Africa was developed and published by then the Department of Environmental Affairs to provide guidance to all spheres of government to establish best practice guidelines on the definition of objectives, strategies, plans, and procedures to meet the requirements of the NEM:AQA on air quality management planning and reporting (DEA, 2012). The aim of the Manual is to improve and harmonise the quality of the AQMPs produced by various spheres of government. According to the Manual, there are six steps that should be followed in the development and implementation of the AQMP as shown in Figure 2-5 and the activity component of Figure 4-2.

4.3.1.6 Other legislations

There are several other pieces of legislation that directly or indirectly affect the implementation of the AQMPs and which are stipulated in detail in the NFAQM as shown in Annex A. Such legislations include the Local Government Municipal Systems Act, 32 of 2000, which requires that municipalities must incorporate their AQMPs into their integrated development plans (IDP). Other key legislation includes the Promotion of Access to Information Act, 2 of 2000, which relates to the regulation of access to information, including air quality information, although it has provisions for refusing access. There is also the Promotion of Administrative Justice Act, 3 of 2000 (effected by section 33 of the Constitution) which deals with formal interactions between government departments, the public and other stakeholders by informing due process in decision making (DEA, 2018). Local municipal by-laws also provide an additional layer of air quality governance at the local level as it is stipulated in section 13(a) of the Local Government: Municipal Systems Act, 32 of 2000.

Based on the above discussion, the design of the AQMP development and implementation process in South Africa is fundamentally prescribed by the legislation. This is also discussed as part of the CaC instruments in the literature review in Chapter 2. This legal mandate cascades starting from the Constitution, to NEMA as the framework legislation, to NEM:AQA as sector-specific legislation for air quality, to the NFAQM, which is also regarded at the national AQMP, to technical guiding documents guiding the development and implementation of AQMPs, to other pieces of legislation that directly or indirectly influence the AQMP development and implementation process.

4.3.1.7 Key assumptions and evaluation questions associated with the design component of AQMP

Assumption:

- The legislative framework provides guidance for AQMP development and its implementation.

Evaluation question related to the design component:

- To what extent does the legislation provide guidance for AQMP development and implementation?

4.3.2 Input component

The input component describes the resources required for the AQMP development and implementation process to be effectively executed (Alberts 2020; Alberts *et al.,* 2021; Bond *et al.,* 2013). In terms of the AQMP development and implementation process in South Africa, these inputs have been identified to be key resources that are required for the development and implementation of an efficient and effective AQMP. They include but are not limited to data, information, skills and competencies, time, money/budget, and infrastructure.

4.3.2.1 Skills and competencies

Engelbrecht and Van der Walt (2007) argue that the effective and efficient development and implementation of an AQMP requires competent technical officers. However, this study finds that, unlike in EIA and other environmental assessment tools, there is not yet a specific formalised regulatory body or legal requirement or guideline that addresses all the technical capacity requirements for AQMP development and implementation in South Africa. The evaluation of the skills and competencies of consultants/specialists in this study is done based on the relevant field of study, experience and relevant specialist registration. The criteria used for evaluation of skills and competencies of consultants/specialists in this study is therefore done based on the assumption that consultants should at least be registered with the South African Council for Natural Scientific Professions (SACNASP). The South African Council for Natural Scientific Professions is a legislated regulatory body in terms of the Natural Scientific Professions Act, 27 of 2003, which requires natural scientists to be registered to practice in one or more of various fields of practice. Registration with SACNASP is used as criterion to evaluate consultants/specialists in the specific field of study, the relevant experience and the applicable specialist registration. In terms of the SACNASP requirements, a recognised three-year qualification (diploma, Bachelor of Science degree, advanced diploma, or equivalent qualification) at NQF Level 7 with 50% of the required credits in natural sciences. The criteria are used to evaluate the skills and competencies of the consultants/specialists who developed the selected case studies. The SACNASP criteria further require at least one year of appropriate work experience (after completion date) in the relevant field of practice, and this is also used to evaluate the consultants/specialists with respect to appropriate experience.

Furthermore, to evaluate the skills and competencies of air quality officials (AQOs) involved in the AQMP development and implementation process, this study adopted “training needs outcomes”. These are the key competencies that AQOs in municipalities must have to manage AQMP matters effectively and efficiently as described by Engelbrecht and Van der Walt (2007). This “training needs outcomes” protocol was then translated into a questionnaire (see Annex D) to be sent out to relevant air officials of the nine sampled reports. Eleven key skills required for an effective AQMP implementation were outlined in the “training needs outcomes” protocol. These skills and competencies are: knowledge of legislative framework; air pollution and its characteristics; engineering control; atmospheric chemistry; air pollution meteorology; air pollution risk assessment; air quality management principles; air pollution modelling; air pollution monitoring; identification and emission quantification; and air quality management planning.

Moreover, the human and technical capacity required for the AQMP as stipulated in the NFAQM and the Manual are:

- The 2017 NFAQM stipulates that:

"…all spheres of government must ensure that the person designated is of the calibre and academic qualifications that will enable him/her to perform the duties of the AQO which include among others";

- Coordination of matters of air quality within his/her jurisdiction;
- Ensuring representation in meetings with other government officials, industry, NGOs, and other stakeholders;
- Providing input and making decisions on behalf of his/her department on air quality matters at various air quality fora;
- Work with environmental management inspectors on AQA matters;
- Input into the national atmospheric emissions inventory;
- Reporting on the state of air;
- Reporting on implementation of AQMP for the jurisdiction; etc.

It also provides for:

- Project steering committee (PSC) / a Priority Area Air Quality Officers Forum (AQOF).
- Specialists – qualified and experienced individuals in the related field.
- Public/civil society – broad public participation in the AQMP process is an important step that will lead to greater "buy-in" and promotes the public's involvement in the development of the AQMP.
- Consultants – the specialists undertake the development of baseline assessments to assess and evaluate the current air quality status of a study area. It assists in identifying the need for further studies and the necessity of performing an AQMP.
- Technical committee / advisory forum / a Priority Multi-Stakeholder Reference Group (MSRG) –
  - It should comprise competent internal and external government officials whose departments have air quality-related functions or concerns and could include expertise from the private sector. The committee should be able to contribute meaningfully in the development and implementation of the AQMP.
- **At national level** – technical committee or a National-Provincial Air Quality Officers Forum would comprise the representatives from national and provincial departments whose functions are air quality related or who have a legal mandate to perform such functions, and representatives from the National Environmental Advisory Forum (NEAF) sub-committee Pollution and Waste.
- **At provincial level** – the technical committee or a Provincial-Municipal Air Quality Officers Forum would comprise representatives from municipalities and national

departments whose functions are air quality related or who have a legal mandate to perform such functions.

- **At municipal level** – the AQO should consult with the department responsible for air quality within the municipal structure and outline the need to develop an AQMP. Consultation should take place with other spheres of government responsible for air quality in the area (provincial and national) or with a forum or technical committee that may already be in place. A brief review should be conducted of what structures or information are already in place.
- Air quality stakeholder groups – this should consist of stakeholders and interested and affected parties, including those affected by air pollution and those who may be affected by interventions aimed at reducing the impacts of air pollution, e.g., industry, business, labour non-governmental organisations (NGOs) and community-based organisations (CBOs). This group has to be consulted during the AQMP process and can act in a review capacity.
- Priority Area Stakeholder Groups – two stakeholder forums must be established for a priority area, namely a Priority Area Air Quality Officer's Forum (AQOF) and the Multi-Stakeholder Reference Group (MSRG).
  - The Priority Area AQOF is coordinated and chaired by the AQO in whose jurisdiction the priority area lies. The emphasis of this forum is on coordinating the governance issues associated with the management of the priority area.
  - The MSRG is a consultative forum that represents a wide range of stakeholders whose primary function is to advise the NAQO in all phases of the management of the priority area. Additionally, the MSRG advises the NAQO on appropriate methods of monitoring compliance with the proposed plan. A priority area declaration goes out with a call for MSRG nomination.

4.3.2.2 Data and information

As stipulated in the Manual, the baseline assessment for AQMP should consider all available data and information, including:

- Air quality data
- Air pollution sources
- Area description and geography (defining the boundaries)
- Description of the meteorology and climate of the area
- Population statistics

- Evaluation of air quality information based on available data (Description of the existing air quality monitoring programme; evaluation of the QA/QC; evaluation of the current air quality by checking if air quality standards are being met)
- Sources and emissions
- Pollutants of concern (main pollutants of concern and listing possible impacts and impact areas.)
- Priority air quality issues
- Current management and tools (e.g., air quality management (AQM) experts, emission inventories, existing AQMS, use of dispersion models in the area).
- Consideration of future developments that may have an effect on air quality.
- Prioritising areas for intervention.

4.3.2.3 Time

Section 3.4.1 of the Manual (Task 1 and 2: Intervention Strategies and Action Plan) requires the AQMP to propose generic achievable timeframes for the set intervention strategies ranging from short-term (1–2 years), medium-term (3–5 years) and long-term (5–10 years). In addition, the Manual requires that the AQMP, once developed, has to be revised every five years.

4.3.2.4 Financial/Budget capacity

The budgetary part of the report describes the budgetary needs for the entire AQMP development and implementation process. According to section 4.1.2 of the Manual, the AQMP must include an estimation of the expected costs and benefits of the intervention strategies.

4.3.2.5 Infrastructure

The infrastructure required for the development and implementation of AQMP as stipulated by the Manual includes the South African Air Quality Information System (SAAQIS) database, from which relevant monitoring information can be obtained i.e.:

- location of monitoring stations;
- monitoring data;
- emission inventory;
- atmospheric dispersion modelling; and
- site access.

4.3.2.6 Key assumptions and evaluation questions for the input component

Assumptions: • Resources are available to develop and implement the AQMP. • Cooperative governance exists between government stakeholders.

Evaluation questions related to the input component:

- To what extent are resources available to develop and implement the AQMP?
- To what extent is there coordination and cooperation between the various spheres of government?

4.3.3 Activity component

As described in Chapter 2, there are six steps that must be followed in accordance with the Manual in the process of developing and implementing the AQMP as shown in Figure 2-5. These steps are:

- Establishment of stakeholder groups to define the boundaries of the AQMP's geographic area and to establish a baseline: This activity entails establishing the different committees and issuing of the draft air quality baseline report.
- Gap and problem analysis: Stakeholders and the technical committee are consulted to evaluate the degree to which the baseline assessment is complete and allows for a clear understanding of air quality and its effects. Once the gaps are identified, the committee should initiate a problem analysis to determine the problems, associated causes of the problems, and the effects. The gap and problem analysis should be documented as part of the AQMP, building on the baseline assessment section.
- Establishing air quality goals: Based on the draft report and problem analysis, the PSC and technical committee / advisory forum must meet and ratify a vision, mission and AQM goals for the AQMP. A meeting should be scheduled with the broader air quality stakeholder group. Thereafter a draft document and a decision on goals being met is made available to stakeholders.
- Development of interventions and a plan to achieve air quality objectives: Intervention strategies for each of the problems identified is formulated by the PSC and technical committee / advisory forum. Once these intervention strategies have been identified, an action plan noting the implementation schedule should be tabled with the buy-in from stakeholders. Once agreed apon, this implementation plan is documented as part of the AQMP and submitted to relevant stakeholders for comment.
- Implementation of the intervention strategies: After this stakeholder consultation and once comments have been incorporated and the document finalised, an internal evaluation/review of the AQMP should be undertaken by the PSC. Once finalised, the AQMP is included in the IDP/EMP/EIP. Implementation of the AQMP is implemented

in a systematic manner based on the rules developed as part of the implementation strategy.

- Monitoring, reporting and evaluation: It is important to monitor and evaluate the effectiveness of the emission reduction strategies on each of the priority pollutants to determine whether the goals are being achieved and the benefits realised. Appropriate indicators must be developed to monitor progress towards achieving compliance or other goals set. The annual report, must be submitted by provincial or local authorities in terms of section 17 of the Air Quality Act, 2004, and section 16(l) (b) of the National Environmental Management Act.

4.3.3.1 Key assumptions and evaluation questions for the activity component

Assumptions:

- Stakeholders are identified and are actively involved in the assessment or AQMP process.
- A thorough baseline air quality assessment is done using current and relevant information and is sufficient to inform the gap and problem analysis.
- Gap and problem analysis is done.
- The intervention strategies and action plans are technically and economically feasible and are indeed implemented.
- The intervention strategies are sufficient to achieve ambient air quality standards.
- The implementation plan is feasible (practical, timeframes, verifiable).
- Monitoring, reporting and evaluation of the AQMP is done.

Evaluation questions related to the activity component:

- To what extent have the stakeholders been actively involved in the AQMP process?
- To what extent was the gap and problem analysis conducted?
- To what extent have SMART air quality goals, interventions strategies and action plans been identified and implemented?
- To what extent have the intervention strategies achieved ambient AQ standards?
- To what extent does the implementation plan meet the SMART criteria?
- To what extent is monitoring, reporting and evaluation of the AQMP conducted?

4.3.4 Output component

The output component of air quality management planning refers to tangible results that are usually in the form of reports (Alberts 2020; Alberts *et al.,* 2021). Output components differ case by case, depending on the nature of the development of each plan. A good quality plan should have clear objectives, factual and truthful information, policies, public participation in the development process, and it should be clear on the implementation and monitoring interventions (Berke & Godschalk, 2009; Lyles & Stevens, 2014). Just like in EIA studies, quality evaluation becomes an important component of effectiveness, since the extent to which a plan achieves its objectives depends on adherence to its procedural requirements and substantive purpose (Sadler, 2012; Sandham *et al.,* 2013). This study therefore, adapted the quality review package of Moreoane *et al.* (2021) to evaluate the quality of the selected case studies.

Outputs information should include the following information:

- A draft baseline assessment report that defines the geography of the area (geographical boundaries, population, climate and other geographic information); describes the meteorology and climate; collects and evaluates existing air quality information; identifies sources and listing pollutants of concern; develops of air quality management system (emissions inventory and dispersion modelling, and monitoring; and evaluates current management and tools available.
- Gap and problem analysis, documented as part of the AQMP, building on the baseline assessment section.
- Draft AQMP comprising the baseline assessment, gap and problem analysis, goals and implementation plan.
- Final AQMP: After stakeholder consultation and once comments have been incorporated and the document finalised, an internal evaluation/review of the draft AQMP should be undertaken by the PSC to become the final AQMP. Once finalised, the AQMP is included in the IDP/EMP/EIP.

4.3.4.1 Key assumptions for the output component

Assumption:

- The AQMP report will address the gaps and problems identified, ensure successful implementation of interventions strategies, and ultimately ensure improvement of AQ in the airshed.

Evaluation question related to the output component:

- What is the quality of AQMP reports? (Considered against report content requirements)

4.3.5 Outcome component

The outcome component of air quality management planning is divided into immediate outcomes and intermediate outcomes.

- Immediate outcome: The immediate outcome depends on the sphere level at which the AQMP is done. In declared priority areas, the AQMP must be approved and gazetted by the relevant minister/MEC. AQMPs for municipalities must be included in IDP/EMP/EIP.
- Intermediate outcomes: According to Euripidou *et al.* (2022), the objective of NEM:AQA read in line with NEMA is to develop means to avoid air pollution and enhance air quality, which then ultimately gives effect to several constitutional rights. To achieve this objective, one of the key regulatory instruments mandated by the act are the national ambient air quality standards (NAAQS) that set out emission limits for eight pollutants, including NO_2, SO_2, PM_{10} and $PM_{2.5}$ (DEA 2009; DEA 2012; Euripidou *et al*., 2022). The objective of the AQMP as one of the instruments is therefore to give effect to NEM:QA and the Constitution. The medium- to long-term objectives stipulated in the act are therefore:

  a) *"To protect the environment by providing reasonable measures for–*

     (i) the protection and enhancement of the quality of air in the Republic;

     (ii) the prevention of air pollution and ecological degradation; and

     (iii) securing ecologically sustainable development while promoting justifiable economic and social development; and

  b) *To give effect to section 24(b) of the Constitution in order to enhance the quality of ambient air for the sake of securing an environment that is not harmful to the health and well-being of people."*

4.3.5.1 Key assumptions for the outcome component

Assumptions:

- The AQMP is gazetted or included in the IDP/EMP/EIP and influence decision making.
- The goal of an AQMP is to bring ambient air into compliance with the ambient air quality standards.
- AQMP gives effect to chapter 3, section 16(1) of NEM:AQA requirements (intermediate outcome).

Evaluation questions related to the outcome component:

- To what extent is the AQMP enforceable?
- To what extent is the AQMP gazetted/ approved by council and included in the IDP/EMP/EIP?
- To what extent has the AQMP been bringing ambient air into compliance with the ambient air quality standards?
- To what extent has the AQMP been effective in achieving its objectives to enhance the quality of ambient air for the sake of ensuring an environment that is not harmful to the health and well-being of people?

4.3.6 Impacts component

The primary impact of the AQMP system is the realisation of core human rights contained in ss 24 of the Constitution (1996). Section 24 of the Constitution states:

"Everyone has the right—

a) to an environment that is not harmful to their health or well-being; and

b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that—

(i) prevent pollution and ecological degradation;

(ii) promote conservation; and

(iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."

4.3.6.1 Key assumption for the impact component

Assumption:

- The AQMP enables a progressive realisation of the environmental right contained in section 24 of the Constitution.

Evaluation question related to the impact component:

- To what extent has the AQMP been effective in achieving its objectives to enhance the quality of ambient air for the sake of ensuring an environment that is not harmful to health and well-being of people? (See section 24 of the Constitution).

4.4 Logical framework for evaluation

The logical framework was conceptualised and completed based on the ToC map and narrative (see Table 4-1). From the workshops conducted, 15 key assumptions that underpin each component were identified and agreed upon from the ToC map. These key assumptions are not the only assumptions that exist relating to the AQMP development and implementation in South Africa, but they are the ones thought to be the critical to achieve a successful AQMP development and implementation process. These identified key assumptions were then used to generate evaluation questions for each component. The evaluation questions then form the bases of the data collection processes to evaluate the selected AQMP reports discussed later in section 4.9. In addition, to answer those key evaluation questions, 57 key performance indicators or KPIs are developed to review every aspect of the AQMP development and implementation process. Table 4-1 provides a logical framework showing the key assumptions and evaluation questions for all the components of the ToC, as well as their associated KPIs and methods of verification.

Table 4-1 Logical framework of evaluation for the development and implementation of AQMPs in South Africa

Assumptions and key evaluation questions	Key performance indicators (KPIs)	KPI	Means of verification
1. Design that sets out what the system aims to achieve			
1. The legislative framework provides guidance for AQMP development and implementation. **Evaluation question 1:** To what extent does the legislation provide guidance for AQMP development and implementation?	To what extent does the legislation provide guidance for AQMP development and implementation?	1.1	Interviews and questionnaires
2. Inputs that contribute to the delivery of the activities and output component			
2. Resources exist to develop and implement the AQMP. **Evaluation question 2:** To what extent are resources available to develop and implement the AQMP?	**Skills and competencies:** To what extent do the skills and competencies of the consultants/specialists conform with relevant fields of study? (i.e., SACNASP requirements as obtained from the database (https://www.sacnasp.org.za/requirements-for-registration): • A recognised 4-year Bachelor of Science degree; Bachelor of Science (Hons); or Postgraduate Diploma; or equivalent qualification at NQF level 8 AND three years appropriate work experience in the field of practice applied for; or	2.1	Documentation review and internet search

Assumptions and key evaluation questions	Key performance indicators (KPIs)	KPI	Means of verification
	• A recognised Master's of Science; Master's of Technology; Master's of Agricultural Science; Master's of Applied Sciences; or equivalent qualification at NQF level 9 AND two years of appropriate work experience in the field of practice applied for; or • A recognised doctoral qualification at NQF level 10 AND one year of appropriate work experience in the field of practice applied for; or • 10 years natural science experience in the field of practice without any formal qualification but with recognition of prior learning (RPL).		
	To what extent do the skills and competencies of the consultants/specialists reflect relevant experience? (i.e., SACNASP requirements)	2.2	Documentation review and internet search
	To what extent do the skills and competencies of the consultants/specialists conform with relevant specialist registrations? (i.e., SACNASP requirements)	2.3	Documentation review and internet search

Assumptions and key evaluation questions	Key performance indicators (KPIs)	KPI	Means of verification
	Do the air quality officials responsible for implementing the AQMP currently have the following knowledge and skills (Engelbrecht & van der Walt, 2007)?: • Legislative framework • Air pollution and its characteristics • Engineering control • Atmospheric chemistry • Air pollution meteorology • Air pollution risk assessment • Air quality management principles • Air pollution modelling • Air pollution monitoring • Identification and emission quantification • Air quality management planning	2.4	Communication with the relevant AQOs by questionnaire (Appendix 3.3)
	Time: To what extent are timeframes provided for the implementation of the AQMP intervention strategies?	2.5	Documentation review and interviews
	Finance: To what extent is a budget drafted for the development and implementation of the AQMP? (i.e., financial plan: budget allocation and medium-term finance and how funds will/were raised)	2.6	Documentation review and interviews

Assumptions and key evaluation questions	Key performance indicators (KPIs)	KPI	Means of verification
	Data: To what extent was the data accessible, accurate, and reliable to develop an AQMP?	2.7	Documentation review and interviews
	Air quality management system (infrastructure): How efficient is the ambient air quality monitoring network?	2.8	Documentation review and interviews
3. There is cooperative governance coordination between the government stakeholders. **Evaluation question 3:** To what extent was there coordination and cooperation between the various spheres of government?	To what extent was there coordination and cooperation between the various spheres of government during the development and implementation of the AQMP?	2.9	Interviews and questionnaire
3. Activity			
4. Stakeholders are established and are actively involved in the assessment or AQMP process. **Evaluation question 4:** To what extent have the stakeholders been actively involved in the AQMP process?	To what extent were the stakeholders identified and included in the AQMP development and implementation process? (i.e., this includes workshops, awareness campaigns, and complaints data)	3.1	Interviews and questionnaire
5. A thorough baseline air quality assessment is done using current and relevant information	**See KPIs under evaluation question 11**		

Assumptions and key evaluation questions	Key performance indicators (KPIs)	KPI	Means of verification
and it is sufficient to inform the gap and problem analysis.			
6. Gap and problem analysis has been done. **Evaluation question 5:** To what extent was the was gap and problem analysis conducted?	To what extent was a gap analysis conducted to evaluate to include the following: • whether the past and current monitoring, emission inventory and modelling information is sufficient to address air quality issues; • description of pressures and challenges faced as a result of rapid population growth and increase of industrialisation (new facilities, vehicle use etc.) activities that result in increased air pollution; • problems associated with enforcement and compliance.	3.2	Documentation review and interviews
7. The intervention strategies and action plans are technically and economically feasible and are indeed implemented. **Evaluation question 6:**	To what extent do the intervention strategies include strategy(ies) on policy, including by-laws implementation and legislative changes? (The purpose of the by-laws is to regulate air quality management in the municipalities. The AQMPs should indicate how by-laws will be enforced.)	3.3	Documentation review

Assumptions and key evaluation questions	Key performance indicators (KPIs)	KPI	Means of verification
To what extent have SMART air quality goals, interventions strategies and action plans been identified and implemented?	To what extent do the intervention strategies include strategy(ies) on the use of international best practice?	3.4	Documentation review
	Intervention strategies relating to air quality: To what extent do the intervention strategies include strategy(ies) on air pollution sources, including the identification of existing emission reduction initiatives and their effectiveness?	3.5	Documentation review
	To what extent do the intervention strategies include strategy(ies) on the identification of all potential reduction strategies – short, medium and long term?	3.6	Documentation review
	To what extent do the intervention strategies include strategy(ies) on technical feasibility and socio-economic impacts and a statement on implementation?	3.7	Documentation review
	To what extent does the AQMP (intervention strategies) include strategy(ies) on the estimation of expected costs and benefits?	3.8	Literature review and documentation review
	To what extent do the intervention strategies include strategy(ies) on determining parties and allocating responsibility to implement the reduction strategy? This includes implementation of task teams	3.9	Documentation review

Assumptions and key evaluation questions	Key performance indicators (KPIs)	KPI	Means of verification
	comprising of relevant government departments and multi-stakeholder groups.		
	To what extent do the intervention strategies include strategy(ies) on the measures to reduce emission from mobile sources identified?	3.10	Documentation review
	To what extent do the intervention strategies include strategy(ies) on community-based organisations assisting the municipalities with conducting awareness and education campaigns?	3.11	Documentation review
	To what extent do the intervention strategies include strategy(ies) on municipalities collaborating with the private sector to get financial assistance on air quality intervention strategies?	3.12	Documentation review
	To what extent do the intervention strategies include strategy(ies) on the funding mechanism for different interventions being outlined in the case of government implementation?	3.13	Documentation review
	To what extent do the intervention strategies include indicators to monitor progress towards achieving the intervention?	3.14	Documentation review
8. The intervention strategies are sufficient to achieve ambient AQ standards.	To what extent have the intervention strategies achieved ambient AQ standards?	See Outcomes	Interviews

Assumptions and key evaluation questions	Key performance indicators (KPIs)	KPI	Means of verification
Evaluation question 7: To what extent have the intervention strategies achieved ambient AQ standards?		and Impacts	
9. The implementation plan is feasible (practical, timeframes, verifiable). **Evaluation question 8:** To what extent does the implementation plan meet the SMART criteria?	To what extent does the implementation plan meet the SMART criteria?	3.15	Documentation review and interviews
10. Monitoring, reporting and evaluation of the AQMP is done. **Evaluation question 9:** To what extent is monitoring, reporting and evaluation of the AQMP conducted?	**Monitoring:** To what extent does the AQMP cover the following requirements on monitoring: • Ambient air quality monitoring network: monitoring is performed in accordance with accepted standard methods;	3.16	Documentation review and interviews
	• Location of monitoring stations is based on locations of main sources, topographical features and meteorological conditions, as well as urban features and population distribution.	3.17	Documentation review and interviews
	• Monitoring covers all compounds of relevance in the area, based on the sources	3.18	Documentation review and interviews

Assumptions and key evaluation questions	Key performance indicators (KPIs)	KPI	Means of verification
	in the area and their emissions of compounds relevant to air pollution and its effects.		
	• Atmospheric dispersion modelling conducted for the area.	3.19	Documentation review and interviews
	• Review and gazetting or inclusion in the IDP/EIP/EMP of AQMPs. (To measure successful implementation of the AQMP the plan should be gazetted if it is a priority area level or approved by council for provincial level or included in the IDP for municipal level and must be reviewed every five years. Therefore, the AQMP should be reviewed every five years in accordance with the IDP requirements. Annual performance reports can also be considered as a reviewing mechanism).	3.20	Documentation review, interviews and questionnaire
4. Outputs			
11. AQMP report will address the gaps and problems identified, ensure successful implementation of interventions strategies,	**The following indicators are indicative of the completeness and substantive quality of the AQMP report content as adapted from the AQMP**	4.1	Documentation review

Assumptions and key evaluation questions	Key performance indicators (KPIs)	KPI	Means of verification
and ultimately ensure improvement of AQ in the airshed. **Evaluation question 10:** What is the quality of AQMP reports?	**quality review by Moreoane *et al.* (2021) (Annex B).** • The goals and objectives have been identified and are SMART (specific, measurable, realistic and timeous).		
	• The geographical area is described, land use, topography, landscape and natural resources and mapped out.	4.2	Documentation review
	• The description of demographics (gender, race, and age, population distribution and population density presented).	4.3	Documentation review
	• The description of socio-economic status (description of number of households distribution, poverty levels, education and employment status).	4.4	Documentation review
	• List of areas that use fossil fuels for domestic use.	4.5	Documentation review
	• Health status of persons living in areas of high fossil fuel use for domestic purposes.	4.6	Documentation review
	Identification of all industrial air pollution sources.	4.7	Documentation review

Assumptions and key evaluation questions	Key performance indicators (KPIs)	KPI	Means of verification
	• Inventory of section 21, 23 and dust generating industries.		
	• Inventory of industries that may cause air pollution and unlisted entities (e.g., controlled emitters).	4.8	Documentation review
	• International agreements and best practice guidelines identified for air quality management and listed.	4.9	Documentation review
	• Pollutants affecting health, environment and climate change.	4.10	Documentation review
	• Assessment of impact of industrial activities, greenhouse gases, indoor exposure and other regional issues, including as acid rain, regional ozone and transboundary issues.	4.11	Documentation review
	• Training, institutional building and information management.	4.12	Documentation review
	Baseline air quality assessment • Description of administrative boundaries, region or municipality, urban populated extension, and urban agglomeration boundary.	4.13	Documentation review

Assumptions and key evaluation questions	Key performance indicators (KPIs)	KPI	Means of verification
	Meteorology and climate description: • Description of the climate of the area.	4.14	Documentation review
	• Presentation of wind, temperature stability inversions and precipitation data.	4.15	Documentation review
	Evaluation of baseline air quality data: • Quality assurance and quality control (QA/QC) programme.	4.16	Documentation review
	Identify sources and pollutants of concern: • List pollutants and compounds and their main sources and types (point, line, area) identified.	4.17	Documentation review
	Evaluate current management and tools available: • Evaluation of the capacity in different spheres of government for air quality management.	4.18	Documentation review
	• Assessment of available emission data and emission inventories.	4.19	Documentation review
	• Existing air quality monitoring programmes.	4.20	Documentation review
5. Outcomes			

Assumptions and key evaluation questions	Key performance indicators (KPIs)	KPI	Means of verification
12. The AQMP is gazetted or included in the IDP/EMP/EIP and influences decision making (immediate outcome). **Evaluation question 11:** To what extent has the AQMP been gazetted/ approved by council and included in the IDP/ EMP/ EIP?	To what extent is the AQMP gazetted or included in the IDP/EMP/EIP? To what extent does the AQMP influence decision making?	3.20 and 5.1	Document review and interviews/questionnaire
13. The goal of an AQMP is to bring ambient air into compliance with the ambient air quality standards (intermediate). **Evaluation question 12:** To what extent has the AQMP been bringing ambient air into compliance with the ambient air quality standards?	To what extent has the AQMP been in bringing ambient air into compliance with the ambient air quality standards?	5.2	Interviews/questionnaire
14. The AQMP gives effect to the objectives of NEM:AQA requirements (intermediate). **Evaluation question 13:** To what extent has the AQMP been effective in achieving its objectives to enhance the quality of ambient air for the sake of ensuring	**To what extent does the AQMP give effect to the objectives of NEM:AQA?**		Documentation review
	To what extent does the AQMP achieve the protection and enhancement of the quality of air in the Republic?		Interviews/questionnaire
	To what extent does the AQMP prevent pollution and ecological degradation?		Interviews/questionnaire

Assumptions and key evaluation questions	Key performance indicators (KPIs)	KPI	Means of verification
an environment that is not harmful to health and well-being of people?	To what extent does the AQMP secure ecologically sustainable development while promoting justified economic and social development?		Interviews/questionnaire
6. Impact component			
15. The AQMP enables a progressive realisation of the environmental right contained in section 24 of the Constitution. **Evaluation question 14:** To what extent has the AQMP been effective in achieving its objectives to enhance the quality of ambient air for the sake of ensuring an environment that is not harmful to health and well-being of people?	To what extent does the AQMP realise an environment that is not harmful to health and well-being?	6.1	Questionnaire and interviews
	To what extent did the AQMP achieve the protection of the environment over the immediate and long term?	6.2	Questionnaire and interviews
	To what extent did the AQMP succeed in preventing pollution and ecological degradation?	6.3	Questionnaire and interviews
	To what extent did the AQMP secure ecologically sustainable development?	6.4	Questionnaire and interviews
	To what extent does the AQMP realise the promotion of justifiable economic and social development?	6.4	Questionnaire and interviews

4.5 Determining the type of evaluation to be conducted

Table 4-2 gives a description of the different evaluation types as outlined in the National Evaluation Policy Framework and also provides the relationship between this study's research objectives, ToC components, evaluation questions and relevant KPIs. Four evaluation types are included in this study, which are design, implementation, outcome and impact evaluations.

Table 4-2 The relationship between research objectives, evaluation questions, and different evaluation and effectiveness types

Type of evaluation	**Covers**	**Research objective**	**Key evaluation question or KPI**	**Relation to causal logic chain (see Figure 3-2)**
Design evaluation	Used to analyse the ToC, internal logic and consistency of the programme, either before a programme starts or during implementation, to see whether the ToC appears to be relevant and working. This is quick to do and uses only secondary information and should be used for all new programmes. It also assesses the quality of the indicators and the assumptions underpinning the theory of change.	To apply the performance evaluation criteria to the selected air quality management plans.	To what extent does the legislation provide guidance for AQMP development and implementation?	Design
Implementation evaluation	"Aims to evaluate whether an intervention's operational mechanisms support achievement of the objectives or not and understand why. Looks at activities, outputs, and outcomes, use of resources and the causal links. It builds on existing monitoring systems and is applied during programme operation to improve the efficiency and efficacy of operational processes. It also assesses	To apply the performance evaluation criteria to the selected air quality management plans.	What is the quality of the baseline air quality assessment?	Output
			What is the quality of the AQMP reports?	Outputs

Type of evaluation	Covers	Research objective	Key evaluation question or KPI	Relation to causal logic chain (see Figure 3-2)
	the quality of the indicators and assumptions. This can be rapid, primarily using secondary data, or in-depth with extensive field work" (DPME, 2011).		To what extent is the AQMP included in the IDP/EMP/EIP or gazetted by the minister?	Outputs and outcomes
			To what extent does the AQMP influence decision making?	Outputs and outcomes
			To what extent was the gap and problem analysis conducted?	Activities
			To what extent have SMART air quality goals, interventions strategies and action plan been identified and implemented?	Activities
			To what extent is monitoring, reporting and evaluation of the AQMP conducted?	Activities

Type of evaluation	Covers	Research objective	Key evaluation question or KPI	Relation to causal logic chain (see Figure 3-2)
			To what extent has the AQMP been gazetted and/or included in the IDP/EMP/EIP?	Outcomes
Outcome evaluation	Should measure the degree to which the programme is having an effect on the target population's well-being and/or behaviours. Outcome evaluations help determine whether or not the intended benefits of a programme are actually being achieved (i.e., whether or not the programme is able to meet its intended purpose).	To apply the performance evaluation criteria to the selected air quality management plans.	To what extent has the AQMP been effective in achieving its objective to enhance the quality of ambient air for the sake of ensuring an environment that is not harmful to health and well-being of people?	Outcomes and impact
Impact evaluation	"Seeks to measure changes in outcomes (and the well-being of the target population) that are attributable to a specific intervention. Its purpose is to inform high-level officials on the extent to which an intervention should be continued or not, and if there are any potential modifications needed. This	To apply the performance evaluation criteria to the selected air quality management plans.	To what extent has the AQMP been effective in achieving the objectives of NEM:AQA and ultimately sustainable development? To what extent has the AQMP been effective in achieving its objectives to enhance the quality of ambient air for	Outcomes and impact

Type of evaluation	Covers	Research objective	Key evaluation question or KPI	Relation to causal logic chain (see Figure 3-2)
	kind of evaluation is implemented on a case-by-case basis" (DPME, 2011).		the sake of ensuring an environment that is not harmful to health and well-being of people?	

4.6 Chapter conclusion

The main purpose of this chapter was to provide a clear theoretical framework on the development of ToC for AQMPs in South Africa. It provides a linkage of the methodology chapter and the results chapter. The researcher thought it is important to have this chapter as standalone chapter so as to avoid confusion to the reader as the AQMP ToC framework is very theory intensive. The chapter was therefore able to provide a very detailed description of the ToC map, key assumptions, and their associated key evaluation questions and KPIs, as well as the ToC narrative pertaining to AQMPs in South Africa. The ToC narrative section 4.3 provided a critical analysis of the information that informs each component of the ToC map for AQMPs. In addition, Table 4-1 provides the reader with a clear understanding of all the 15 key assumptions and their associated evaluation questions with their KPIs as well as the methods which were employed to evaluate them. Furthermore, Table 4-2 shows the linkage between research objectives, evaluation questions and the different evaluation types discussed in chapter 3 section 3.2.2. Now that the reader understands how and where the AQMP ToC map, assumptions and narrative came about, the next chapter provides the actual results from the evaluations of the KPIs outlined in Table 4-1.

CHAPTER 5: RESULTS

5.1 Introduction

Chapter 5 offers an interpretation of the results following the data collection process using methods described in detail in Chapter 3 as well as the ToC framework in chapter 4. This chapter addresses objective 4 of this study, which is to apply the designed performance evaluation criteria to the selected air quality management plans (AQMPs). The performance evaluation criteria were designed and developed in Chapter 3, which resulted in 15 assumptions, 14 evaluation questions, as well as 57 key performance indicators (KPIs). To address Objective 4, this study applied the evaluation questions and KPIs to the selected nine AQMP reports from municipalities across different spheres of government. The results in this chapter are presented in the following order, first the chapter presents findings resulting from the document or case study reviews method of evaluation which were done for evaluation questions and KPIs in the input and activity components in sections 5.2 and 5.3 below. Section 5.4 presents results obtained from interviews and questionnaires from stakeholders for the evaluation questions and KPIs in the design, output, outcome and impact components as well some KPIs in the activity component. The reason for not presenting the results in line with the causal narrative flow outlined in the logical framework in Table 4-1 of chapter 4 was to avoid confusion on the manner in which data was interpreted using different methods (i.e. document reviews, interviews and questionnaires).

At the end of this chapter, a

Table 5-10 summarising all the results in line with their ToC component and KPIs is provided at the end of this chapter. The AQMP evaluation as discussed in Chapter 3 was done against the designed KPIs for each of the 15 evaluation questions and are scored in terms of conformance (A), partial conformance (B) and non-conformance (NC). This chapter first provides results obtained from document reviews, followed by results obtained from questionnaires and interviews from participants.

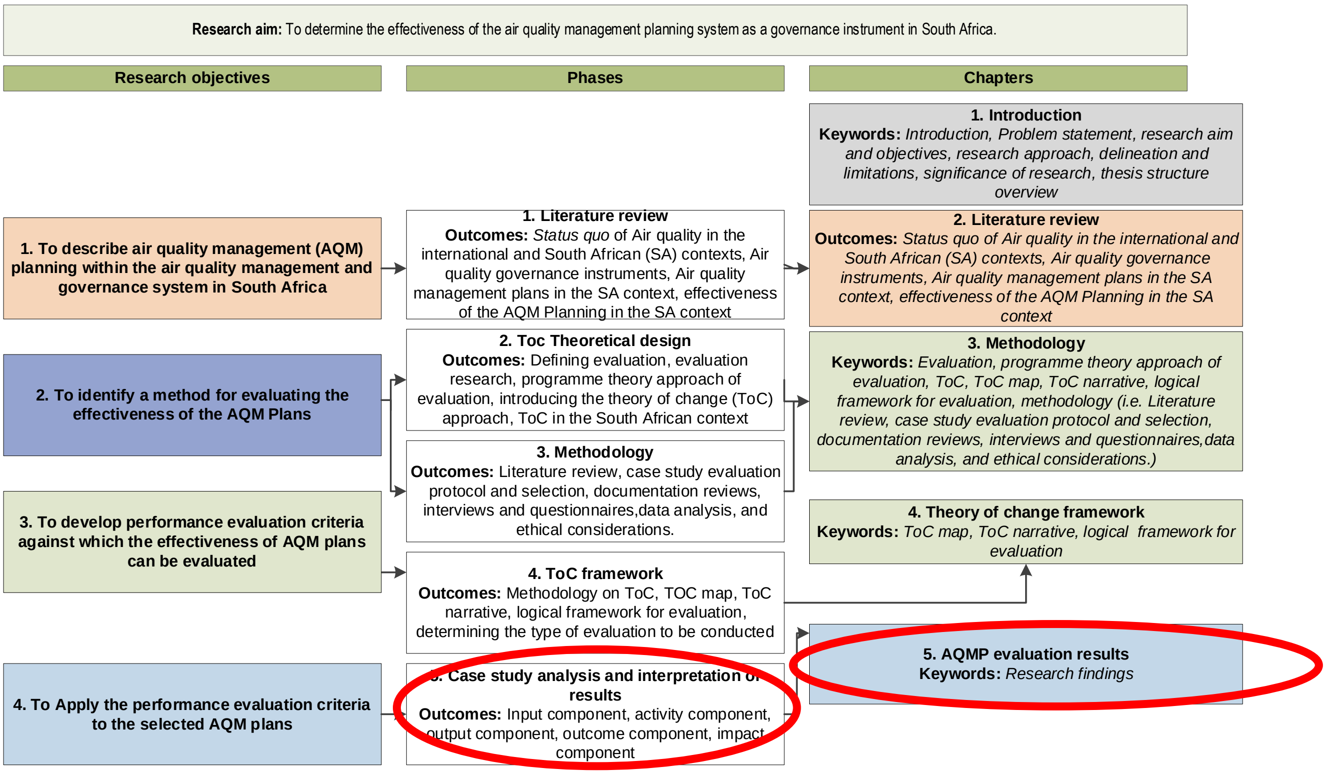

Figure 5-1 Thesis structure that provides the link between Objective 4 (on the left-hand side) and Phase 4 and Chapter 4 of the thesis report

5.2 Input component

As discussed in Chapter 4, the input components outline the required aspects that are important in producing the expected outcomes (Lipsey, 1993). In terms of the AQMP development and implementation process in South Africa, these inputs have been identified to be key resources that are required for the development and implementation of an efficient and effective AQMP. Two evaluation questions and nine KPIs were used in evaluating this component. These resources include but are not limited to budget, staff, equipment, and infrastructure.

5.2.1 Skills and competencies

As discussed earlier, there is no specific legal requirement or guideline outlining the skills and competency requirements of consultants/specialists and officials in South Africa for developing and implementing AQMPs. This study subsequently adopted the SACNASP requirements for the evaluation of consultants/specialists and adopted the training needs outcomes identified by Engelbrecht and Van der Walt (2007).

5.2.1.1 Consultants/specialists

Three KPIs were used to evaluate the skills and competencies of consultants/specialists and the results show that seven of the nine case studies do conform to KPIs 2.1 and 2.2 with respect to the relevant fields of study and experience respectively, with two of the case studies not being applicable to the KPIs as they were developed internally and not by consultants. This is shown in Figure 5-2 below. This means that the consultants/specialists who were involved in the development of the selected case studies all met the SACNASP minimum requirement of at least a recognised four-year science qualification, with at least three years of appropriate work experience in the field of practice. The KPI 2.3 that requires the consultants to be registered with SACNASP shows that only one case study did not conform, meaning the consultants involved in the development of the plan were not registered. Two cases were also not applicable to that KPI. Overall, the skills and competency KPIs (2.1-2.3) performed very well, with seven case studies conforming to KPIs 2.1 and 2.2 and one non-conformance with KPI 2.3. Two of the case studies were not applicable to all three KPIs.

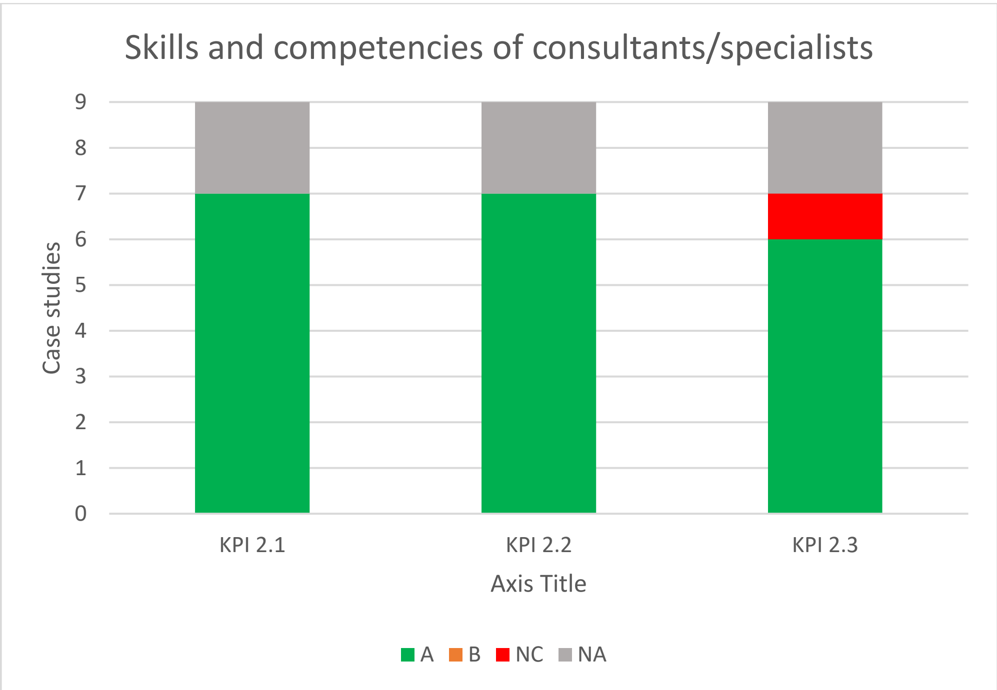

Figure 5-2 Results for the skills and competencies of consultants/specialists for the the case studies (A = Conformance, B = Partial conformance, NC = Non-conformance, NA = Not Applicable, NE = Not Evaluated)

5.2.1.2 Officials

The training needs outcomes identified by Engelbrecht and Van der Walt (2007) were adopted as KPI 2.4 to evaluate the current skills and competencies of the relevant air quality officers (AQOs) of the selected case studies outlined in Annex D. Eight of the nine responses were received from the AQOs. The results show that engineering control (six non-conforming (NC) and two conforming (As)) and air pollution modelling (five NC's and three A's) are the biggest skills gaps, followed by skills for the identification and emission quantification and air pollution risk assessment both scoring four NC's and four A's as shown in Figure 5-3. Moreover, 50% of the case studies responded that other key skills found to be lacking are the identification of sources and emission quantification, as well as air pollution risk assessment.

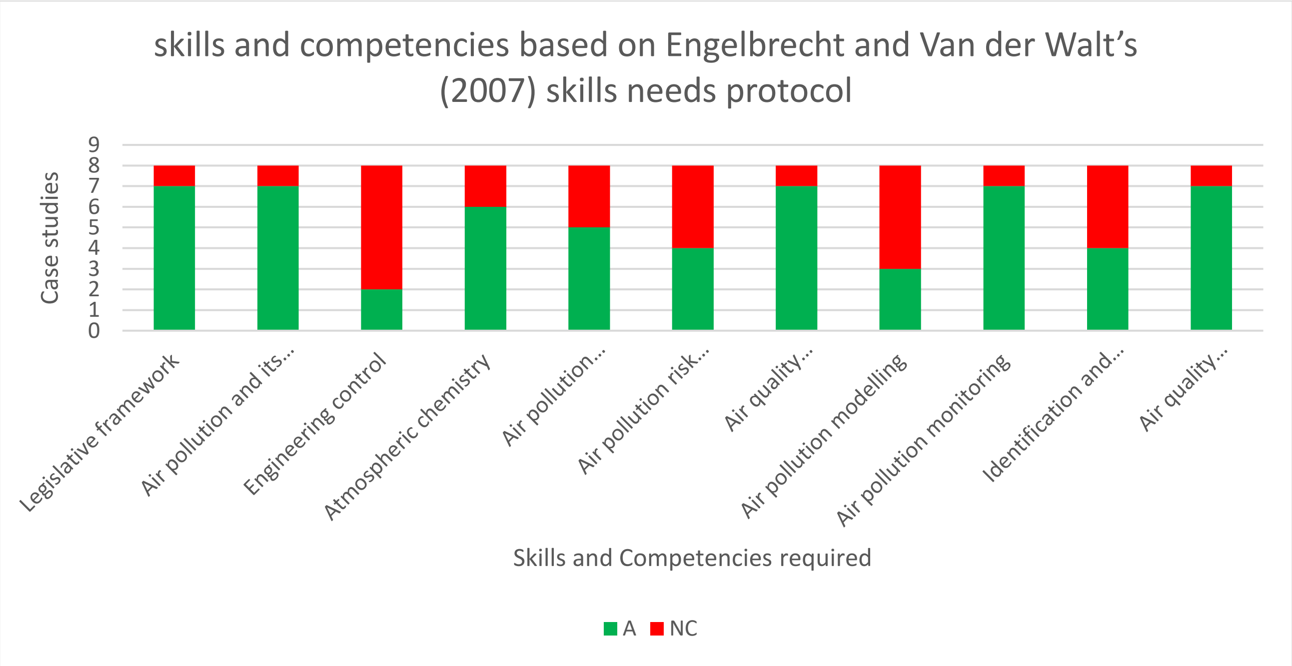

Figure 5-3 Performance of skills and competencies based on Engelbrecht and Van der Walt's (2007) skills needs protocol. (A = Conformance, NC = Non-conformance).

5.2.2 Time, budget, data and information infrastructure, and cooperative government

The input component (excluding skills and competency) did not perform well with respect to the five KPIs (2.5-2.9) evaluated as shown in Figure 5-4 below. The evaluation shows that in total, there are more partially conforming (B) than conforming (A) case studies, with 16 As, 28 Bs and one NE across all case studies. With regard to specific KPIs:

- The results show that all nine AQMP case studies conformed (A) to KPI 2.5 regarding the description or provision of timeframes for the implementation of the AQMP intervention strategies.

- Three case studies conformed (A) and six case studies scored partial conformance (B) to KPI 2.6 regarding the description of the budget provision for the development and implementation. The evaluation found that of the six case studies that were scored B, three (i.e., Limpopo (LP), Buffalo City (BCMM), Langeberg (LLM)) were found to have only indicated that funding should be provided for the implementation of the plans, but without providing any detailed specifications on the budgetary needs and operational costing. Three of the case studies (i.e., West-Coast (WCDM), LLM and Steve Tshwete (STLM)) did not mention or describe any budgetary needs. In addition, two of the interview responses indicated that the actual budget allocation for implementing the plans did not materialise despite the report having indicated budgetary needs.
- All nine case studies scored B for KPIs 2.7 and 2.8. KPI 2.7 deals with data accessibility, accuracy, and reliability to implement the AQMP and KPI 2.8 deals with the efficiency of the ambient air quality monitoring network. Seven reports (BCMM, John Taolo Gaetsewe (JTGDM), WCDM, STLM, LLM, LP, and GP) identified the following key issues as limitations: poor or no ambient AQ monitoring network and data, poor or non-functioning monitoring stations, no human and/or skills capacity for monitoring. It is found that most case studies including GP, JTGDM, WCDM, STLM, LLM depend on other entities such as industry, provincial and local governments and departments, weather services etc., for data collection and analysis, monitoring and reporting to SAAQIS.
- KPI 2.9 evaluated whether there is coordination and cooperation between the various spheres of government, and this was done through interviews with the relevant AQOs for the case studies selected. Four of the case studies conformed (GP, City of Johannesburg (CoJ), BCMM and LLM) while the other four cases were in partial conformance (B) and one (STLM) did not provide a response, as shown in Figure 5-4 below. A common response provided was that there is more interest and attendance during the initial stages of development, but the attendance decreases with time during implementation phase. Another comment from three of the respondents was that there is not much cooperation from other government entities, particularly local municipalities and mainly due to no capacity of staff. However, the respondents further indicated that there is good cooperation from industries.

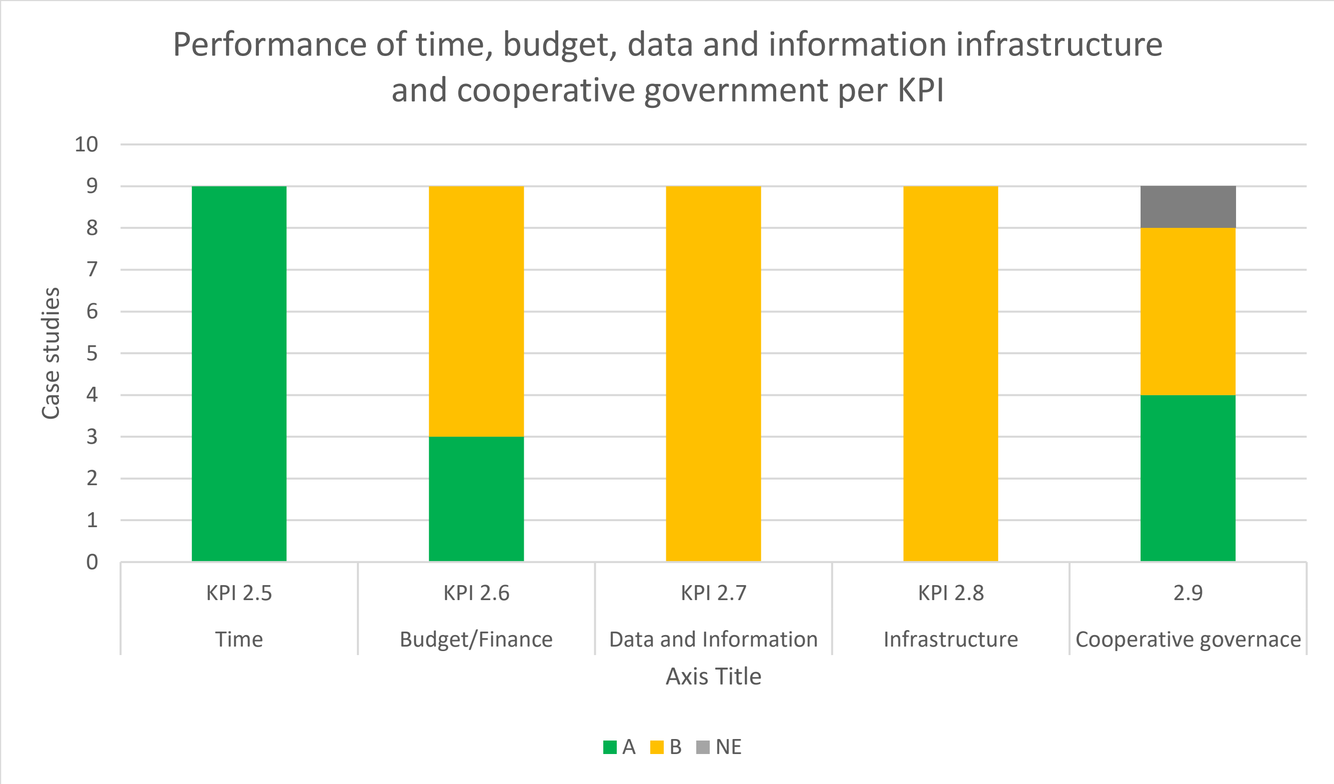

Figure 5-4 Performance of time, budget, data and information infrastructure and cooperative government per KPI. (A = Conformance, B = Partial conformance, NC = Non-conformance, NA = Not Applicable, NE = Not Evaluated).

5.3 Activity components

Seven key assumptions and twenty KPIs were identified from the six steps that should be followed during the development and implementation of AQMP in the activity component.

5.3.1 Stakeholder involvement and gap and problem analysis

Figure 5-5 below shows that eight cases studies scored A and only one case study scored NC for KPI 3.2, which deals with the extent to which a gap analysis was conducted during the AQMP development and implementation process. This shows that almost all the case studies except for LLM did conduct the gap and problem analysis step as per the *Manual for Air Quality Management Planning* guidelines.

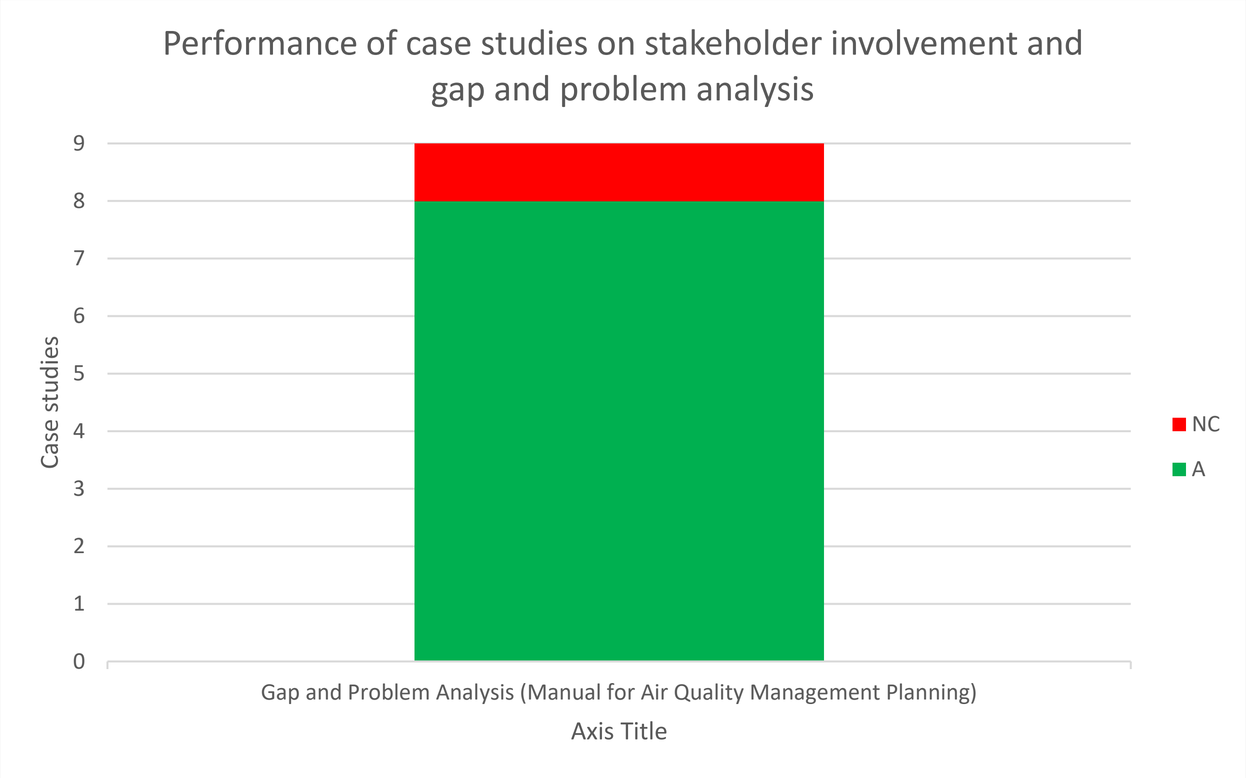

Figure 5-5 Performance of case studies relating to stakeholder involvement and gap and problem analysis. (A = Conformance, B = Partial conformance, NC = Non-conformance, NA = Not Applicable, NE = Not Evaluated)

The case studies generally performed well regarding KPIs 3.3-3.15 on intervention strategies and implementation plan with 82 conformances (A's) and 20 partial conformance (B's) and 15 non-conformances (NCs) across all cases. The major aspect in relation to which eight case studies failed to conform relates to KPI 3.8 on the extent to which the intervention strategies estimated the expected costs and benefits as shown in Figure 5-6 below. Five of the case studies partially conformed (B) (WBPA, LP, CoJ, JTGLM and STLM) and three case studies failed to conform (NC) (BCMM, WCDM, LLM). Furthermore, only three of the nine case studies (WBPA, GP, and CoJ) scored conformed (A) on KPI 3.12 dealing with municipalities collaborating with the private sector to get financial assistance on air quality intervention strategies. It is found that air quality goals, interventions strategies and action plans in three case studies (LP, BCMM, LLM) did not meet the SMART criteria in terms of KPI 3.14 and 3.15. These case studies are found to have omitted the indicators in their intervention strategies to monitor or measure progress towards achieving the interventions, meaning that measurability is not fully addressed. Although the case studies performed well overall, implementation remains a challenge in most case studies due to constraints identified in other components of the ToC in this study.

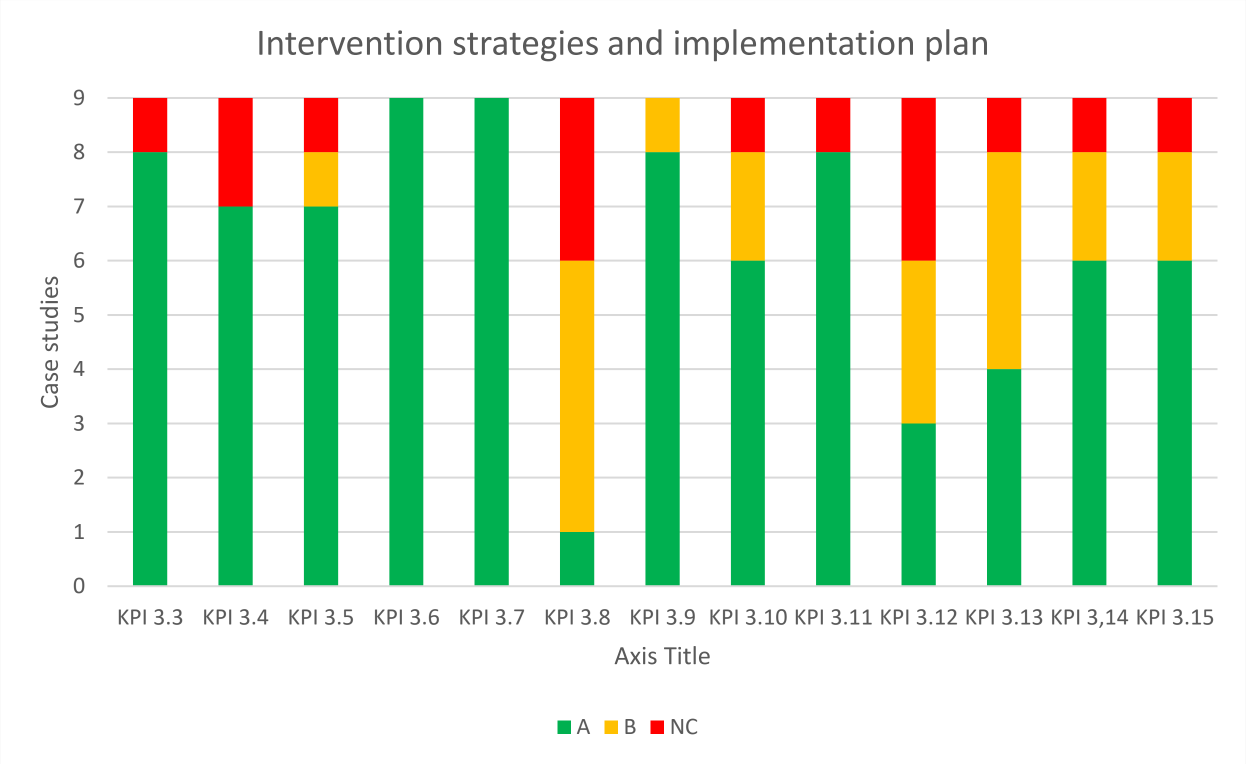

Figure 5-6 Intervention strategies and implementation plan. (A = Conformance, B = Partial conformance, NC = Non-conformance)

5.3.2 Air quality monitoring and evaluation (air quality management system) (Manual for Air Quality Management Planning)

The results in Figure 5-7 show that the case studies performed well with regard to air quality monitoring and evaluation, with an overall score of 22 A's, 4 B's,10 NCs and 3 NA's. The KPI 3.16 evaluates the extent to which ambient air quality monitoring is performed in accordance with accepted standard methods. The results show that six case studies scored A, one scored B and two scored NC. The three case studies that did not conform to KPI 3.16 are found to lack their own monitoring networks and stations (i.e., JTGDM, WCDM and LLM). They rely on either industries or other departments, municipalities or state-owned entities. KPI 3.17 assessed whether the location of monitoring stations is based on locations of main sources, topographical features and continuous meteorological conditions, as well as urban features and population distribution. The case studies scored five A's, one B, and three NC's. KPI 3.18 evaluated whether monitoring covers all compounds of relevance in the area based on the sources in the area and their emissions of compounds relevant for air pollution. This KPI was not assessed in this study due to a lack of available information for the evaluation. Results further show that five case studies conformed, with KPI 3.19 having done the atmospheric dispersion modelling, while two partially conformed (BCMM and JTGLM) and another two case studies (WCDM and LLM) totally did not conform particularly at district and local government. The last KPI in this category (3.20) evaluated whether the AQMP has been reviewed every five years and has been gazetted or included in the IDP/EIP/EMP. The case studies scored six A's and three NC's. The three non-conforming case studies (WBPA, LP, LLM) revealed that their plans have not been revised in the past five years.

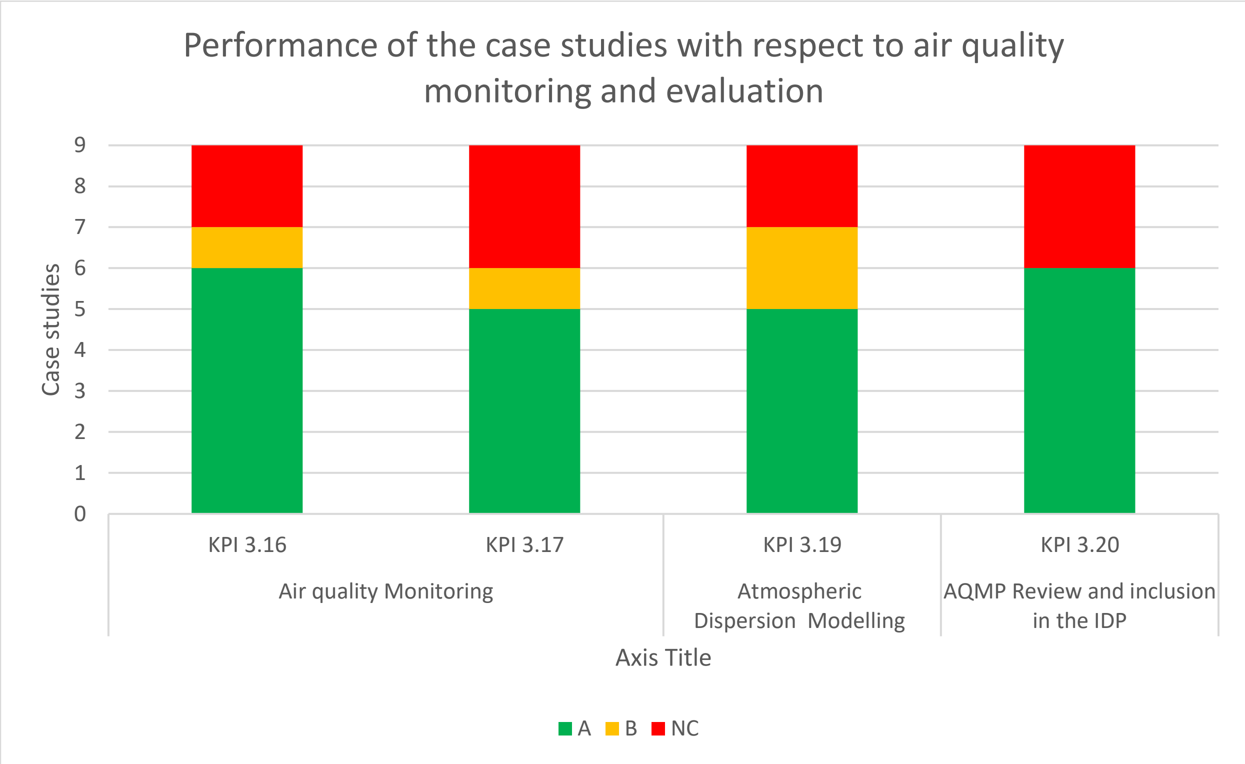

Figure 5-7 Performance of the case studies with respect to air quality monitoring and evaluation. (A = Conformance, B = Partial conformance, NC = Non-conformance).

5.3.3 Description of government roles, responsibility and goal setting

As discussed in the methodology chapter, the output component indicators (KPIs 4.1–4.20) indicate the completeness and substance quality of the AQMP reports content. It was adapted from the AQMP quality review package by Moreoane *et al.* (2021). In terms of the AQMP air quality goal setting and assigning roles and responsibilities (i.e., KPIs 4.1–4.12), the results show an overall poor performance in terms of report quality and completeness across all the case studies, with less conformances (38 A's) and more partial-conformances (53 B's), as well as 25 non-conformances shown in Figure 5-8 below. The major poor-performing KPIs relate to (see Figure 5-8):

- the description of demographics (KPI 4.3 with eight B's and one NC);
- socio-economic statuses (KPI 4.4 with one A, seven B's, and one NC);
- health status (KPI 4.6 with two B's and seven NC's);
- inventories (KPI 4.7 with seven B's and two NC's);

- international agreements and best practice guidelines (KPI 4.9 with one A, six B's, and six NC's);
- pollutants impacting health, environmental impacts and climate change related (KPI 4.10 with three A's, five B's, and one NC) and,
- assessment of impact of industrial activities and greenhouse gases, indoor exposure and other regional issues such as acid rain, regional ozone and trans boundary issues (KPIs 4.11 with nine B's).

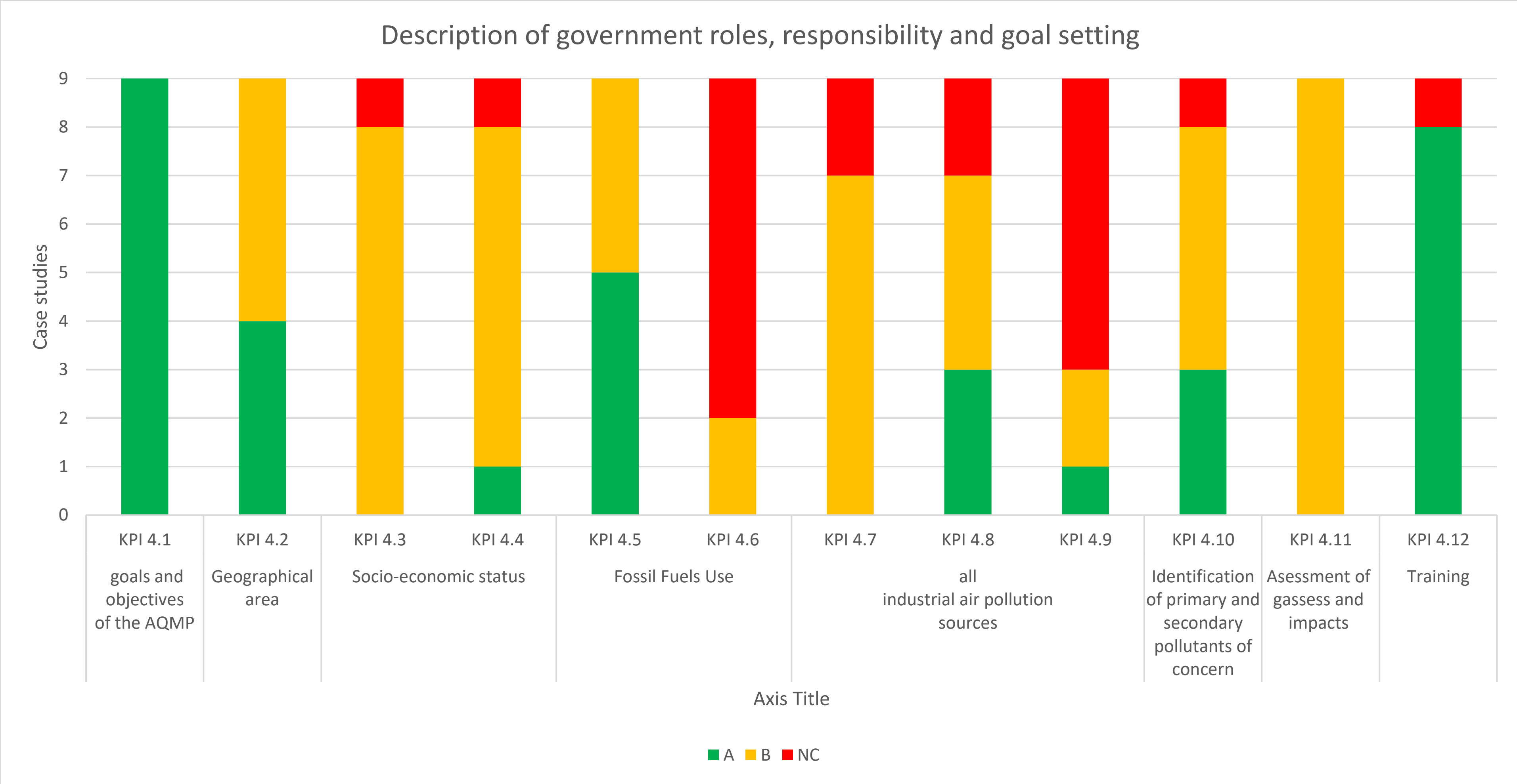

Figure 5-8 Description of government roles, responsibility and goal setting. (A = Conformance, B = Partial conformance, NC = Non-conformance)

5.3.4 Baseline air quality assessment

Figure 5-9 shows the results of the baseline assessments KPIs 4.13–4.20, and also evaluate the quality of the AQMP report. The most significant poor performance across all cases relates to KPI 4.16, which involves quality assurance and quality control (QA/QC) programme of baseline air quality data. Three case studies (WBPA, GP, CoJ) scored A, while LP, WCDM, and STLM scored B in KPI 4.16, and the other three case studies did not provide information on the quality assurance or quality control (QA/QC) programme of the data and information used to develop and implement the plans. However, there was an overall good performance with respect to baseline assessment evaluation meaning the case studies were generally of good quality despite some omissions discussed above with fifty-four non-conformances, twelve partial conformances and six non-conformances.

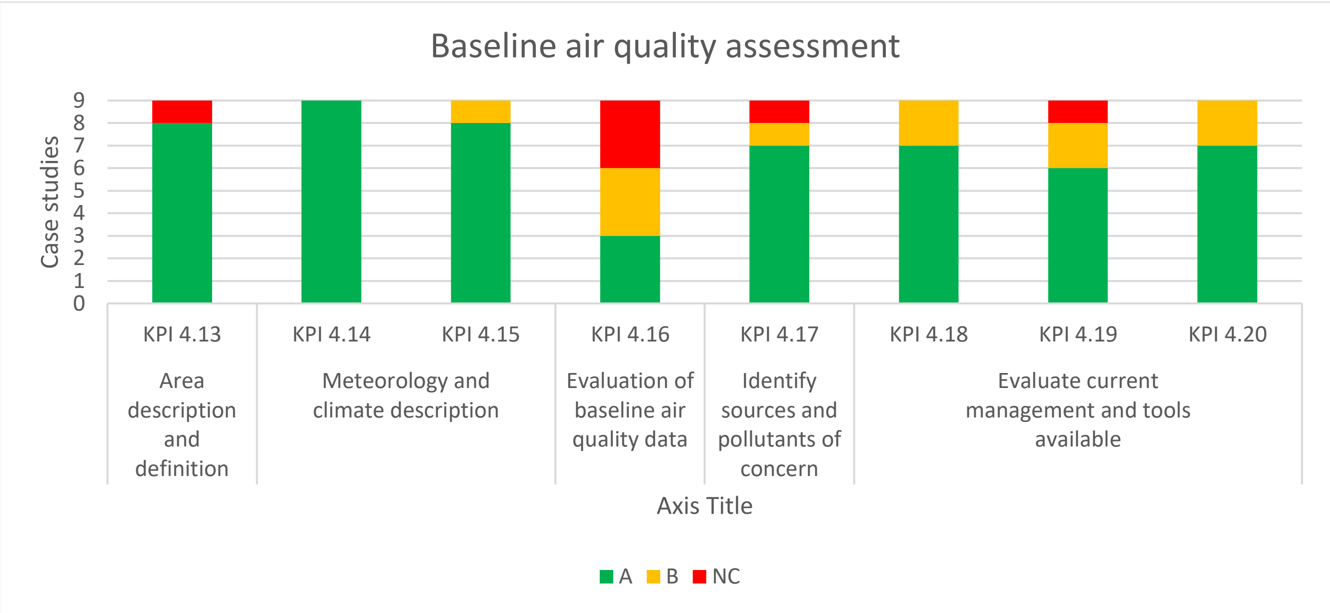

Figure 5-9 Baseline air quality assessment. (A = Conformance, B = Partial conformance, NC = Non-conformance)

5.4 Design, activity, outcome and impact components

This section gives the results with respect to the perceptions of participants from four stakeholder groups which were used to evaluate the design, activity, outcome and impact components (i.e., 11 government air quality or environmental officials, 11 consultants, 10 industry and 10 civil society who have experience in the AQMP development and implementation process provided responses). The results are also found in detail in Annex G.

The section provides results evaluating whether the AQMP system helps achieve compliance with relevant legislation and standards, as well as the broader objectives of a progressive realisation of the environmental right contained in section 24 of the Constitution. A total of 42 participants from different stakeholder groups, who have experience in the AQMP development and implementation process, provided responses. Ten questions were asked in the questionnaires and interviews related to the design, activities, outcome and impact components of the ToC to evaluate nine KPIs associated with nine assumptions identified in the ToC map and logical framework. The nine KPIs were each allocated a category from A to D and several themes were identified within each category, as shown in to Table 5-1 to Table 5-7 below (also see Annex G). A total of 33 themes were identified from all 10 categories based on the responses of participants. Category A was the KPI from the ToC's design component evaluating participants' perception of whether the legislation provides sufficient guidance towards the development and implementation of AQMP. Category B evaluates whether stakeholders are actively involved in the development and implementation AQMPs. Category C evaluates whether the AQMP influences decision making once included in the IDP, EMP or EIP. Lastly, category D combines six KPIs from the outcome and impact components of the ToC.

5.4.1 KPI category A: Legislation provides sufficient guidance for the development and implementation of AQMP

Category A asked the participants their views on whether they think the legislation provides sufficient guidance for the development and implementation of AQMP. Forty-two responses were received, and the results show that four key themes (A1 to A4) are identified from the responses. As shown in Table 5-1 below, Theme A1 shows that 67% (28 out of 42) of the respondents suggested that indeed the legislation is sufficient for both development and implementation. In suggesting that the legislation is sufficient, one of the respondents indicated that *"Tools are available to develop AQMP such as the Manual, legislation is fine"*.

Theme A2 shows 17% (7 out of 42) of respondents indicating that the legislation is sufficient for AQMP development only and not implementation. In this category one of the respondents indicated that: *"There certainly is guidance towards the development, but I don't think guidance for implementation is clear".* Another respondent provided the reason that there are no clear guidelines on the outlines for implementation: *"an AQMP compiled as per the framework and other related legislation does not provide the user adequate information to implement any actions. Details on the formulation of an implementation plan that is usable for the end user is required to promote consistency in AQMPs"*.

In Theme A3 the respondents suggested that the legislation is not sufficient for either development and implementation, and 14% (6 out of 42) fell into this theme. Only one respondent suggested Theme A4, indicating that they did not know the answer. Moreover, the majority (9) of the participants in Theme A1 are officials, followed by industry (7), then civil society and consultants both with six individuals each. Consultants and industry groups both have three respondents from the seven respondents in Theme A2. Only one respondent from the civil society group fell into Theme A4.

Table 5-1 Participants' responses to Category A on whether the legislation provides sufficient guidance for the development and implementation of AQMP

KPI Category	Description	Theme	Key Responses	Reponses				
				Officials	Consultants	Industry	Civil society	Total across all groups
A	The legislation provides sufficient guidance towards the development and implementation of AQMP	(A1) Sufficient legislation and implementation	*"Tools are available to develop AQMP such as the manual, legislation is fine".."yes the legislation provides guidance on the Development of the AQMP"…"Legislation provides sufficient guidelines on the development and implementation of AQMPS"…".Legislation (including regulations is clear, guidance documentation is provided by DFFE)"...."the guidelines are clear".*	9	6	7	6	**28**
		(A2) Sufficient legislation but no implementation	**Since th promulgation of the _AQA there have been at least 10 revisions, and/or regulations to give effect to the meaningful implementation of AQMP.".."Sufficient framework for the development of the AQMP. The challenge is on the skill sets from the government's end particularly with the implementation"..."Yes, for development of AQMPs. Unsure about implementation of AQMPs"...."There certainly is guidance towards the development but I don't think guidance for implementation is clear."..."an AQMP compiled as per the framework and other related legislation does not provide the user adequate information to implement any actions. Details on the formulation of an implementation plan that is usable for the end user is required to promote consistency in AQMPs"..."Yes; however, the regulatory department (DEFFE) lack administrative capability to ensure effective implementation of the AQMP."*	1	3	3	0	**7**
		(A3) Legislation is not sufficient for both development and implementation	*"I do not think the legislation is clear enough on the development and implementation."…."The legislation requires what must be done but not how it must be done"…"implementation of AQMP. Particularly in communities where air quality monitoring stations are situated"..."legislation does not provide any sufficient guidance especially for local communities as most communities are not informed about the AQMP process."*	1	2	0	3	**6**
		(A4) Difficult to say	*"Not yet sure as is early to be sure of what really the income will be"*	0	0	0	1	**1**

5.4.2 KPI category B: Stakeholders are actively involved in the development and implementation of AQMPs

Table 5-2 below shows the results for category B, which evaluates whether stakeholders are actively involved in the development and implementation. Four themes (B1 to B4) were identified. This category addresses KPI 3.1 from the ToC logical framework. Forty responses were received, with 55% (22 out of 40) of respondents across all groups falling into Theme B1, suggesting that there are certain stakeholders who are actively involved during both the AQMP development and implementation process. One of the respondents suggested that *“Stakeholders such as institutions of higher learning, government departments and NGOs do participate in the development of AQMP. But ordinary members of the community don’t seem to be interested in the development of AQMPs”.*

Another respondent suggested that those who are actively involved include academics and government institutions: *“Yes they are actively involved, but it’s mostly academics and government institutions, other stakeholders don’t understand or have limited interest on air quality therefore attendance to public meetings is always poor”*.

Theme B2 shows that 33% (13 out of 40) of the respondents across all groups suggested that there is a lack of stakeholder involvement during the process of the AQMP development and implementation process. Furthermore, 8% (3 out of 40) respondents across all groups fell into Theme B3, which argued that stakeholders are involved only at the beginning of the process. *“Stakeholders have been actively involved in the development of the AQMPs I have been involved in, but has not been active in the implantation thereof”*.

Five percent (2 out of 40) of respondents fell into Theme B4 where respondents indicated that they were simply not sure or had no experience on the topic. In terms of stakeholder groups, seven of the respondents in theme B1 were officials, followed by industry with six, then consultants with five, and lastly civil society with four. The majority of the respondents in Theme B2 are civil society with six followed by officials and industry, together with three. Only two groups were in theme B3, which included two consultants and one official.

Table 5-2 Responses with respect to category B on stakeholders' involvement in the AQMP process

Category	Description	Theme	Key Responses	Reponses (Total 42) Officials	Consultants	Industry	Civil society	Total across all groups
B	Stakeholders are actively involved in the development and implementation AQMPs.	(B1) Certain stakeholders are actively involved	*"Stakeholders such as institutions of higher learning, government departments and NGO do participate in the development of AQMP. But ordinary members of the community don't seem to be interested in the development of AQMPs."…"Yes they are actively involved but its mostly academics and government institution, other stakeholders don't understand or have limited interest on Air Quality therefore attendance to public meetings is always poor"..."In my experience there is typically stakeholder engagement – never really sure though to what extent it 'shapes' the final document."..." Stakeholder were involved in the development and implementation of the AQMP through the public participation process to begin with and the subsequent MSRG's established in the South Durban Basin, VTAPA and the HPA's - also including the various ITT's in the HPA. However the active involvement does not necessarily imply the successful achievement of the AQMP's goals and milestones - largely because the AQMP lacked the necessary legal requirements for implementing and enforcing the AQMP's thus essentially rendering them paper Tigers!"..."Yes, I&AP should be part of the development process.".*	7	5	6	4	**22**
		(B2) Lack of stakeholder involvement	*"not getting the buy in and participation of the main role players when Brendan was drafting the District's AQMP and it not being identified in our IDP".. "Mining sector is the second source of air pollution in the area, however their participation in air quality structures in the region is very minimal."..."In a City like Johannesburg there is minimal stakeholder engagement. It is not clear if this is due to lack of awareness or something else. The current AQMP for the City went to public participation together with the by-law but very few stakeholders attended the public participation".."not everyone is actively involved, especially the marginalised communities."..."Because they don't consult the most affected community they do the short cut by putting it on internet for comment and most people are vulnerable and illiterate"..."Not really some are still not involved yet".*	3	1	3	6	**13**
		(B3) stakeholders are involved only at the beginning	*"Stakeholders are mostly involved in the development of AQMP but less involved in the implementation thereof."..."Stakeholders have been actively involved in the development of the AQMPs I have been involved in but has not been active in the implantation thereof.".....\"Development of AQMP's have been successfully led by consultants. Implementation is led by municipalities and provincial departments and have not been successfully implemented"*	1	2	0	0	**3**
		(B4) Difficult to say/Not Sure/Do not know	*I'm not sure about this. The AQMPs for Priority areas had several workshops when being drawn up. AQMPs for municipalities are oftern drawn up by consultants and the "public participation" box is always ticked. The question is about the efficiency of the latter process*	0	1	1	0	**2**

5.4.3 KPI category C: the AQMP influences decision making once included in the IDP, EMP or EIP

This category asks the four stakeholder groups their views on whether they think the AQMP influences decision making once included into IDP, EMP or EIP (see Table 5-3). Thirty-seven responses were received, and two themes were identified. Theme C1 reports the views of participants who generally agreed that AQMP does influence decision making and Theme C2 of respondents who were of the view that it is not clear what inclusion in the IDP means or who simply did not know the answer. The results further show that most responses (20) fell under Theme C2, while 17 of the respondents were in Theme C1. Several respondents whose views fell under theme C2 argued that the requirement to integrate the AQMP with IDP, for example, is not clear, while others argued that there are other pressing issues that are prioritised in the IDP before air quality matters and therefore a budget is not provided. The majority of the people whose views fell under Theme C2 came from civil society (8) and the majority of respondents whose themes resorted under Theme C1 were air quality officials.

“As different practitioners, we still struggle to understand what this integration means.”

“… in the context of SA, there so many competing factors, such as unemployment, creating new businesses to grow the economy, bringing of investments (to name a few). When new industry comes to the municipality they tend to check its viability in terms of EIA and AQMP is seen as an after effect, maybe because impacts of air quality are seen in long term, so the AQMP is overlooked when developing an IDP for instance.”

“… many municipalities are still struggling to develop AQMPs because it is not prioritised at IDP level, there is no budget for it.”

Table 5-3 Stakeholders' response with respect to Theme C on whether the AQMP influences decision making once included in the IDP, EMP or EIPs

KPI Category	Description	Theme	Key Responses	Reponses				
				Officials	Consultants	Industry	Civil society	Total across all groups
C	AQMP does influence decision making once included in the IDP, EMP or EIP.	(C1) AQMP does influence decision making	*"Most definitely. It influences budgeting and boost in terms of debates with and for politicians as we interact with the public".."Yes, If the AQMP are represented in the IDP, budget can be allocated to air quality projects and can be measured against the performance system) SDBIP."..."yes they do influence decision making".."This would vary from place to place. In Richards Bay for example it certainly would but not sure for other places"...."It will influence it in municipalities having EMIs, and Environmental Compliance Officers/ Managers with good knowledge and credibility".*	6	5	5	1	**17**
		(C2) It is not clear what inclusion in the IDP mean/ Do not know/Im not sure	*"As different practitioners, we still struggle to understand what this integration means.".."many municipalities are still struggling to develop AQMPs because it is not prioritised at IDP level, there is no budget for it."…."Very little".."Not really, the process to integrate AQMP in the IDP is not clear and the City of Johannesburg has never done it except asking the approval by the council. The budgeting process doesn't allow it."…"Disagree, currently the gap is very wide between AQMP, the IRP, IEP, EMP, IDP etc. these plans are all suppose to be interlinked but currently they are not. e.g. The IDP does not say anything about air quality, but rather infrastructure development in local communities".."It doesn't implement decision making because of the corruption". ."In view of the other pressing problems that beset local authority, I'm not sure that AQMPs play a significant role.".."*	4	4	4	8	**20**

5.4.4 KPI category D: Outcome (intermediate) and impact components

Using stakeholder perceptions, this section evaluates whether AQMP as an instrument helps realise the objectives of section 2 of NEM:AQA and section 24 of the Constitution. The following six key assumptions and KPIs were evaluated based on the intermediate outcomes and impact components of the ToC:

- AQMP does bring air quality in compliance with the ambient air quality standards (NAAQS);
- AQMP does improve air quality to give effect to chapter 3, section 16(1) of NEM:AQA requirements;
- The AQMP does realise an environment that is not harmful to health and well-being;
- The AQMP achieves protection of the environment in the immediate and long term;
- The AQMP succeed in preventing pollution and ecological degradation; and
- The AQMP secures ecologically sustainable development and economic and social development.

The results show that 23 potential themes were initially identified from the six evaluation questions. These were further grouped into four key themes (D1-D4) as shown in Figure 5-10 below. Theme D1 shows the respondents across all groups. In general, they agreed that the AQMP indeed does meet its mandate with respect to the six KPIs. Theme D2 on the other hand indicates responses that in general did not agree with the KPIs, while theme D3 represent the stakeholders who argued that the AQMP does not achieve its mandate of addressing the KPIs due to a lack of implementation. Lastly, theme D4 denotes the respondents who felt that they do not know the answer to the questions.

Overall, the results in Figure 5-10 show that from the 42 participants, a combined total of 85 responses from the six KPIs or evaluation questions resorted under theme D2, meaning that the stakeholders' general perception is that the AQMP as an instrument does not realise the NEM:AQA objectives, achieve compliance with the NAAQS and realise a human environmental right provided in section 24 of the Constitution. This was followed by 76 responses that resorted under theme D3, which holds that these six KPIs are not being achieved due to a lack of implementation of the AQMPs. Seventy-four (74) responses resorted under theme D1 across the six KPIs. These were stakeholders who generally agreed that the AQMP does meet its mandate relating to the KPIs. Theme D4 had 18 responses across the six KPIs, and these were stakeholders who responded that they did not know the answer. The detailed results for each individual KPI are provided in Sections 5.4.5 to 5.4.10 below.

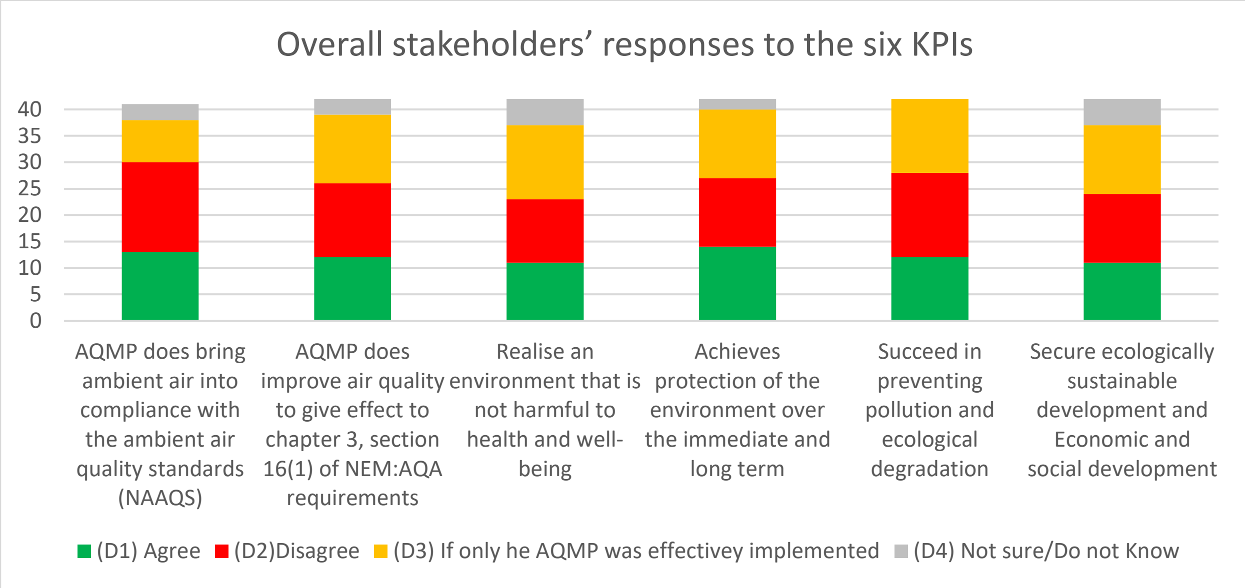

Figure 5-10 Overall stakeholders' responses to the six KPIs

5.4.5 AQMP does bring air quality into compliance with the ambient air quality standards (NAAQS)

Table 5-4 shows that 41 responses were received on this KPI. Most (17) respondents across the four stakeholder groups fell under theme D2 with the view that the AQMP does not bring air quality into compliance with the ambient air quality standards. Six respondents whose answers fell under this theme came from the civil society group and five were consultants, with four from industry. Some of the respondents expressed their strong views that: *“The AQMP as a document will not achieve compliance with NAAQS. The intention of an AQMP is to develop realistic implementation strategies that will help reduce emissions from problem sources, which in turn should move air quality in a specific area towards compliance with NAAQS.”*

“I think conditions embedded in the atmospheric emissions licences for various facilities is serving the purpose to reduce the ambient air quality pollution. AQMP alone may not be effective due to administrative in capabilities by the regulator to enforce the plan outside the AEL”.

Theme D1 represents those respondents who agreed that the AQMP does bring ambient air into compliance with the NAAQS. This group of answers consisted of 13 respondents. One of the respondents indicated that: “*This is the main objective of an AQMP, and if implemented and enforced should achieve the set objective. However, this has not been the case in the VTAPA or HPA and is in my opinion because of a lack of resources and implementation*”.

Eight of the respondents whose answers fell under Theme D3 argued that this could be true if the AQMP was effectively implemented. Only four individuals’ answers resorted under Theme D4, meaning that they were not sure or had no knowledge. One of the respondents indicated that: *“In theory yes, but the fact that is not implementable and cross-cutting nature of air pollution problems makes it difficult to say”.*

Table 5-4 Stakeholders' responses relating to theme D on the NAAQS.

KPI Category	Description	Theme	Key Responses	Reponses				Total across all groups
				Officials	Consultants	Industry	Civil society	
D	AQMP does bring ambient air into compliance with the ambient air quality standards (NAAQS)	(D1) Does	*"yes through implantation strategies"…."The baseline report in the AQMP identify all sources of pollution in the area and the intervention strategies are developed to address those"…."It certainly is a step forward towards managing air quality. Even if just creating awareness of management possibilities"..."Durban's South Industrial Basin is a great example of an AQMP bringing air quality into compliance. Otherwise it is very difficult to say that an AQMP has achieved this. There are examples where the implementation of Minimum Emission Standards have brought about noticeable reductions in ambient concentrations, Richards Bay is one"..."to a certain extent it does but not to its full capacity."....."We are in compliance from January up to march the winter kicks in then we are in non-compliance again"*	4	4	3	2	**13**
		(D2) DOES NOT	*"Not always, but it serve as a road map towards achieving compliance standards. It cannot absolutely be enforced on polluters"…"I have never experienced a circumstance where this has happened. Least of all in the priority areas"…"The AQMP as a document will not achieve compliance with NAAQS. The intention of an AQMP is to develop realistic implementation strategies that will help reduce emissions from problem sources, which in turn should move air quality in a specific area towards compliance with NAAQS."..."Looking at the statistics, I must disagree"..."there is no certainty that it can necessarily bring ambient air quality into compliance."...."I think conditions embedded in the Atmospheric Emissions Licences for various facilities is serving the purpose to reduce the ambient air quality pollution. AQMP alone may not be effective due to administrative in capabilities by the regulator to enforce the plan outside the AEL."Z..."it provides standards, but it is not enough to ensure compliance"…."The DFFE is not doing enough of what they are supposed to do. When most of the time they don't listen to the affected communities. They failed the communities."..."The basic premise of an AQMP is to bring a priority area out of compliance with National ambient Air Quality standards into compliances and to progressively lead to a reduction of air pollution that can affect the receiving environment and ultimately public health. This has largely not happened."..."The state of the environment reports by the NAQO speak for themselves. The ambient AQ in the VTAPA and the HPA remain out of compliance with our ambient air quality standards and even so our NAAQS are not sufficient to protect public health. The WHO has recently reviewed their ambient AQ guideline limits and we remain way above these limits for the most important public health criteria pollutants (Particulate matter PM10 and PM2.5, O3, NOx, TVOC's, etc."*	2	5	4	6	**17**
		(D3) If only the AQMP was effectively implemented	*"It does if it is well implemented"…"This is the main objective of an AQMP, and if implemented and enforced should achieve the set objective. However, this has not been the case in the VTAPA or HPA and is in my opinion because of a lack of resources and implementation"..."Only implementation can bring about air quality improvements. A document does not guarantee results"..."No, the AQMP per se will not. The successful implementation of the improvement strategies should bring the ambient air into compliance"......."No, the AQMP per se will not. The successful implementation of the improvement strategies should bring the ambient air into compliance"..."Provided that implementation plan is adhered too and budget is available for proper implementation"...*	2	2	2	2	**8**
		(D4) Not sure	*"In theory yes but the fact that is not implementable and cross-cutting nature of air pollution problems makes it difficult to say"..."Emission Reduction programmes on the AQMPs should be evaluated against ambient air results."…."In view of the other pressing problems that beset local authority, I'm not sure that AQMPs play a significant role."*	2		1		**3**

5.4.6 AQMP does improve air quality to give effect to chapter 3, section 16(1) of NEM:AQA requirements

Table 5-5 shows that of the 41 responses, 14 resorted under Theme D2, being respondents suggesting that the AQMP does not improve air quality to give effect to NEM:AQA. Twelve responses fell under Theme D1, being the opposite, generally agreeing with the KPI. Twelve stakeholders whose answers resorted under Theme D3 were of the view that AQMP could give effect to the act if only it was effectively implemented. Only three individuals' responses resorted under Theme D4 as they were not sure or knowledgeable on the matter. The results further show that majority (6) of the consultants' responses fell under theme D2, while none of them were found under Theme D4. Some of the responses include:

> *"AQMPs all have the goal to improve air quality, but I don't think that they do. They rather improve the enforcement of AQM regulations."*

> *"It depends on how effective the implementation process is, otherwise the AQMP is meant to give guidance and bring cooperative engagement amongst relevant stakeholders to implement the plan."*

> *"It is supposed to, but priority is not given to air quality issues in the municipality and hence no tangible outcome so far as a result of AQMP."*

Table 5-5 Stakeholders responses relating to theme D on AQMP giving effect to NEM:AQA.

KPI Category	Description	Theme	Key Responses	Reponses				
				Officials	Consultants	Industry	Civil society	Total across all groups
D	AQMP does improve air quality to give effect to chapter 3, section 16(1) of NEM:AQA requirementst	(D1) AQMP does improve air quality		5	2	2	3	**12**
		(D2) AQMP does NOT improve air quality	*"Most Authorities do AQMP for compliance and not fund or resource the AQMP."…"I have never seen this happen "…."In theory yes. I am yet to see it in practice – measurable outcomes that will improve the actual AQ in a region will have to be included in AQMPs and compared over a period of time for this to be true. "...."AQMPs all have the goal to improve air quality, but I don't think that they do. They rather improve the enforcement of AQM regulations"..."Disagree - there is no certainty that it will improve ambient air quality."..it's just a piece of paper"...."because the WHO released a study showing more than 2000 deaths as a result of Eskom's power stations emissions, this is evidence enough that the air quality is bad."*	2	6	3	3	**14**
		(D3) If only the AQMP was effectively implemented	*"It depends on how effective the implementation process is, otherwise the AQMP is meant to give guidance and bring cooperative engagement amongst relevant stakeholders to implement the plan"…"It suppose to but priority is not given to Air Quality issues in municipality and hence no tangible outcome so far as a result of AQMP"..."yes if implemented correctly"..."If implemented right but implementation is always a challenge due to budget constraints"..."The effectiveness of the AQMP is only realised when it is implemented in the sources of emissions. So, I would say that the plan is improving the air quality as it encourages the execution of projects to minimize high emissions from big industries."..."It can once is implemented "..."It can once is implemented "...."The AQMP will not realise anything. It's just a plan (roadmap) to compliance. The successful implementation of the improvement strategies should improve air quality, if properly addressed.".*	4	1	3	4	**12**
		(D4) Not sure		0	1	2	0	**3**

5.4.7 Realising an environment that is not harmful to health and well-being

This KPI evaluates participants' views on whether the AQMP helps realise an environment that is not harmful to health and well-being based on the 42 responses as shown in Table 5-6. Theme D1 indicates respondents generally agreeing, which had 11 respondents. Theme D2 represents respondents in disagreement with the KPI, which had 12 respondents as shown in Table 4-6. Theme D3 represents respondents who were of the view that this could be true if the plans were effectively implemented, and most (14) responses fell here, while Theme D4 were those that did not know or were unsure, which had only five responses. Six respondents in Theme D1 were officials while six respondents from the civil society group gave answers that fell under Theme D3. Some of the responses include:

"This will depend on the successful implementation of intervention strategies."

"Good and reasonable AQMP is developed but no implementation at all."

"It is hard to say whether this goal is achieved through any AQMP."

Table 5-6 Stakeholders' response relating to theme D on the AQMP realising an environment that is not harmful to health and well-being.

KPI Category	Description	Theme	Key Responses	Reponses				
				Officials	Consultants	Industry	Civil society	Total across all groups
D	Realize an environment that is not harmful to health and well-being.	(D1) Agree		6	2	2	1	**11**
		(D2) Disagree	*"I believe that AQMP on its own will never improve AQ"…"Comparing ambient air quality to local standards (which have not in all cases followed recent guidelines from WHO and other international guidelines) I must again disagree.".."there is no certainty that it will realize an environment that is not harmful to health and well-being."......"Not currently - potentially if enforceable with strong criminal and administrative penalties."*	1	5	4	2	**12**
		(D3) If only the AQMP was effectively implemented	*"It could if implemented"…"When the ambient results are below the national ambient air quality standards "…"Good and reasonable AQMP is developed but no implementation at all."…"This will depend on the successful implementation of intervention strategies"..."It does work towards this goal, but progress is always slow"...."it does in paper, but in a practical form its not."..."In paper not through implementation".."The AQMP will not realise anything. It's just a plan (roadmap) to compliance. The successful implementation of the improvement strategies should bring the ambient air into compliance, if properly addressed".....'if the plan is effective".*	4	2	2	6	**14**
		(D4) Not sure	*"It is hard to say whether this goal is achieved through any AQMP"*	0	2	2	1	**5**

5.4.8 Achieves protection of the environment in the immediate future and over the long term

Table 5-7 below shows that 14 of the 42 respondents' responses fell under Theme D1 where they generally agreed with the KPI that the AQMP does achieve protection of the environment in the immediate future and in the long term, while 13 of the respondents in theme D2 disagreed with the KPI. Some of the responses include:

"In principle yes, but I have not yet seen it happen in practice."

"More than 10 years on and AQMP proved wholly inadequate to achieve protection of the environment over the immediate and long term."

Theme D3 also received 13 respondents arguing that this could be true if only the AQMP was effectively implemented. Theme D4 represents respondents who were not sure. This theme included five responses. Furthermore, five participants from the officials' group and five from industry gave answers that resorted under Theme D1 while five consultants and five from civil society groups gave answers that fell under Theme D2. None of the officials and civil society's answers were in Theme D4.

"The AQMP will not realise anything. It's just a plan (roadmap) to compliance. The successful implementation of the improvement strategies should achieve protection of the environment over the immediate and long term, if properly addressed."

"If AQMP were correctly implemented by competent personnel and resourced there could be a substantial achievement. The AQMPs are done for ticking the box and compliant purposes."

Table 5-7 Theme D relating to the AQMP protecting of the environment in the immediate future and in the long term.

KPI Category	Description	Theme	Key Responses	Reponses				
				Officials	Consultants	Industry	Civil society	Total across all groups
D	Achieve protection of the environment over the immediate and long term.	(D1) Agree	*"to a certain extent"…."The AQMP may achieve protection of the environment more so over the long term than the immediate"…"Yes, projects and technologies which are implemented to solve a current emissions problem as aligned with the AQMP, are effective for a long term. "*	5	2	5	2	**14**
		(D2) Disagree	*"In principle yes but I have not yet seen it happen in practise"…"Not currently - potentially if enforceable with strong criminal and administrative penalties"…"More than 10 years on and AQMP proved wholly inadequate to achieve protection of the environment over the immediate and long term"..."despite the poor air quality conditions in south Africa, particularly in Mpumalanga and Limpopo; to date coal mining authorisation is granted which has long term impact."*	1	5	2	5	**13**
		(D3) If only the AQMP was effectively implemented	*"When the ambient results are below the national ambient air quality standards"….."If AQMP were correctly implemented by competent personnel and resourced there could be a substantial achievement. The AQMPs are done for ticking the box and compliant purposes."..."It is the intent of AQMPs to maintain or improve air quality. The success thereof depends on the success of implementation strategies"...."Only if law can be enforced and corruption being stopped"..."The AQMP will not realise anything. It's just a plan (roadmap) to compliance. The successful implementation of the improvement strategies should achieve protection of the environment over the immediate and long term, if properly addressed."..."Provided that funds are available to implement proposed projects"...*	5	3	2	3	**13**
		(D4) Not sure	*"This would certainly be an intention of an AQMP, but don't have any input on the extent of the AQMP achieving this."…."Do not know"*	0	1	1	0	**2**

5.4.9 The AQMP succeeds in preventing pollution and ecological degradation.

This category looks at stakeholders' views on whether the AQMP succeeds in preventing pollution and ecological degradation. From the 42 responses, theme D2 had the most respondents with 16. Here the participants generally disagreed with the KPI, followed by theme D3 were 14 participants where respondents argued that if only the AQMP was effectively implemented, the AQMP would succeed. Most of the participants from the civil society group's answers fell under Theme D2 with seven individuals. None of individuals from this group's answers fell under Theme D1. Theme D3 had almost balanced responses from the four groups, with consultants and officials both having four individuals each, while industry and civil society both had three individuals each (see Table 5-8).

"No, AQMP does not prevent pollution and environmental degradation. It contributes towards minimizing the impacts of pollution and ecological degradation."

"Way too ambitious for an AQMP – if it were to happen, it would have to be way more than an AQMP."

"it may assist with monitoring of pollution, but is not preventing it."

"This will depend on the successful implementation of intervention strategies that focus on environmental protection and ecological degradation."

Table 5-8 Theme D relating to the AQMP preventing pollution and ecological degradation.

KPI Category	Description	Theme	Key Responses	Reponses: Officials	Consultants	Industry	Civil society	Total across all groups
D	Succeed in preventing pollution and ecological degradation	(D1) Agree	*"It does but it's a long journey"…"the mandate of the implementing AQO considers industrial emissions and regulation through AELs and the associated regulations. Reducing emissions from industry has had some success"*	5	3	4	0	**12**
		(D2) Disagree	*"No AQMP does not prevent pollution and environmental degradation. It contributes towards minimizing the impacts of pollution and ecological degradation"…"Way too ambitious for an AQMP – if it were to happen, it would have to be way more than an AQMP"…" it may assist with monitoring of pollution, but is not preventing it"..."More than 10 years on and AQMP proved wholly inadequate in preventing pollution and ecological degradation."..."Disagree, failure to compel compliance and monitoring of SOE's like Eskom and other mining companies, lot of companies get away with a lot of damage behind"*	2	4	3	7	**16**
		(D3) If only the AQMP was effectively implemented	*"Once it has been reviewed and updated, it will certainly be successful"…"When the ambient results are below the national ambient air quality standards, then legislation could achieve secure ecologically sustainable development."…"The available AQMPs were done for compliance purposes only and were never properly implemented due to lack of capacity within the relevant institutions."..."If implemented, it should succeed. Bit to date the main limitation was the implementation of these AQMPs"..."This will depend on the successful implementation of intervention strategies that focus on environmental protection and ecological degradation."..."The AQMP can assist in pollution prevention as long as the requirements of the AQMP are known by all stakeholders that need to ensure that its implemented."..."most of the municipalities does not implement the measures identified on the AQMP"..."The AQMP will not realise anything. It's just a plan (roadmap) to compliance. The successful implementation of the improvement strategies should prevent pollution and ecological degradation, if properly addressed."..."There is not a strong focus on ecologically sustainable development of AQMP's in SA"..."only if everything goes according to plan"..*	4	4	3	3	**14**

5.4.10 The AQMP secures ecologically sustainable development and economic and social development

As shown in Table 5-8, this category evaluates if the AQMP does secure ecologically sustainable development and economic and social development. Four themes were identified from 42 responses. Both Themes D2 and D3 received 13 responses across all groups, followed by D1 with 11 individuals and lastly theme D4 with five individuals. Five of the 11 officials who participated gave answers that resorted under Theme D3 while four consultants and four respondents civil society gave answers that fell under Theme D2. Some of the respondents argued the following:

“There should be better instruments that leverage economic and social development and impacts to the environment.”

“There is not a strong focus on economic and social development of AQMP’s in SA.”

“These gains could only be achieved or realised when there is capacity and skills to implement the air quality. In most cases the authorities appoint good consultants to do AQMP for them and not implement it.”

Table 5-9 Theme D on ecological degradation and securing ecologically sustainable development and economic and social development.

KPI Category	Description	Theme	Key Responses	Reponses				
				Officials	Consultants	Industry	Civil society	Total across all groups
D	secure ecologically sustainable development and Economic and social development	(D1) Agree	*Most definitely, the AQMP seeks to address the right to a sustainable environment which automatically promote a justified economic and social development"…"it is my opinion that an AQMP does to a certain extent, secure ecologically sustainable development and promote justified economic and social development."*	4	3	3	1	**11**
		(D2) Disagree	*"Some essential development, like the provision of electricity, is not always ecologically sustainable."…"it seems to me that, in view of other societal problems, the political will to enforce AQMP requirements is lacking".."There should be better instruments that leverage economic and social development and impacts to the environment"..."More than 10 years on and AQMP proved wholly inadequate to secure ecologically sustainable development and promote justified economic and social developmen"...."Disagree, It does not, the plan has gaps which allows industries to continue polluting, making profit at an expense of people's health and the environment."....*	2	4	3	4	**13**
		(D3) If only the AQMP was effectively implemented	*"It could if implemented".."Once the ambient results is below the national ambient air quality standards, then focus of the legislation seek to achieve justified economic and social development"…."These gains could only be achieved or realized when there is capacity and skills to implement the air quality. In most cases the authorities appoint good consultants to do AQMP for them and not implement it"..."AQMP is intended to promote justified economic and social development but it is not considered in most decision-making processes relating to development."..."If implemented correctly, this should be the case"..."There is not a strong focus on economic and social development of AQMP's in SA"*	5	3	2	3	**13**
		(D4) Not sure	*"Hard to say, but probably not significantly."…."AQMPs are still fairly new in our district Nkangala /Highveld, and some questions need a 10 years old established AQMP, to assess it effectiveness"*	0	1	2	2	**5**

5.5 Chapter Summary

This chapter presented the results obtained from the document review and interviews conducted during this study. Table 5-10 provides a summary of results obtained in line with each of the six ToC components and KPIs. The next chapter offers an interpretation of these results.

Table 5-10 Summary of the results obtained from the six ToC components and associated KPIs.

ToC component for AQMP	KPI	Results Summary
1. AQMP design component: the design components relate to the design of the South African protected area system as reflected and prescribed in:		
S24 Constitution NEMA principles NEM: AQA sector-specific legislation 2017 National Framework on Air Quality Management in South Africa (also referred to as National AQMP) Technical Guiding documents: Manual For Air Quality Management PLANNING - Other legislations: Municipal Systems Act; PAJA; PAIA; Municipal By-laws.	1.1	Interviews and questionnaires: Forty-two responses were received and the results show that four key themes (A1 to A4) are identified from the responses. As shown in **Error! Not a valid result for table.**, Theme A 1 shows that 67% (28 out of 42) of the respondents suggested that indeed the legislation is sufficient for both development and implementation. Theme A2 shows 17% (7 out of 42) of respondents indicating that the legislation is sufficient for AQMP development only and not implementation. In Theme A3 the respondents suggested that the legislation is not sufficient for either development and implementation, and 14% (6 out of 42) fell into this theme. Only one respondent suggested Theme A4, indicating that they did not know the answer.
2. AQMP inputs component: input component for AQMP development and implementation process describes the resources required for the process to be effectively executed:		
skills and competencies of consultants/specialists	2.1 – 2.3	Three KPIs were used to evaluate the skills and competencies of consultants/specialists and the results show that seven of the nine case studies do conform to KPIs 2.1 and 2.2 with respect to the relevant fields of study and experience respectively, with two of the

ToC component for AQMP	KPI	Results Summary
		case studies not being applicable to the KPIs as they were developed internally and not by consultants (Figure 5-2)
skills and competencies of AQOs	2.4	The results show that engineering control (six non-conforming (NC) and two conforming (As)) and air pollution modelling (five NC's and three A's) are the biggest skills gaps, followed by skills for the identification and emission quantification and air pollution risk assessment both scoring four NC's and four A's as shown in Figure 5-3)
Time	2.5	all nine AQMP case studies conformed (A) to KPI 2.5 regarding the description or provision of timeframes for the implementation of the AQMP intervention strategies (Figure 5-4).
Finding/money	2.6	Three case studies conformed (A) and six case studies scored partial conformance (B) to KPI 2.6 regarding the description of the budget provision for the development and implementation. The evaluation found that of the six case studies that were scored B, three (i.e., Limpopo (LP), Buffalo City (BCMM), Langeberg (LLM)) were found to have only indicated that funding should be provided for the implementation of the plans, but without providing any detailed specifications on the budgetary needs and operational costing (Figure 5-4).
Data & Information and Infrastructure	2.7-2.8	All nine case studies scored B for KPIs 2.7 and 2.8. KPI 2.7 deals with data accessibility, accuracy, and reliability to implement the AQMP and KPI 2.8 deals with the efficiency of the ambient air quality monitoring network. Seven reports (BCMM, John Taolo Gaetsewe (JTGDM), WCDM, STLM, LLM, LP, and GP) identified the following key issues as limitations: poor or no ambient AQ monitoring network and data, poor or non-functioning monitoring stations, no human and/or skills capacity for monitoring (Figure 5-4).

ToC component for AQMP	KPI	Results Summary
Cooperative governance	2.9	Four of the case studies conformed (GP, City of Johannesburg (CoJ), BCMM and LLM) while the other four cases were in partial conformance (B) and one (STLM) did not provide a response, as shown in Figure 5-4.
3. AQMP activities component There are generally six steps that should be followed to develop and implement an AQMP as prescribed in the 2012 manual for air quality management planning (Figure 2-5).		
1) Establishment of stakeholder groups	3.1	Table 5-2 shows the results for category B, which evaluates whether stakeholders are actively involved in the development and implementation. Four themes (B1 to B4) were identified. This category addresses KPI 3.1 from the ToC logical framework. Forty responses were received, with 55% (22 out of 40) of respondents across all groups falling into Theme B1, suggesting that there are certain stakeholders who are actively involved during both the AQMP development and implementation process. Theme B2 shows that 33% (13 out of 40) of the respondents across all groups suggested that there is a lack of stakeholder involvement during the process of the AQMP development and implementation process. Furthermore, 8% (3 out of 40) respondents across all groups fell into Theme B3, which argued that stakeholders are involved only at the beginning of the process. Five percent (2 out of 40) of respondents fell into Theme B4 where respondents indicated that they were simply not sure or had no experience on the topic.
(2) Gap and problem analysis;	3.2	Figure 5-5 shows that eight cases studies scored A and only one case study scored NC for KPI 3.2, which deals with the extent to which a gap analysis was conducted during the AQMP development and implementation process
(3) Establish air quality goals;	3.3 – 3.1	

ToC component for AQMP	**KPI**	**Results Summary**
(4) Develop interventions and a plan to achieve air quality objectives; (5) Implementation of the intervention strategies; and		The case studies generally performed well regarding KPI s 3.3 - 3.15 on intervention strategies and implementation plan with 82 conformances (A's) and 20 partial conformance (B's) and 15 non-conformances (NCs) across all cases. The major aspect in relation to which eight case studies failed to conform relates to KPI 3.8 and the extent to which the intervention strategies estimated the expected costs and benefits as shown in Figure 5-6.
(6) Monitoring, reporting and evaluation as outlined in the national framework for air quality management planning (DEA, 2012, 2018)	3.16 – 3.19	The results in Figure 5-7 show that the case studies performed well with regard to air quality monitoring and evaluation, with an overall score of 22 A's, 4 B's,10 NCs and 3 NA's.
4. AQMP Process Outputs Output component is tangible results usually in reports and documents.		
Draft AQMP Final AQMP	4.1 – 4.20	In terms of the AQMP air quality goal setting and assigning roles and responsibilities (i.e., KPIs 4.1–4.12), the results show an overall poor performance in terms of report quality and completeness across all the case studies, with less conformances (38 A's) and more partial-conformances (53 B's), as well as 25 non-conformances shown in Figure 5-8. Figure 5-9 shows the results of the baseline assessments KPIs 4.13–4.20, and also evaluate the quality of the AQMP report. The most significant poor performance across all cases relates to KPI 4.16, which involves quality assurance and quality control (QA/QC) programme of baseline air quality data.

ToC component for AQMP	KPI	Results Summary
5. AQMP Immediate outcome component The outcome component in AQM planning is divided into immediate and intermediate outcomes. The immediate outcome depends on the sphere/level at which the AQMP is done. In declared priority areas, the AQMP must be approved and gazetted by the relevant minister/MEC. AQMPs for municipalities must be included into the IDP/EMP/EIP		
immediate: Gazetted or included in the IDP, EIP	3.20 and 5.1	**Document review:** Figure 5-5**:** The last KPI in this category (3.20) evaluated whether the AQMP has been reviewed every five years and has been gazetted or included in the IDP/EIP/EMP. The case studies scored six A's and three NC's. **Interviews & questionnaires:** Table 5-3: Thirty-seven responses were received, and two themes were identified. Theme C1 reports the views of participants who generally agreed that AQMP does influence decision making and Theme C2 of respondents who were of the view that it is not clear what inclusion in the IDP means or who simply did not know the answer. The results further show that most responses (20) fell under Theme C2, while 17 of the respondents were in Theme C1
6. AQMP intermediate outcome and impact components		
• AQMP does bring air quality in compliance with the ambient air quality standards (NAAQS);	5.2 and 6.1 – 6.4	The results show that 23 potential themes were initially identified from the six evaluation questions. These were further grouped into four key themes (D1-D4) as shown in Figure 5-10. Theme D1 shows the respondents across all groups. In general, they agreed that

ToC component for AQMP	KPI	Results Summary
• AQMP does improve air quality to give effect to chapter 3, section 16(1) of NEM:AQA requirements; • The AQMP does realise an environment that is not harmful to health and well-being; • The AQMP achieves protection of the environment in the immediate and long term; • The AQMP succeed in preventing pollution and ecological degradation; and • The AQMP secures ecologically sustainable development and economic and social development.		the AQMP indeed does meet its mandate with respect to the six KPIs. Theme D2 on the other hand indicates responses that in general did not agree with the KPIs, while theme D3 represent the stakeholders who argued that the AQMP does not achieve its mandate of addressing the KPIs due to a lack of implementation. Lastly, theme D4 denotes the respondents who felt that they do not know the answer to the questions, Overall, the results in Figure 5-10 show that from the 42 participants, a combined total of 85 responses from the six KPIs or evaluation questions resorted under theme D2, meaning that the stakeholders' general perception is that the AQMP as an instrument does not realise the NEM:AQA objectives, achieve compliance with the NAAQS and realise a human environmental right provided in section 24 of the Constitution. This was followed by 76 responses that resorted under theme D3, which holds that these six KPIs are not being achieved due to a lack of implementation of the AQMPs. Seventy-four (74) responses resorted under theme D1 across the six KPIs. These were stakeholders who generally agreed that the AQMP does meet its mandate relating to the KPIs. Theme D4 had 18 responses across the six KPIs, and these were stakeholders who responded that they did not know the answer. The detailed results for each individual KPI are provided in Sections 5.4.5 to 5.4.10.

CHAPTER 6 DISCUSSION

6.1 Introduction

This chapter provides a discussion of the results presented in Chapter 5 as weighed against the evidence found in the available literature. The discussion is Phase 5 of the thesis as highlighted in red in Figure 6-1 below. The chapter follows the same pattern as in Chapter 4 were the results of the document analysis are discussed first, followed by the results of the questionnaires and interviews with participants.

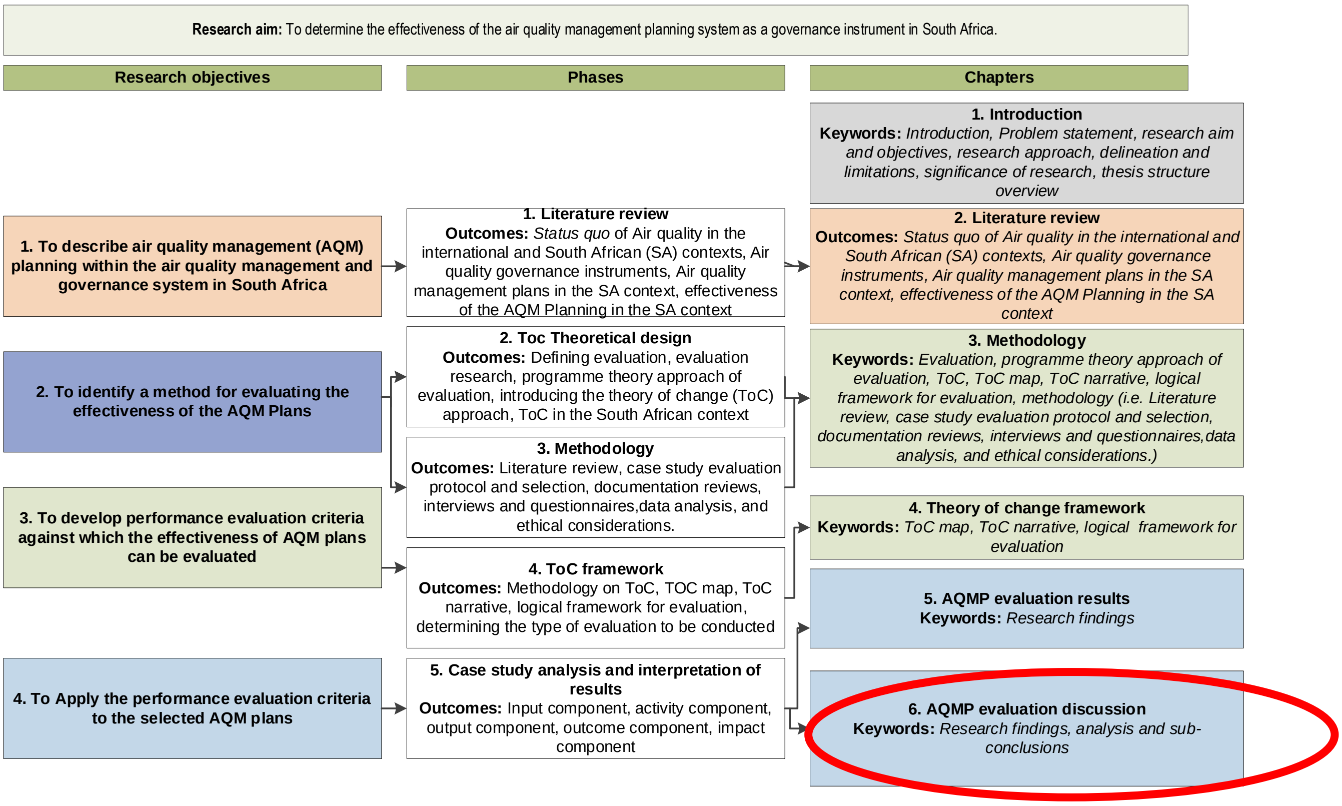

Figure 6-1 Thesis structure showing the link between Objective 4 (on the left-hand side) and Phase 4 in Chapter 5

6.2 A ToC map for AQMPs in South Africa

As discussed in Chapter 3, ToC as an evaluation method can help unpack how the activities of a given programme will lead to the desired outcomes by understanding the causal links from design to inputs, to activities, to outputs, to outcomes, to impacts. It also includes the assumptions underpinning the progress of the programme (Mayne, 2015). Based on the outcomes of the results chapter, Figure 6-2 below shows the actual situation pertaining to the development and implementation of AQMPs in South Africa. The ToC map shows causal links between the different components. It also includes 15 key underlying assumptions that underpin the process of AQMP development and implementation in South Africa. These assumptions were tested in this study to determine their validity and to see whether they are flawed or not using 14 evaluation questions and 57 KPIs. The green dotted arrows on the map show that the causal links are working as intended and are based on a valid assumption. Red dotted arrows show the causal links that are not working as intended and that are based on flawed assumptions. These red dotted arrows are found in all the ToC components except for the design component. Sections 6.4 to 6.8 below discuss the red dotted arrows in detail and bring a deeper understanding as to what is not functioning as intended and why based on the results as well as linking back to existing literature. Black dotted arrows mean the causal links have not been evaluated in this study and require further evaluation. The results relating to the causal links in the ToC map for the AQMP process are further discussed from Sections 6.3 to 6.8.

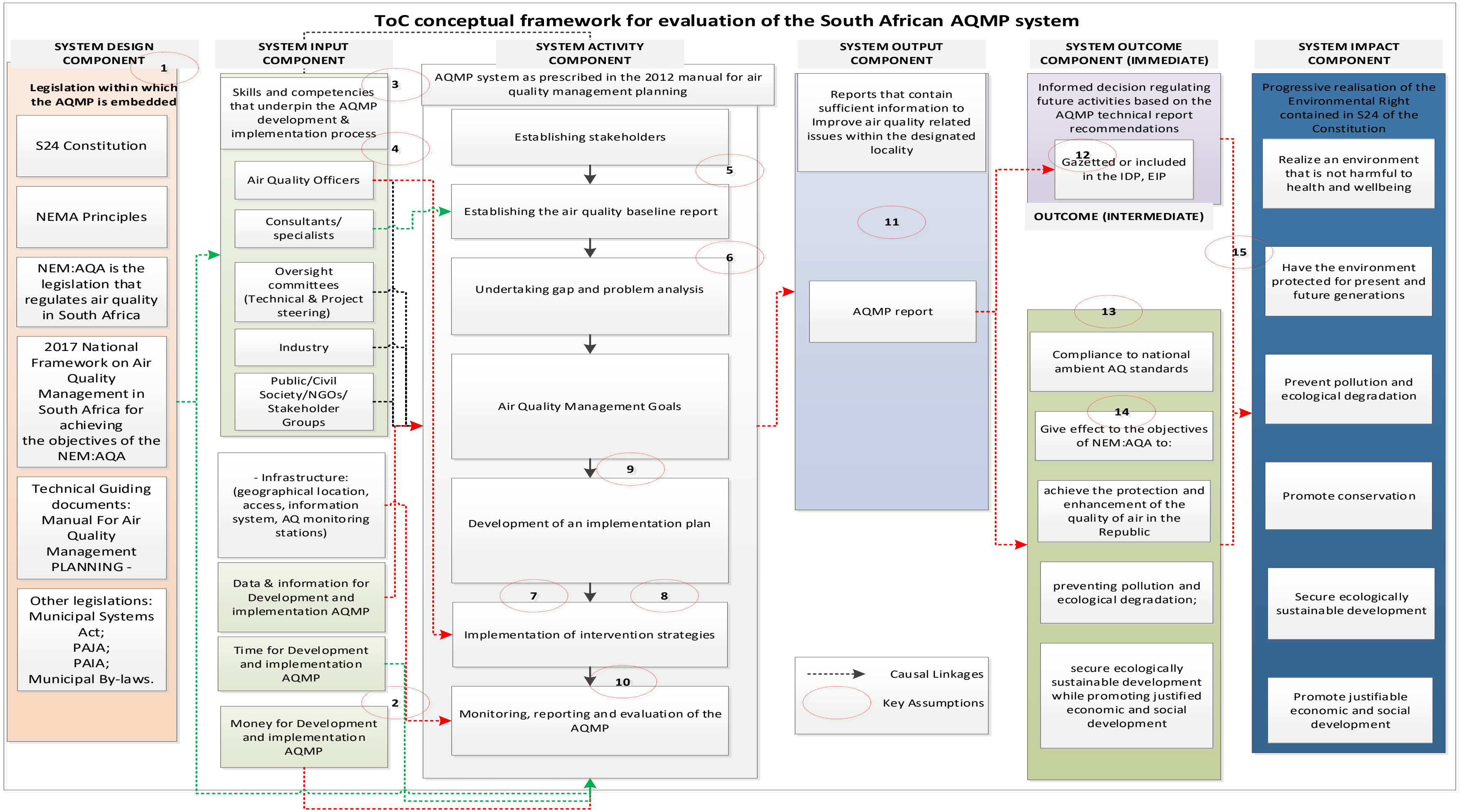

Figure 6-2 **ToC map showing the current situation of AQMP development in South Africa. Green dotted arrows = the causal linkages are working as intended and they are based on valid assumptions. Red dotted arrows = the causal links are not working as intended and are based on flawed assumptions. Black dotted arrows = the causal links have not been evaluated in this study and require further investigation.**

6.3 Design component

The key assumption with respect to the ToC design component is that the legislative framework provides sufficient guidance for the development and implementation of an AQMP. The AQMP process was evaluated against this assumption using one evaluation question and one KPI by means of questionnaires and interviews. A total of 42 responses were received from different stakeholder groups. It can be seen from the results that there is a general satisfaction among most (28 of 42) role players, especially government air quality officials in South Africa, that the current legislation does provide sufficient guidance for the development and implementation of the AQMP. However, seven of 42 respondents argue otherwise, namely that the legislation is sufficient for AQMP development only and not implementation. One of the respondents indicated that: "*There certainly is guidance towards the development, but I don't think guidance for implementation is clear*." The results further show that six of the 42 respondents suggested that the legislation is not sufficient for either development or implementation and only one respondent suggested that they did not know the answer. These results are rather interesting in that although the majority of stakeholders agree on the legislation being sufficient, not all the spheres of government have developed and implemented their AQMP since the promulgation of NEM:AQA in 2004. Two provinces, 34 districts and even more local municipalities still have no AQMPs in place (DFFE, 2021; Tshehla & Wright, 2019). Several underlying issues were identified in this study, such as the availability of resources like money, skills and infrastructure, as well as the prioritisation of air quality matters during decision-making in government. These are some of the factors that contribute to poor development and implementation of AQMPs, despite the law being found sufficient by most stakeholders which are discussed in the sections below. This outcome can also be attributed to that, NEM:AQA only makes the provision that the Minister or MEC may prescribe regulations necessary for implementing and enforcing approved priority AQMPs but however silent on penalties relating to other actors such as district and local municipalities. The evaluation also found that some district municipalities such as the West-Coast District Municipality have developed one AQMP report for the district and its five local municipalities. There is an urgent need to strengthen and enforce air quality-related legislation, including AQMPs to minimise air pollution, which will then reduce the burden of disease (Roomaney *et al*., 2022).

6.4 Input component

6.4.1 Skills and competencies

It is clear from the existing literature that there is currently a skills and competency gap, especially in government, with respect to AQMP planning system in South Africa (DEA, 2018; Engelbrecht & Van der Walt, 2007; Engelbrecht & Van der Walt, 2012; Naiker, 2007; Naiker *et al.,* 2012). In addition, unlike in EIA and other environmental assessment tools, there is not yet a specific formalised regulatory body or legal requirement or guideline that addresses all the technical capacity requirements for AQMP development and implementation in South Africa. As a result, this study used the criteria of the SACNASP to evaluate the skills and competencies of specialist consultants and criteria identified by Engelbrecht and Van der Walt (2007) to evaluate air quality officers (AQOs). The discussion is as follows:

6.4.1.1 Consultants/Specialist

Based on the results of this study, there are sufficient skills and competencies among the specialist consultants who were involved in the development of AQMPs in terms of the relevant field of study and experience in South Africa as all the specialist consultants of the evaluated case studies met the SACNASP criteria.

6.4.1.2 Air quality officials (AQOs)

Engelbrecht and Van der Walt (2007) argue that for an AQMP to be effectively and efficiently developed and implemented, the gap in technical capacity in municipalities is a matter that requires urgent prioritisation. The “training needs outcomes” protocol of Engelbrecht and Van der Walt (2007) was used to evaluate the selected case studies.

Figure 5-2 of the results in the previous chapter 5 (page 108) show that engineering control and air quality modelling are the biggest skills gaps followed by the identification of sources and emission quantification, as well as air pollution risk assessment. This study therefore supports previous studies that found that a lack of critical skill sets in municipalities is indeed still one of the underlying factors for poor or no implementation of AQMPs in South Africa (Engelbrecht & Van der Walt, 2007; Engelbrecht & Van der Walt, 2012; Naiker, 2007; Naiker *et al.,* 2012). According to Naiker (2007), there is a need to empower authorities with respect to their technical aspects such as monitoring and licencing, more so at the local government level, to ensure effective implementation.

In addition, there is currently no regulatory body (besides SACNASP), legal framework or guidelines that specifically govern the skills and competency requirements of both consultants/specialists and air quality officials. The absence of such specific regulatory body or requirements for the skills and competencies related to air quality could contribute to the current lack of technical capacity, especially in local government. This study, therefore, proposes that in an attempt to address the skills gap issue, an approach similar to that followed by EIA should perhaps be explored. In the EIA instrument, regulation 14 GNR 849 requires environmental assessment practitioners (EAPs) to be registered with the Environmental Assessment Practitioners’ Association of South Africa (EAPASA) in order to hold the responsibility of planning, coordinating or reviewing the EIA and associated EMPs (Roos *et al.,* 2020). EAPASA is a regulatory body established under section 24H of the NEMA regulations, with the objective to improve quality of the EIA practice in South Africa. There is therefore a need to explore criteria for regulating skills and competency requirements for air quality practitioners in South Africa. such criteria can address the minimum requirements for education, professional experience, competency and continued professional development requirements, and perhaps a regulatory body for the registration and sanctioning of consultants/specialist and government air quality officials should be considered.

6.4.2 Time, budget, data and information, infrastructure, and cooperative governance

From the document analysis conducted, the input component (excluding skills and competency) did not perform well given the six KPIs (2.5-2.9) evaluated (see Figure 5-4 in results chapter 5 page 111). The evaluation shows that in total there are more partially conforming (28 B's) than conforming (i.e. 16 A's, and one NE) cases across all case studies. The poor performing KPIs are budget/financial provision, data management and ambient air quality monitoring networks, as well as cooperative governance.

The results show that all nine AQMP case studies conformed (A) with KPI 2.5 on the description or provision of timeframes for the implementation of the AQMP intervention strategies.

Three case studies conformed (A) and six case studies scored partial conformance (B) to KPI 2.6 on the description of budget the provision for the development and implementation. The evaluation found that of the six case studies that scored B, only three were found to have indicated the need for funding to be provided for the implementation of the plans. However, they did not provide any detailed specifications for the budgetary needs and operational costing. Two of the case studies did not give any mention or description of budget provisions. In addition, two of the interview responses indicated that the budget allocated to the implementation of the plans did not materialise, despite the report having indicated budgetary needs. These results support previous studies that suggested a lack of funding interventions as a primary factor for poor AQMP implementation (Engelbrecht & Van der Walt, 2007; Engelbrecht & Van der Walt, 2012; Moreoane *et al.,* 2021; Naiker, 2012,).

Moreover, South Africa is currently facing challenges with regard to the accuracy and reliability of air quality data obtained from various monitoring stations, especially government owned. According to the 2020 National Air Quality Officer's annual report on air quality management (DFFE, 2021), there were 135 government-owned stations in 2020 reporting on the SAAQIS database, of which 63 were not meeting the data requirements. Results from this study support this as none of the nine case studies conformed with KPIs 2.7 and 2.8, which evaluated data accessibility, accuracy, and reliability to implement the AQMP, as well as the efficiency of ambient air quality monitoring network. The key issues identified were mostly related to a lack of an ambient AQ monitoring network within municipalities, non-functioning monitoring stations, and no human and/or skills capacity for monitoring (Figure 5-4). It is found that most municipalities depend on other entities such as industry, provincial government and departments, weather services, etc., for data collection and analysis, monitoring and reporting to SAAQIS. The results are in support of previous local and international studies that AQMP development and implementation remains a challenge in developing countries due to a lack of real-time air quality data and emission inventories, poor stakeholder participation, and government commitment (Engelbrecht & Van der Walt, 2007; Gulia *et al.,* 2015; Naiker *et al.,* 2012).

KPI 2.9 evaluated whether there is coordination and cooperation between the various spheres of government, and this was done through interviews with the relevant AQO for the selected case studies. Four of the case studies we found to conform and four of the case studies partially conformed (B). One was not evaluated. A common response was that there is more interest and attendance during the initial stages of development, but attendance decreases with time during implementation phase. Another comment from three of the respondents was that there is not much cooperation from other government entities, particularly local municipalities, mainly due to the lack of staff capacity. The respondents further indicated that there is good cooperation from industries, although not all of them. Partnerships and cooperative governance are important contributors to South Africa's current governance set-up and should be encouraged to drive air quality management interventions (Naiker *et al.,* 2012). Due to the way South Africa's air quality governance is structured with a delegation of key functions to local government, this study argues that poor cooperative governance does contribute significantly to the ineffectiveness of these plans, especially with poor implementation.

With respect to the resource needs for development and implementation, this study supports previous studies (Engelbrecht & Van der Walt, 2007; Engelbrecht & Van der Walt, 2012; Moreone *et al.,* 2021; Naiker, 2012,). In Engelbrecht and Van der Walt (2007) identified resources such as AQM infrastructure, technical capacity, budget, skills and competencies, and human capacity as the main shortcomings for AQMP development and implementation. Fifteen years later a shortage in the same resources is still a challenge for AQMP development and implementation in the country, especially at the lower spheres of government. However, this study contends that unless the identified assumptions, including resource needs, are addressed, the AQMP development and implementation will not improve in its effectiveness in South Africa.

6.5 Activity components

6.5.1 Gap and problem analysis

KPI 3.1 regarding stakeholder involvement is discussed under Section 5.7. Key performance indicator 3.2 on gap analysis and problem identification during the AQMP development and implementation process performed very well, with results showing that eight cases studies did address this requirement.

6.5.2 Intervention strategies and implementation plan

Emission reduction strategies are interventions to decrease pollution into the air. They can be in the form of capacity building plans, awareness, etc. and the aims of these strategies are to find best suitable measures to minimise the impact of air pollution by controlling the sources (DEA, 2012; Miranda, 2015; Sivertsen & Bartonova, 2012). Results show that the case studies generally performed well, with 82 conformances (A's) and 20 partial conformances (B's) and 15 non-conformances (NC's) across all cases with respect to 13 KPIs (3.3-3.15). However, the poorest performance was for KPI 3.8 regarding the extent to which the intervention strategies estimate the expected costs and benefits. The results found that only one case study conformed while five of the case studies partially conformed (B) and three case studies did not conform at all (NC) as shown in Figure 5-6 of the results chapter. This requirement is stipulated in section 3.1.4 of the Manual, which specifies that during the development of intervention strategies and action plans, the main aim is to identify the most cost-effective interventions, goals and strategies for pollution reduction by controlling the sources. This should include an estimation of expected costs and benefits for the sources (DEA, 2012). As discussed in Chapter 2 of this study, cost-efficiency analysis is one of the most critical steps to identify which intervention strategies should be prioritised for implementation (WHO 2013). In the UK, the assessment of the cost effectiveness of intervention strategies is one of the key requirements in the success of implementing air quality action plans (Woodfield *et al*., 2003). The UK guidelines for the development of an air quality action plan by local authorities includes a cost effectiveness assessment for pollution reduction measures, even if it is not a formal cost-benefit analysis (CBA) (Woodfield *et al*., 2003). The guideline requires the assessments to cover two key aspects, with the first one being the likelihood of emissions reduction or the air quality benefits of the intervention. The second aspect is the assessment of the costs of implementing the intervention, while also considering other additional costs or possible revenue streams (Woodfield *et al*., 2003). Sivertsen and Barternova (2012) argue that a CBA is possibly the most applied method to identify suitable strategies for mitigating air pollution. In addition, Chae (2010) proved that doing a cost effectiveness and co-benefit analysis enables the discovery of new cheaper options to mitigate emissions, such as optimisation that can lead to both air quality improvements and CO_2 reduction targets at the lowest cost.

Moreover, the results show that only three of the nine case studies (WBPA, GP, and CoJ) conformed on KPI 3.12, which addresses municipalities collaborating with the private sector to get financial assistance on air quality intervention strategies (Figure 5-6). Similarly, the case studies also performed poorly on KPI 3.13, which deals with intervention strategies such a strategy(ies) on the funding mechanisms for different interventions outlined in the case of government implementation. Moreoane *et al.* (2021) also found a similar outcome when they evaluated the quality of the VTAPA AQMP. They argue that to improve the quality of the plan, funding mechanisms must be explored to ensure effective implementation of intervention strategies. Naiker *et al.* (2012) also stress that partnerships and cooperative governance are important for South Africa to mobilise an AQMP development and implementation process. This study's results support both Naiker *et al.* (2012) and Moreoane *et al.* (2021) and suggest that identifying funding mechanisms are key driver of the effectiveness of AQMP development and implementation in South Africa.

Three cases studies failed to conform to KPI 3.14 and 3.15, which evaluate the extent to which the intervention strategies include indicators to monitor progress with the interventions. KPIs are important for checking progress towards the achievement of specific goals or objectives and are therefore important in determining the measurability of the intervention strategies. The use of air quality indicators provides simpler means for effective communication with stakeholders in a scientifically defensible manner (Garland *et al.,* 2017). This also means that the three case studies also failed to meet the SMART criteria (specific, measurable, achievable, realistic and timeous) in terms of KPI 3.15. Measurability is not addressed due to this omission. Although the case studies generally performed well in this category, implementation remains a challenge in most case studies due to constraints identified in other components of the ToC. The AQMP should be implementable, quantifiable (either quantitatively or qualitatively), clear and truthful, and should provide report requirements such as compliance dates and programmes (Moreoane *et al.,* 2021; Sivertsen & Bartonova, 2012). It is also a requirement in Section 1.4 of the NFAQM that goals and objectives should meet the SMART criteria which is also in line with NEMA principles stipulated in section 2 (Moreoane *et al.,* 2021).

6.5.3 Air quality monitoring and evaluation

The initial step in evaluating the effectiveness of air quality regulations is to check performance trends on emission reductions in line with the set objectives, and this is done through monitoring (Sivertsen & Bartonova, 2012; Van Erp *et al.,* 2008). The AQMP is therefore dependent on technical tasks like monitoring and dispersion parameters (Sivertsen & Bartonova, 2012). KPI 3.16 evaluated the extent to which ambient air quality monitoring is performed in accordance with accepted standard methods. The results show that six case studies scored A, one case study scored B, and two case studies scored NC. Three of the case studies (i.e., JTGDM, WCDM and LLM) that did not conform were found to not have their own monitoring networks and stations in place. In addition, all the case studies were found to report their monitoring information inconsistently. This includes reports to the SAAQIS database as required by the NFAQM, which states that ambient monitoring data collected for the purpose of assessing compliance with the NEMA:AQA by the different spheres of government must be submitted SAAQIS for public access. The reduction in the levels of air pollution emissions is directly proportional to the reduction of non-communicable and infectious diseases, and it is therefore important to increase efforts to have a comprehensive system of monitoring stations measuring ambient air quality to gather accurate and reliable information in Africa, including South Africa (Roomaney *et al.,* 2022; Sicard *et al.,* 2023). According to Gulia *et al.* (2020), although there are challenges around technology and finance, there is a need to improve AQMNs in many low- and middle-income countries, and South Africa is found to be no different in this study.

The case studies performed well overall against KPI 3.17, which assessed whether the location of monitoring stations is based on the locations of main sources, topographical features and continuous meteorological conditions, as well as urban features and population distribution. The case studies scored five A’s, one B, and three NC’s. This study did not assess KPI 3.19 on whether monitoring covers all compounds of relevance in the area based on the sources in the area and the emission of compounds relevant for air pollution due to a lack of sufficient available information for the evaluation. It therefore, recommended that a separate study should be conducted to evaluate the current existing ambient air quality monitoring networks against this KPI.

Results further show that four case studies did not conform to KPI 3.19 on the atmospheric dispersion modelling in the AQMPs. This is a deviation from the NFAQM, which requires that ambient air quality status for AQMP planning should be determined using air quality monitoring and dispersion modelling and this should be done in accordance with the Regulations on Air Dispersion Modelling (Notice 533, *Government Gazette* 37804). A few case study reports reviewed in this study, such as the BCMM, have highlighted that limitations in dispersion modelling are due to poor and incomplete emissions data, which ultimately affects the identification of priority emission sources and the understanding of the extent of impact that priority pollutants may be having on human health. As discussed in Chapter 2, air quality modelling plays an important role in providing information on several aspects such as whether pollutants are not exceeding the National Ambient Air Quality Standards (NAAQS) (USEPA, 2007). By modelling the movement and pathways of air pollutants and the chemical and physical processes in plumes, researchers can more accurately analyse air pollutants in different locations (Lee *et al.,* 2014; Li *et al.,* 2021). This study also suggests that a resource needs assessment must be conducted as an initial step prior to any development of AQMPs within municipalities. The resource needs assessment should look at skills and competency, human capacity, and infrastructure, including monitoring network availability, to ensure implementation of the AQMP after development.

The last KPI in this category (3.20) assessed whether the AQMP is reviewed every five years. Six case studies scored A while three case studies scored NC's. The Manual stipulates that the AQMP must be revisited every five years for the goals to be realigned.

6.5.4 Stakeholder involvement in AQMP development

Stakeholder involvement in the AQMP development and implementation process is important as a civil based approach, especially considering the history of South Africa to ensure that communities are involved in decision-making of matters relating to air quality which relates to their health. It is imperative that government authorities must effectively provide a flow of information to civil society and provide mechanisms to allow participation (Naiker *et al*., 2012; Sivertsen & Bartonova, 2012). The public is an important resource for municipalities as they provide key information such as problem area identification through complaints (Naiker, 2007). However, interview and questionnaire results suggest that most (22) of the forty respondents argued that only certain stakeholders are actively involved during the AQMP development and implementation processes. Further responses from respondents suggest that those who are actively involved include academics, NGOs and government institutions, and this is due to a lack of understanding of the process and limited interest. One of the respondents argued that: *"Stakeholders such as institutions of higher learning, government departments and NGOs do participate in the development of AQMP, but ordinary members of the community don't seem to be interested in the development of AQMPs."* Respondents further highlighted that some stakeholders, especially the public, who do not participate usually do not understand the process or have limited interest in air quality matters, resulting in poor attendance. Other respondents were of the view that marginalised communities are usually not adequately consulted. Public participation is an important component of a good quality plan and should be incorporated during the planning process (Longhurst *et al.,* 1996; Berke & Godschalk, 2009; Lyles & Stevens, 2014). The *Manual for Air Quality Management Planning* requires that the AQMP must be developed and implemented in consultation with stakeholders at various stages. However, there is no clear directive in the Manual as to how that must be done. A successful AQMP is developed and implemented with input from various stakeholders and public participation. Consultation is an integral part of the process. It begins in the initial phases of the development of the plan by informing the public and allowing them an opportunity to bring inputs. Effective public engagement should therefore ideally form part of a legal requirement of the regulatory body (Sivertsen & Bartonova, 2012). An important part of addressing air pollution is the inclusion of various stakeholders, including, law makers, civil society, communities and academia, and especially the involvement of civil society in the development of solutions and control strategies that are realistic to achieve at a local context (Okello *et al.,* 2023). Naiker *et al.* (2012) found there is a need for more suitable programmes or mechanisms for communicating to the public as there is currently no consistency in public participation.

6.6 Output component (completeness and substance quality)

The ToC output component applied the implementation evaluation type with the key evaluation question on the completeness and substance quality of the AQMP reports. As discussed in Chapter 2, impact evaluation aims to determine whether the programme's operational measures support the achievement of the objectives and to understand why it does or does not (DPME, 2011). This study argues that evaluating the completeness and substance quality of AQMP reports does help to provide clarity on whether these plans and operational mechanisms can realistically meet their own objectives. A good quality plan therefore should have clear objectives, factual and truthful information, policies, and public participation in the development process, and should be clear in the implementation and monitoring interventions (Berke & Godschalk, 2009; Lyles & Stevens, 2014). In addition, this study suggests that similar to the EIA studies, quality becomes an important component of effectiveness since the extent to which the plan achieves its objectives is based on adherence to its procedural requirements and substantive purpose (Sadler, 2012; Sandham *et al.,* 2013).

6.6.1 Air quality goal setting and description of roles and responsibilities

The quality review package by Moreoane *et al.* (2021) was adapted to evaluate the quality of the selected nine case studies. There were 13 KPIs relating to AQMP air quality goal setting and assigning roles and responsibilities (i.e., KPIs 4.1–4.13). Results once again show an overall poor performance on report quality and completeness across all the case studies, with 38 A's, 53 B's, and 25 NC's as shown in Figure 5-8. The following are major poor performing KPIs:

- **KPI 4.2: Description of geographical area, land use, topography, landscape and natural resources and mapped out.** Five case studies partially conformed, while four case studies conformed, and these partial non-conformances were associated with the omission of topography, land use, landscape and natural resources. As stipulated in section 5.4.6.1

of the NFAQM, the description of geographic and air quality information is of great importance to the AQMP (DEA, 2017).

- **KPI 4.3: Description of the demographics** (i.e., gender, race, and age, population distribution and population density). With regard to KPI 4.3, the case studies scored eight B's and one NC. These results show that none of the case studies conformed to a comprehensive description of demographics, including gender, race, and age, population distribution and population density. The inclusion of distribution and population density in the baseline assessment is required in terms of section 1.3.3 of the Manual, which stipulates that including distribution and population density in the emission inventory and in the exposure estimates can provide additional information on source emissions distributions if the total consumptions are known. This can also allow for better model estimations (DEA, 2012).
- **KPI 4.4 Description of socio-economic status,** i.e., number of households, distribution, poverty levels, education and employment status. This KPI scored one A, seven B's, and one NC. According to DEFF (2020), some of the consequences of air pollution are due to the socio-economic status of an area and the way fuel is utilised. Furthermore, socio-economic effects should be determined as part of the intervention strategies in the AQMP. It is therefore important to understand the socio-economic status (DEA, 2012; Moreoane *et al.,* 2021). However, as can be seen from the results in Figure 5-8, only one case study conformed to this requirement.
- **KPIs 4.5 and 4.6: List of areas that use fossil fuels for domestic use and description of health status.** Five case studies conformed to KPI 4.5, while four case studies partially conformed. According to Altieri and Keen (2019), many developing countries that rely on fossil fuels are encountering serious obstacles, including health problems, reduction in production and high death rates due to increased air pollution levels. The description of areas that use fossil fuels for domestic use is therefore important as an input towards a description of the health status of such areas. None of the case studies conformed to KPI 4.6 on the description of health statuses and the case studies scored two B's and seven NC's.
- **KPIs 4.7 Description of inventories (section 21, 23 and dust generating industries) and 4.8 of Inventory of industries that may cause air pollution and are not listed (e.g., controlled emitters).** The case studies performed very poorly in KPI 4.7 with a score of seven B's, two NC's and KPI 4.8 scored three A's, four B's, and two NC's. As stipulated in section 5.4.6.1 of the, the AQMP should include information on the type and location of the different emission sources and inventories, as well as the status of ambient air quality (DEA, 2018). In addition, Moreoane *et al*. (2021) stipulate that the identification of all industrial air

pollution sources should include inventories of section 21 and section 23 industries, an inventory of industries generating dust, as well as inventory of industries that may cause air pollution but that are not listed. It is therefore important for an AQMP to include all these sources to give effect to section 16(a)(v) of NEM:AQA, which is to seek to address the effects of industrial sources. Sivertsen and Bartonova (2012) argue that identifying sources of emissions, including areas of impact and concern, is important for AQMP implementation. According to Roomaney *et al*. (2022), to reduce the concentration of pollutants and thus reduction of the burden of diseases, the longer-term solutions in South African should include phasing out fossil fuels combustion as the main source for energy and transportation for substitution with sustainable and clean energy sources.

- **KPI 4.9 International agreements and best practice guidelines.** KPI 4.9 scored one A, two B's, and six NC's. As part of NEMA:AQA's chapter 16(a)(viii) requirement, it is important that the AQMP provides some information on international agreements and the use of best practices guidelines.
- **KPI 4.10 Pollutants affecting health, the environment and climate change.** Case studies scored three A's, five B's, and one NC. The identification of sources and list of primary and secondary pollutants of concern is an important step that should be taken as part of the baseline assessment process of the AQMP development and implementation process (DEA, 2012; Sivertsen & Bartonova, 2012). These should include health-related, environmental and climate change-related pollutants. As shown in the results, only three case studies conformed to this requirement, which is another indication of poor quality of the AQMPs in general in South Africa. Most of the case studies that partially conformed were found to have just listed pollutants, with no indication or distinction as to which pollutants relate to health, environment or climate change.
- **KPI 4.11 Assessment of the impact of industrial activities, greenhouse gases, indoor exposure and other regional issues, including acid rain, regional ozone and transboundary issues.** All nine case studies scored B's and most of the case studies were found to have omitted an assessment of other regional issues like acid rain and transboundary issues. As argued by Sivertsen and Bartonova (2012), the assessment should rely on accurate monitoring data from a sufficient number of sites and should be supported by modelling. Many of the case studies performed poor perhaps due to issues such as lack of monitoring stations and data, skills, and competencies. According to Roomaney *et al.* (2022), there is a need to create a multi-country Southern African co-operation at the regional scale for air pollution reduction. The identification of transboundary issues is therefore important in this regard.

6.6.2 Baseline air quality assessment

The results of the baseline assessments measured by KPIs 4.12 to 4.20 show that the most significant poor performing KPI of concern is KPI 4.16 on quality assurance and quality control (QA/QC) programme of baseline air quality data. Only two case studies scored A for KPI 4.17, which means the six other reports did not provide information on the quality assurance or quality control (QA/QC) programme for the data for the AQMP development and implementation. Strict quality assurance and control measures should be implemented to improve the quality of the technical data used (Naiker *et al*., 2012). Gulia *et al.* (2020) also found a similar outcome that many low- and middle-income countries do not have a well-defined AQ and AC procedures and common regulatory guidelines for data quality, technical manpower for operating monitoring equipment. However, there was an overall good performance relating to baseline assessment evaluation from other KPIs with 54 A's, 12 B's and 6 NC's.

6.7 The immediate outcome component

According to the NFAQM and the Manual, once the AQMP has been developed, it should be gazetted if it is at the priority area level, or included in the environmental implementation plan (EIP) and/or environmental management plan (EMP) if it is at the provincial level, and included in the integrated development (IDP) if it is at the municipal level as required by NEM:AQA and the Municipal Systems Act (DEA, 2018). However, as can be seen from the results, the majority of respondents (20 of 37) argued that AQMPs do not realistically influence decision-making as there are challenges relating to understanding the interpretation of integrating the AQMP with other sector plans such as IDPs, EIPs, EMPs, etc. In addition, there seems to be a lack of prioritisation of AQMP matters, particularly from a budgeting perspective. Some of the concerns raised by the respondents include:

> "… *in the context of SA, there are so many competing factors, such as unemployment, creating new businesses to grow the economy, bringing of investments (to name a few). When new industry comes to the municipality, they tend to check its viability in terms of EIA and AQMP is seen as an after effect, maybe because impacts of air quality are seen in long term, so the AQMP is overlooked when developing an IDP for instance*."

This outcome is similar to that of Mohlala (2020), who found that air quality is not prioritised or treated as "service delivery" by the local government and thus or little or no finances are made available. This is a similar finding to that of Naiker *et al*. (2012), showing that even ten years later, there is still no prioritisation of air quality matters by the local government level due to other developmental objectives and political will. In earlier research, Engelbrecht and van der Walt

(2007) found that only a few AQMP municipalities had included their AQMPs in their IDPs. This study therefore, submits that the lack of clear guidelines on the integration of AQMPs with other decision-making plans such as the IDPs, EIPs and EMPs is one of the underlying factors of the unchanging status quo. Moreover, for air quality policy supporting-instruments such as AQMPs to be effective in influencing decision-making, there should be political buy-in, especially from local governments where most responsibilities reside (Naiker *et al.,* 2012). China is a good example as 338 cities saw a remarkable decline of key pollutants such as $PM_{2.5}$, PM_{10}, and SO_2 from 2013 to 2017 due to the effective implementation of their air pollution prevention and control action plan policy. This emphasises a great political will of the Chinese government with respect to reducing air pollution (Feng *et al.,* 2019). In light of this, the AQMP development and implementation stem in South Africa should consider developing awareness capacity-building mechanisms to bring a mindset change of different role players and political buy-in on air quality decision-making in provinces and municipalities.

6.8 The intermediate outcome and impact components

As discussed in Chapter 2, the main objective of AQMPs as policy instruments in South Africa is to give effect to chapter 2 of the NEM:AQA, which ultimately seeks to realise section 24 of the Constitution. In addition, as described in the NFAQM, AQMPs provide a logical narrative on the strategies and the resource needs for implementing the interventions or meeting specific targets (DEA, 2018). Such objectives and targets aim to reduce air pollution by identifying and mitigating anthropogenic activities that have negative effects on human health and the environment by complying with the NAAQS. AQMP as a central high-level policy instrument becomes a key vehicle towards the realisation of NEM:AQA objectives, which include air pollution prevention and the prevention of ecological degradation and securing ecologically sustainable development while promoting justifiable economic and social development. This means that the NEM:AQA, through AQMPs as one of the mechanisms, must ultimately give effect to section 24 of the Constitution of the Republic of South Africa, which aims to enhance the quality of ambient air for the sake of securing an environment that is not harmful to the health and well-being of people.

As seen earlier from Chapter 5 Figure 5-10, the results show that from the respondents' point of view, the AQMP in general, is not effective in realising the NEM:AQA objectives. They do not achieve compliance with the national air quality management standards (NAAQS) or realise the human environmental right provided in section 24 of the Constitution. This is based on the 85 responses that resort under theme D2 that disagreed with all six KPIs (Figure 5-10). This means most key respondents are of the view that the current AQMP as a policy instrument in South Africa is ineffective in achieving compliance with the NAAQS and fulfilling NEM:AQA objectives. This in turn leads to a failure to realise the environmental human right provided in section 24 of the Constitution. Seventy-four responses from the 42 participants are of the view that the AQMP is failing mainly due to a lack of implementation of the plans.

The results concur to several studies which argue that despite many interventions and amidst the plethora of instruments, some of which have been in existence for decades such AQMPs and AELs, trends show that air quality in South Africa is deteriorating, especially in those areas that have been declared as priority areas (Feig *et al.,* 2019; September, 2012; Tshehla & Wright, 2019). Muyemeki *et al.* (2022) further predict that without any strict policy interventions, air quality in South Africa is luckily to get worse in the future and to contribute more to the health burden because of the current rate of urbanisation, population growth, and economic development. Some priority pollutants such as $PM_{2.5}$ do exceed NAAQS daily and annual emission limits in various regions of South Africa especially during these winter periods (Adesina *et al.,* 2020; de Lange *et al.,* 2019; Cairncross, 2016; Govender & Sivakumar, 2019, Moletsane *et al.,* 2021). In addition, the tropospheric O3 concentrations in various regions of South Africa have been on the rise and remains high. They exceed standards in the northern part of the country during some parts of the year (Bencherif *et al.,* 2020; Diab *et al.,* 2003; Clain *et al.,* 2009; Govender & Sivakumar 2019; Josipovic *et al.,* 2009; Thompson *et al.,* 2012; Thompson *et al.,* 2014).

Moreover, the seventy-four respondents are somewhat in line with the landmark court judgment in 2022 in South Africa in Groundwork and Vukani Environmental Justice Movement in Action (VEM) v the Minister of the Department of Environmental Affairs 2019 (hereafter Groundwork & Vukani case). The applicant argued that the Minister and the government have failed to implement AQMPs set to improve air quality in the Highveld, which is declared as a priority area. In this judgment, the court highlighted that failure to comply with the NAAQs is a violation of human rights stipulated in section 24 of the Constitution. The court further argued: “When the failure to meet air quality standards persists over a long period of time, there is a greater likelihood that the health, well-being, and human rights of the people subjected to that air is being threatened and infringed upon”. The outcome of the Groundwork and Vukani case judgement was that the Minister must without any delay develop and promulgate regulations to implement and enforce the HPA AQMP, which was developed to meet the NAAQS. This judgement is in line with results in Themes A1 and D2 on the KPIs relating to the sufficiency of legislation and the AQMP with respect to realising a healthy environment. The results represented by Theme A2 in Table 5-1 indicate that 17% of respondents argued that the legislation provided sufficient guidance for AQMP development, but not for implementation. Thirty-three percent of the respondents represented by Theme D2 argued that due to a lack of implementation, the AQMP does not realise an environment that is not harmful to health and well-being. The Groundwork and Vukani case judgement also held that a right to an environment that is not harmful to health and well-being is not something that should be progressively realised over time, but it is a right that should be achieved immediately.

The results furthermore suggest that most of the respondents (16), especially from civil society, argued that the AQMP as policy instrument fails in preventing pollution and ecological degradation. One of the respondents was of the view that an AQMP can contribute to minimising the impacts of pollution and ecological degradation but cannot prevent pollution. The stakeholders further argue that the AQMP does not lead to secure, ecologically sustainable, economic, and social development. Feris (2010) contends that sustainable development can be achieved through good governance, and this depends on the way decisions are taken, implemented, and carried out. In addition, environmental governance must be based on certain principles, including openness, accountability, public participation in decision making and freedom of association (Feris, 2010). It is, however, difficult at this stage to quantitatively measure or quantify the impact of an AQMP on pollution prevention, securing an ecologically sustainable development, and promoting justified economic and social development due to the lack of quantifiable and well-defined targets and objectives for the AQMP development, and implementation as a whole. However, from a stakeholder perspective, study maintains that the AQMP as a policy instrument in South Africa is not bringing us closer to sustainable economic and social development in line with section 24 of the Constitution.

6.9 Chapter conclusion

This chapter provide an interpretation of the results on whether they conformed or not to their associated KPIs and the implication of this in the context of literature. This research used ToC as a method of evaluation to identify several underlying constraints that inhibit the effective development and implementation of these plans within the various spheres of government. The outcome suggests that, like other low to middle income countries, the effective development and implementation of AQMPs as a policy instrument for air quality management still remain a challenge in South Africa. There should be more legal pressure with respect to AQMP development by local government as the legislation does provide sufficient guidance for the development of the plans. However, this study also suggests that a resource needs assessment must be conducted as an initial step prior to any development of AQMPs within municipalities. The resource needs assessment should look at skills and competency, human capacity, and infrastructure, including monitoring network availability, to ensure implementation of the AQMP after development.

CHAPTER 7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

The aim of this research was to evaluate the effectiveness of AQMPs as a governance instrument in South Africa. Four research objectives were set to achieve the research aim, namely:

- Research Objective 1: To critically reflect on the current air quality management planning measures within the air quality governance and management system in South Africa;
- Research Objective 2: To identify a method to evaluate the effectiveness of the AQMPs in South Africa;
- Research Objective 3: To develop performance evaluation criteria against which the effectiveness of AQMPs can be evaluated;
- Research Objective 4: To apply the performance evaluation criteria to selected AQMPs in South Africa.

The research was structured into seven chapters in five phases as shown in Figure 7-1 below.

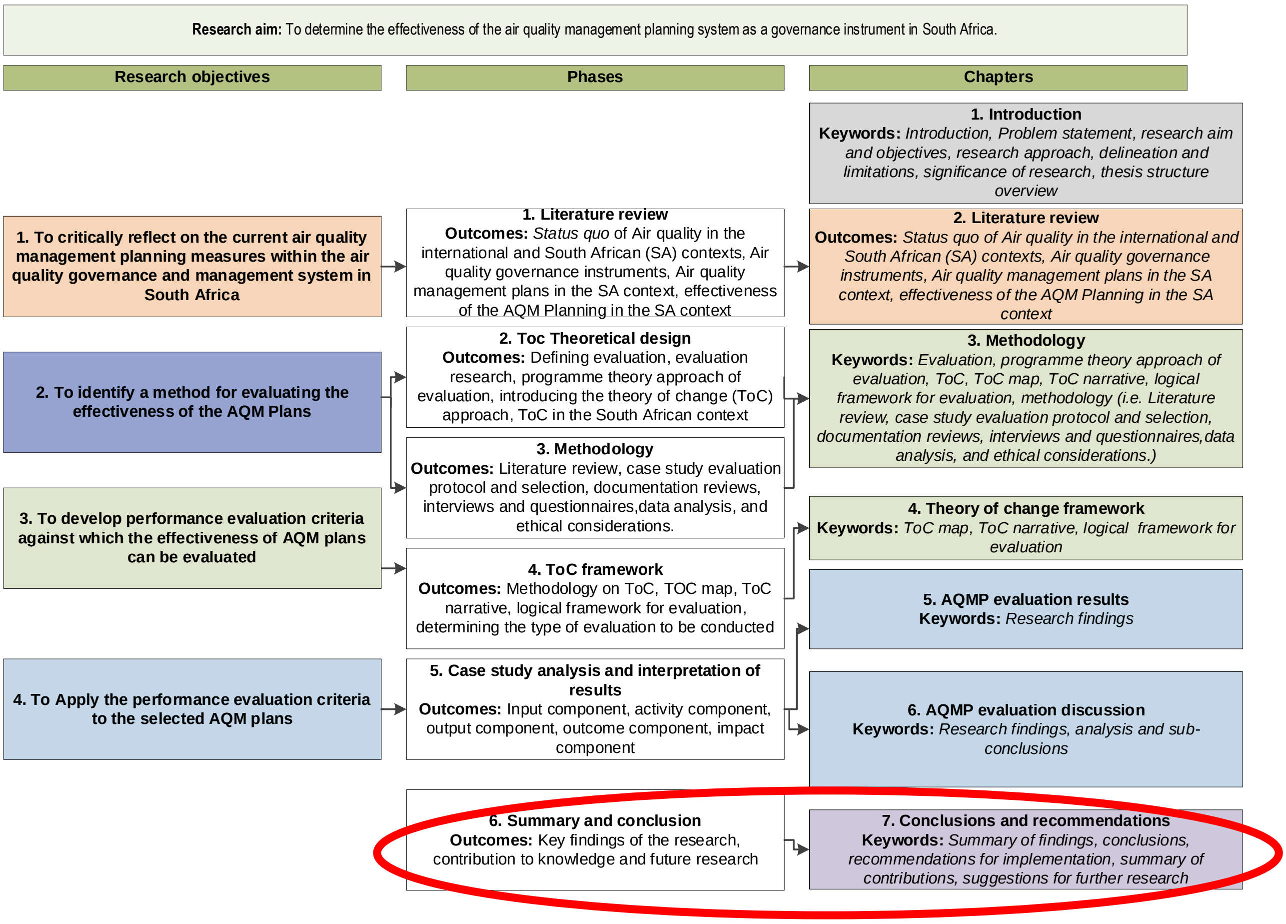

Figure 7-1 Phase 5 as documented in Chapter 6 on conclusions and recommendations

7.2 Overall research conclusion: Achievement of the research aim

The aim of this research was to evaluate the effectiveness of AQMPs as a governance instrument in South Africa. This aim has been achieved using the ToC approach as a suitable method of evaluation of AQMP development and implementation in South Africa.

The ToC approach (through stakeholder engagement) enabled the development of the ToC map and narrative, as well as identification of 15 key assumptions underpinning the AQMP development and implementation process in South Africa. These key assumptions were then used to generate evaluation questions and key performance indicators, which were then used to evaluate selected case studies to better understand the effectiveness of AQMP development and implementation.

From this research's case studies evaluations, several underlying key issues affecting the effectiveness of the current AQMP development and implementation process in South Africa have been identified. Some of the key findings identified included a lack of critical skills and competencies among the AQOs who are responsible for AQMPs implementation; a lack of key resources such budgetary provisions, ambient air quality monitoring networks within municipalities, no existing or non-functioning monitoring stations, and no human and/or skills capacity for monitoring as input in AQMP development and implementation. Other key issues identified included poor cooperative governance, stakeholder engagements, and cost-benefit intervention strategies. Results also found several gaps relating to report quality and completeness, including poor the description of key matters such as geographical area, land use, topography, landscape and natural resources, demographics, socio-economic status, lists of areas that use fossil fuels for domestic use, health statues, inventories of industries that may cause air pollution and that are not listed (e.g., controlled emitters), international agreements and best practice guidelines, and pollutants affecting health, the environment and climate change.

This research can therefore conclude that AQMP as a central air quality management policy instrument across the different spheres of government is currently not effective in achieving its outcomes or objectives. These objectives and intended outcomes include realising the NEM:AQA objectives, achieving compliance with the NAAQS, as well as realising a human environmental right prescribed in section 24 of the Constitution.

This study contributes to international knowledge and literature by firstly justifying that ToC is a valuable method of AQMP or air quality related policy instruments. Secondly the study has identified and tested some key underlying assumptions impacting the effectiveness of AQMP system. Recommendations are also provided to address some of the key issues identified. This study can provide a basis on which the findings are generalisable for adoption to improve other AQMP systems elsewhere. Based on these conclusions, recommendations for the improvement of AQMP system are provided in Table 7-1 below.

7.3 Specific Conclusions

The section below offers conclusions related to the specific objectives.

7.3.1 Objective 1: To critically reflect on the current air quality management planning measures within the air quality governance and management system in South Africa.

As a response to the air pollution challenges, many international and regional governments, including the South African government, have developed an abundance of policies since the 1960s that have over time introduced various regulating instruments to inform air quality governance decision making (Emilsson *et al.,* 2004; Engelbrecht & Van der Walt 2007; Engelbrecht & Van der Walt, 2012; Naiker, 2007; Naiker *et al.,* 2012). This study identified and conceptualised these instruments in accordance with the four broader environmental management approaches (i.e., command and control-based instruments, incentive and disincentive or fiscal-based instruments, agreement-based instruments and civil-based instruments) (Nel & Alberts, 2018; Nel & du Plessis, 2001; Nel & Wessels, 2010). A conceptualisation paper was accepted and presented at the NACA conference in 2020 and formed part of the conference proceedings. A revised version of this paper was published in the peer-reviewed *Clean Air Journal* (CAJ) in 2022 (Mukwevho *et al.,* 2022). The main conclusion learned from the conceptualisation is that there is an over-reliance on CaC instruments in South Africa and that these instruments are highly hybridised. There is also a high level of complexity due to the maturity of the country's legal framework and an overall lack of synergy between instruments. There is therefore a need to further evaluate the effectiveness of each of these instruments.

As one of the CaC policy instruments, an AQMP is a strategic instrument that describes past trends, the current state of air quality in a defined geographic administrative unit (typically a city or region), the goals and objectives, and short- and long-term strategies, policies and controls to improve air quality within that city or region (DEA, 2012; Sivertsen & Bartonova, 2012). AQMPs provide a logical narrative on the strategies and the resource needs for implementing the interventions or meeting specific targets (DEA, 2018). Such objectives and targets aim to reduce air pollution in a defined area and to identify and mitigate the negative effect on human health and the environment. AQMPs through these objectives therefore, become a key vehicle towards the realisation of NEM:AQA objectives, which includes air pollution prevention and the prevention of ecological degradation, and securing ecologically sustainable development while promoting justifiable economic and social development. However, 15 years after the promulgation of the NEM:AQA, not all municipalities have developed and effectively implemented their AQMPs, and AQ in general in South Africa has not improved, particularly in those areas declared as priority areas.

7.3.2 Objective 2: To identify and justify a method for evaluating the effectiveness of AQMPs

This study has identified programme theory as a suitable method for evaluating the effectiveness of air quality management plans in South Africa, more particularly ToC. According to Biggs *et al*. (2017), ToC is an instrument that supports decision making by identifying the causal relationships and sequences of events required for a programme to reach its intended outcomes and it describes the key assumptions of each step of the process. No study had been done prior to this to evaluate the effectiveness of AQMPs in South Africa by using ToC as a method of evaluation. In addition, the ToC is the method formally prescribed by the South African government for policy evaluation and monitoring (DPME, 2011). The ToC allows the South African AQMP development and implementation process to be dissected into six components (i.e., design, input, activities, output, outcome and impact components). Another learning is that ToC evaluation approach has helped to logically discover the causal links between the six components, which in turn enabled the identification of underlying key assumptions. This task resulted in a ToC map (Figure 4-2 and Figure 6-2), key assumptions, narratives, and logical framework (Table 4-1) for AQMP development and implementation in South Africa. Fifteen key assumptions were identified and were further used as evaluation criteria to evaluate the effectiveness of the nine selected AQMP case studies. Connell and Kubisch (1998) argue that ToC is not an evaluation method on its own, but rather relies on other qualitative and quantitative methodologies for data collection and analysis. Using the developed ToC framework, qualitative methods such as a literature review, case study evaluations, interviews and questionnaires were used to evaluate the effectiveness of the selected air quality management plans. This study has found ToC to be a suitable method for evaluating AQMPs in South Africa.

At international level, this research has successfully justified that ToC is a suitable method to evaluate AQMPs in South Africa. Through robust and extensive engagements and networking with various stakeholders, experts, as well as literature and case studies reviews, this research has developed a ToC map and logical framework for evaluating and transforming AQMPs which can be applied anywhere in the world towards a better understanding of the AQMPs and similar policy instruments. The study also identified and tested key underlying assumptions affecting the effectiveness of AQMP development and implementation.

7.3.3 Objective 3: To develop performance evaluation criteria against which the effectiveness of AQMPs can be evaluated

After the development of the ToC map, key assumptions, narratives, and logical framework for AQMP development and implementation in South Africa, evaluation criteria were developed to evaluate the nine selected AQMP case studies. The criteria development started with the identification of 15 key underlying assumptions regarding the AQMP development and implementation in South Africa. This was done by means of workshops with several key stakeholders. Once the assumptions have been agreed upon, evaluation questions with 57 KPIs were derived from these assumptions. The evaluation questions were then answered using mixed methods, including document review, interviews, and questionnaires. In terms of document review as a data collection method, this study adapted the quality review package by Moreoane *et al.* (2021). This research therefore concludes that key ToC assumptions and logical framework developed in this study are suitable for AQMP evaluations and can be used to evaluate other AQMPs, not only locally but also internationally.

7.3.4 Objective 4: To apply the performance evaluation criteria to the selected air quality management plans

The evaluation criteria developed in Objective 3 were then applied to evaluate nine selected AQMP case studies in South Africa and the results were discussed for each component of the ToC:

7.3.4.1 Design component

This component was evaluated by gauging the stakeholders' (government officials, industry, consultants, and civil society) perspectives. It was found that there is general satisfaction among most (67%) participants, mostly government air quality officials, that the current air quality legislation does provide sufficient guidance for the development and implementation of AQMPs. However, 17% of participants were of the view that the legal framework only provides sufficient guidance for the development of the plans and not for the implementation. The latter argument is also supported by the fact that since the promulgation of NEM:AQA in 2005, most municipalities in South Africa have not developed and/or fully implemented their AQMPs (DFFE, 2021; Tshehla & Wright, 2019). Several underlying issues were identified in this study, such as the availability of resources like money, skills and infrastructure, as well as the lack of prioritisation of air quality matters during decision-making in government. These factors contribute to the poor development and implementation of AQMPs, despite the law being found sufficient by most stakeholders.

7.3.4.2 Input component

The input component was evaluated by means of a document review, interviews with relevant AQOs, as well as general stakeholder perceptions. A document review was conducted to evaluate the availability of skills and competencies, time, budget, data and information, infrastructure, as well as cooperative governance. It was found that the case studies performed poorly on KPIs related to budget/finance provision, data management, ambient air quality monitoring networks and cooperative governance.

The study found that all case studies conformed with the KPI related to the skills and the competencies of consultants/specialists, all of whom met the SACNASP requirements. As for AQOs, however, 50% of officials did not have the skills and competencies for sources and emissions identification or conducting air pollution risk assessment. In addition, most AQOs (6 of 8) did not have knowledge and skills in air quality modelling and engineering control. These results correspond with other studies that found that skills capacity is another underlying factor that leads to the poor implementation of these plans (DFFE, 2021; Engelbrecht & Van der Walt, 2007; Engelbrecht & Van der Walt, 2012; Naiker, 2007; Naiker *et al.,* 2012). There is therefore a need to establish criteria for the skills and competencies required among role players in air quality in South Africa to address education, professional experience, competency and continued professional development requirements. Perhaps a regulatory body for registration and sanctioning of consultants/specialist and government air quality officials should be considered.

The case studies were also found to have performed poorly on KPIs on intervention strategies, including a strategy(ies) related to funding mechanisms. Most case studies failed to provide information regarding funding mechanisms, which is similar to the finding by Moreoane *et al.* (2021). In improving the quality of the AQMP, funding mechanisms must be explored to ensure effective implementation of intervention strategies (Moreoane *et al.,* 2021). This study supports previous studies that found that lack of funding is a primary factor in the poor implementation of the plans. It was also found from interviews with AQOs and general stakeholders that air quality matters are not prioritised in decision-making within municipalities, especially when it comes to budget provision.

All nine case studies did not conform to KPIs on data accessibility, accuracy, reliability or ambient air quality monitoring networks. This is supported by the 2020 annual report on air quality management by the national air quality officer (DFFE, 2021). Sixty-three of the 135 government-owned monitoring stations were not meeting the data quality requirements at the time. Key issues identified in the case studies were related to poor or no monitoring networks in municipalities, non-functioning monitoring stations, and lack of capacity in terms of skills and personnel.

The interviews conducted with relevant air quality officers for the case studies revealed that 50% of case studies indicated that there is no good cooperative governance with other government entities when it comes to matters of AQMP, especially at the local government level. This is due to a lack of capacity. This study suggests that poor cooperative governance does contribute to the ineffectiveness of these plans when considering that the legal framework in South Africa devolves the key responsibilities to the local government.

In addition, 52% of participants were of the view that only certain stakeholders, such as academics, NGOs and some government institutions, are actively involved in the process. It was said that other stakeholders, such as the public, usually do not understand the process or have limited interest in air quality matters. The *Manual for Air Quality Management Planning* requires the AQMP to be developed and implemented in consultation with stakeholders at various stages. Nevertheless, there is no clear mandate as to how that must be done, unlike in the atmospheric emission licencing (AEL) process. According to Naiker *et al*. (2012), there is a need for more suitable programmes or mechanisms for communicating to the public as there is currently no consistency in public participation.

7.3.4.3 Activity component

The evaluations using document review and general stakeholder perceptions showed that the case studies performed poorly regarding the extent to which intervention strategies include an estimation of expected costs and benefits. It was found that only one case study conformed, while five of the case studies scored B's and 3 NC's. Conducting cost and benefit effectiveness is one of the key requirements for the success of implementing air quality action plans in the UK (Woodfield *et al*., 2003). According to Chae (2010), cost-effectiveness and co-benefit analysis enable the discovery of new, cheaper options to mitigate emissions.

In terms of progress monitoring of the AQMP implementation, the inclusion of KPIs is important to monitor the achievement of goals and objectives. The results show that three of the case studies failed to include KPIs in their intervention strategies or implementation plans.

This study found that there are still challenges regarding monitoring and evaluation, particularly pertaining to municipalities having their own monitoring networks and stations in place, dispersion modelling, as well as review of AQMPs. Reducing the levels of air pollution emissions is directly proportional to the reduction of the non-communicable and infectious diseases and it is therefore important to increase efforts to have a comprehensive system of monitoring stations measuring ambient air quality to gather accurate and reliable data and information in South Africa (Roomaney *et al.,* 2022).

7.3.4.4 Output component

The output component was evaluated based on completeness and substance quality. This study suggests that, similar to the EIA studies, quality becomes an important component of effectiveness since the extent to which an AQMP achieves its objectives is also based on the adherence to its procedural requirements and substantive purpose (Sadler, 2012; Sandham *et al*., 2013). In addition, a good quality plan should have clear objectives, factual and truthful information, policies, and public participation in the development process. It should also be clear in the implementation and monitoring interventions (Berke & Godschalk, 2009; Lyles & Stevens, 2014).

This study finds an overall poor performance on KPIs relating to air quality goal setting and assigning roles and responsibilities. The specific KPIs in which the case studies performed poorly relate to the following KPIs:

- Description of geographical area, land use, topography, landscape and natural resources
- Description of demographics and socio-economic status
- Description of a list of areas that use fossil fuels for domestic use

- Description of health status;
- Description of inventories (section 21, 23 and dust generating industries) and inventory of industries that may cause air pollution and that are not listed (e.g., controlled emitters)
- Description of international agreements and best practice guidelines
- Description of pollutants affecting health, environment and climate change;
- Assessment of the impact of industrial activities, greenhouse gases, indoor exposure and other regional issues including acid rain, regional ozone and transboundary issues

In terms of the baseline assessment, six case studies did not conform to the KPI on a quality assurance and control (QA/QC) programme, and six case studies failed to provide information regarding the quality assurance of the data used. According to Naiker *et al.* (2012), there should be strict quality assurance and control measures to improve the quality of the technical data used. In addition, there should be efforts to improve QA and QC guidelines for data management and technical manpower for operating monitoring equipment in many low- and middle-income countries. South Africa is no different (Gulia *et al.,* 2020).

7.3.4.5 Outcome and impact components

The outcome and impact components were evaluated by gauging stakeholder perceptions. Regarding the short or immediate outcome component, the results show that 54% of the 37 responses received are of the view that AQMPs do not really influence decision-making as there are challenges relating to understanding the interpretation of integration of AQMP with other sector plans such as IDPs, EIPs, EMPs, etc. In addition, there is a lack of prioritisation of AQMP matters in municipalities, particularly from a budgeting perspective. In order for air quality policy instruments such as AQMPs to be effective in influencing decision-making, there should be political buy-in, especially from local government where most responsibilities reside.

The results for the intermediate outcome and impact components show that the AQMP development and implementation in South Africa is currently not effective in realising the NEM:AQA objectives, achieving compliance with the national air quality management standards (NAAQS) and fulfilling the human environmental right provided in section 24 of the Constitution.

7.4 Contribution to knowledge and future research

This research has resulted in 1 international conference and 3 national conference proceedings and 2 papers as follows:

- Mukwevho, P., Retief, F. and Burger, R., 2022. Conceptualising air quality management instruments in South Africa. Clean Air Journal, 32(2), pp.1-15.

- Mukwevho, P., Retief, F., Burger, R. and Moolna, A., 2024. Identifying critical assumptions and risks in air quality management planning using Theory of Change approach. Clean Air Journal, 34(1).
- Outputs of this study were presented at 3 National Association for Clean Air (NACA) conferences in 2020 (available online at: https://2020.nacaconference.co.za/programme/), 2021 (available online at: https://2021.nacaconference.co.za/programme/) and 2023 (https://nacaconference.co.za/programme-2/) where the papers were accepted and formed part of the conference proceedings (Mukwevho *et al.,* 2020; Mukwevho & Burger, 2021). A poster was also displayed in 2022 at the Keele University Faculty of Natural Sciences postgraduate symposium.
- A Poster was also presented at the 2024 international Association for Impact Assessment (IAIA) Conference in Dublin, Ireland.

The main contribution of this research is that ToC has been justified as a suitable method to evaluate AQMPs in South Africa. Through robust and extensive engagements and networking with various stakeholders, experts, as well as literature and case studies reviews, this research has developed a ToC map and logical framework for evaluating and transforming AQMPs which can be applied anywhere in the world towards a better understanding of the AQMPs and similar policy instruments. The study also identified and tested key underlying assumptions affecting the effectiveness of AQMP development and implementation.

The implementation of the intervention strategies rely on a number of instruments stipulated in the NEM:AQA, including emission standards for listed activities, air quality officer (AQO) appointment within each environmental authority, controlled emitters and fuels designation, and regulations (Naiker *et al.,* 2012). Future research should focus on evaluating the effectiveness of other air quality management instruments particularly those stipulated in NEM:AQA as they play a vital role in the effective implementation of AQMPs. Future research can also look at the extent to which AQMP reporting (implementation plans) is done across the various spheres of government, as well as a further evaluation on the challenges faced in the enforcement of AQMPs intervention strategies and implementation plans in local government. Future studies should also be conducted to evaluate the current existing ambient air quality monitoring networks and whether monitoring covers all compounds of relevance of the relevant area in the AQMP based on the sources in that area and their emissions of compounds relevant for air pollution.

7.5 Recommendations for improvement

Table 7-1 Recommendations for the improvement of AQMP development and implementation in South Africa

Key Assumptions	Key evaluation questions	Conclusions	Recommendations
Design			
The legislative framework provides guidance for AQMP development and implementation.	To what extent does the legislative framework provide guidance for AQMP development and implementation?	There is a general satisfaction from most (67%) participants that the current air quality legislation does provide sufficient guidance for the development and implementation of AQMPs. However, 17% of participants are of the view that the legal framework only provides guidance for the development of the plans and not implementation.	This study suggests that in terms of AQMPs development by municipalities in the country, legal pressure should be increased, particularly at local government level, as it is found that the legislation does provide sufficient guidance for the development of the plans and not for the implementation. However, this study also suggests that a resource needs assessment should be conducted as an initial step prior to any development of any AQMP within municipalities. The resource needs assessment should look at finance, skills and competency, human capacity, and infrastructure including monitoring networks availability to ensure implementation of the AQMP after development
Input			
Resources exist to develop and implement the AQMP.	To what extent are resources available to develop and implement the AQMP?	It is found that the case studies performed poorly on KPIs relating to budget/finance provision, data management, ambient air quality monitoring networks and cooperative governance.	**Skills and competency:** There is a need to explore a relevant criteria for the skills and competency requirements for air quality practitioners in South Africa. The criteria may cover education, professional experience, competency and continued

Key Assumptions	Key evaluation questions	Conclusions	Recommendations
		Skills and competencies: This study finds that engineering control, air quality modelling, identification of sources and emission quantification are the most lacking skills in municipalities. This study echoes previous studies that the lack of such critical skill sets in municipalities is indeed one of the underlying factors for poor or no implementation of AQMPs in South Africa.	Consider exploring a regulatory body, legal framework or guidelines that governs the skills and competency requirements of consultants/specialists and air quality officials.
Cooperative governance exists between governments stakeholders.	To what extent was there coordination and cooperation between the various spheres of government?	The results show that 50% of the AQOs for the selected case studies responded that there is often poor cooperative governance between government structurers when it comes to air quality matters. A common response was that there is more interest and attendance during the initial stages of development, but the attendance decreases with time during the implementation phase. Respondents also highlighted that there is not much cooperation from other government entities, particularly at local municipalities and mainly due to no capacity of staff. However, the respondents	It is recommended that to improve the AQMP development and implementation process, there must be a strict adherence to the requirements of chapter 3 of the Constitution on cooperative governance, as well as the Inter-governmental Relations Framework Act, 13 of 2005 (IRFA). Section 41 of the Constitution stresses all spheres of government should cooperate with one another with transparency and integrity. It should encourage effective intergovernmental relations, communication, coordination, and respect the constitutional status, institutions, powers and functions of government, and avoid taking their disputes to court (Edwards, 2008).

Key Assumptions	Key evaluation questions	Conclusions	Recommendations
		further indicated that there is good cooperation from industries, although not all of them.	
Activities			
The intervention strategies and action plans are technically and economically feasible and are indeed implemented.	To what extent have SMART air quality goals, interventions strategies and action plan been identified and implemented?	• The major poor performance was on KPI 3.8 regarding the extent to which the intervention strategies estimate the expected costs and benefits. Only one case study conformed, while five of the case studies scored B and three case studies scored NC. • Six case studies failed to conform to KPI 3.12 dealing with municipalities collaborating with private sector to get financial assistance on air quality intervention strategies. • It is also found that intervention strategies air quality goals, interventions strategies and action plans of three case studies do not meet the SMART criteria, as they omitted indicators for measuring progress towards achievement of the interventions	• It is recommended that the next revision of the Manual should provide guidelines to conduct cost effectiveness assessments by learning from international experiences such as the UK guidelines. These assessments should cover two key aspects, the first one being the likelihood of emissions reduction or air quality benefits of the intervention. The second aspect can be the assessment of the costs of implementing the intervention, while also considering other additional costs or possible revenue. • The following recommendation by Moreoane *et al.* (2021) is also suggested: industries identified to cause any air pollution could be utilised as funding mechanisms to generate revenue in the form of environmental pollution taxes/levies by putting in place regulations in line with the NEMA polluter-pays principle.

Key Assumptions	Key evaluation questions	Conclusions	Recommendations
		meaning measurability is not addressed. Lastly, although the case studies over all performed well in this evaluation question, the overall implementation remains a challenge in most case studies due to constrains identified in other components of the ToC.	
Output			
AQMP report addresses the gaps and problems identified, to ensure successful implementation of interventions strategies, and ultimately ensure improvement of AQ in the airshed.	What is the quality of AQMP reports?	The results show an overall poor performance of the case studies in terms of completeness and quality, specifically on the description of the following issues: • Description of geographical area, land use, topography, landscape and natural resources • Description of demographics and socio-economic status • Description of list of areas that use fossil fuels for domestic use • Description of health statuses • Description of inventories (section 21, 23 and dust generating industries) and	It is recommended that future developed or updated AQMP reports should also cover the following information: • Description of geographical area, land use, topography, landscape and natural resources • Description of demographics and socio-economic status • Description of list of areas that use fossil fuels for domestic use • Description of health statuses • Description of inventories (section 21, 23 and dust generating industries) and inventory of industries that

Key Assumptions	Key evaluation questions	Conclusions	Recommendations
		inventory of industries that may cause air pollution and that are not listed (e.g., controlled emitters • Description of international agreements and best practice guidelines • Description of pollutants impacting health, the environmental and climate change; • Assessment of impact of industrial activities, greenhouse gases, indoor exposure and other regional issues, including acid rain, regional ozone and trans boundary issues. In terms of the baseline assessment the six case studies did not conform to the KPI on quality assurance and control (QA/QC) programme where six case studies failed to provide information regarding quality assurance of the data used. According to Naiker *et al*. (2012) there need to be strict quality assurance and control measures to improve the quality of technical data used.	may cause air pollution and that are not listed (e.g. controlled emitters; • Description of international agreements and best practice guidelines • Description of pollutants impacting health, the environment and climate change • Assessment of impact of industrial activities, greenhouse gases, indoor exposure and other regional issues including as acid rain, regional ozone and trans boundary issues • There should also be efforts toward improving QA and QC guidelines for data management and technical manpower for operating monitoring equipment in many low- and middle-income countries and South Africa is found to be no different in this study (Gulia *et al*., 2020).

Key Assumptions	Key evaluation questions	Conclusions	Recommendations
Outcome (immediate)			
The AQMP is gazetted or included in the IDP/EMP/EIP and influence decision making (immediate outcome).	To what extent is the AQMP gazetted or included in the IDP/EMP/EIP? To what extent does the AQMP influence decision making?	Naiker *et al*. (2012) found that there was no prioritisation of air quality matters at the local government level due to other developmental objectives and political will and ten years later this study presents the same result.	It is recommended that the next revision of the *Manual for Air Quality Management Planning* include a clear guidance on the integration of the AQMP with the IDP/EMP/EIP.
The goal of an AQMP is to bring ambient air into compliance with the ambient air quality standards (intermediate).	To what extent has the AQMP been bringing ambient air into compliance with the ambient air quality standards?	The results show that from a stakeholder's perspective, AQMP development and implementation in general is ineffective in realising the NEM:AQA objectives, and to achieve compliance to the national air quality management standards (NAAQS), as well as realise a human environmental right provided in section 24 of the Constitution.	It is recommended that in order for AQMP to bring ambient air into compliance to the NAAQs, once the sources of emissions have been identified, they should be prioritised and managed according to their significant contribution to the negative impacts to the environment. The impact evaluation can be done through emission inventories and dispersion modelling. This will allow for assigning the effects of the sources and then prioritising them and ultimately managing them according to their impact.

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ANNEX A: NATIONAL LEGISLATION DIRECTLY OR INDIRECTLY LINKED TO THE MANAGEMENT OF AIR QUALITY AS ADOPTED AND UPDATED FROM THE 2017 NATIONAL FRAMEWORK FOR AIR QUALITY MANAGEMENT IN THE REPUBLIC OF SOUTH AFRICA (SOURCE)

Legislation	Air quality management links	Relevance
Climate Change Bill	• Transitional provisions relating to the declaration of greenhouse gases as priority air pollutants, the National Pollution Prevention Plans Regulations and the National Greenhouse Gas Emissions Reporting Regulations published in terms of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004)	To enable the development of an effective climate change response and a long-term, just transition to a low-carbon and climate-resilient economy and society for South Africa in the context of sustainable development.
National Building Regulations and Building Standards Act 103 of 1977	• To further efforts to decrease energy consumption and associated GHG emissions of new commercial and residential buildings, the government has implemented energy efficiency and energy consumption standards under the National Building Regulations and Buildings Standards Act. The first of these is the South African National Standard (SANS) 204 ± Energy Efficiency in Buildings. This standard specifies the design requirements for energy efficiency in buildings and of services in buildings with natural environmental control and artificial ventilation or air conditioning systems. The second, SANS 10400-XA ± Energy Usage in Buildings, includes the provisions of SANS 204 and others, providing a standard for energy efficient buildings.	To provide for the promotion of uniformity in the law relating to the erection of buildings in the areas of jurisdiction of local authorities; for the prescribing of building standards.
Carbon Tax Act (Act No. 15 of 2019)	• Gives effect to the "polluter pays" principle of NEMA. • Price carbon by internalising the costs of emitting carbon.	To provide for the imposition of a tax on the carbon dioxide (CO2) equivalent of greenhouse gas emissions; and to provide for matters connected therewith.
National Key Points Act, 1980 (Act No. 102 of 1980)	• Provides for the protection of significant state or private assets, relative to national security. • Regulates the flow of information regarding key point activity. • Allows for measures to be implemented to maintain the security of a key point.	Many significant emitters have been classified as national key points, and the act is used to regulate access to information.
Protection of information Act, 1982 (Act No. 84 of 1982)	• Covers the protection of information related to defence, terrorism and hostile organisations. • Information regarding these activities in any form is prohibited access and cannot be disseminated. • Prohibited places can be declared, which also fall under this protection.	Can be used to regulate access to information on air quality.
Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983)	• Regulates burning of veld, except in state forests. • Allows for control and prevention of veld fires through prescribed control measures. • Allows for control measures to be prescribed regarding the utilisation and protection of veld that has been burned.	Addresses controlled burning, which directly impacts on ambient air quality.
Local Government Municipal Structures Act, 1988 (Act No. 117 of 1998)	• Establishes municipal categories. • Designates functions and powers of municipalities.	Specifies that responsibility for integrated development planning, within which air quality management plans must reside, rests with district municipalities.

Legislation	Air quality management links	Relevance
National Veld and Forest Fires Act, 1988 (Act No. 101 of 1998)	• Purpose is to combat and prevent veld, forest and mountain fires. • Fire protection agency can be designated for control and has power to conduct controlled burning with respect to conservation of ecosystems and reduction of fire danger. • Lighting, maintenance and using of fires are regulated.	Addresses controlled burning, which directly impacts on ambient air quality.
National Water Act, 1998 (Act No. 36 of 1998)	• Establishes strategy to address management of water resources including protection and use of water. • Establishes management agencies. • Provides for pollution prevention and remediation, including land-based sources. • Addresses emergency incidents, including land based pollutant sources.	Pollution sources from land-based activities that impact on water resources.
Local Government Municipal Systems Act, 2000 (Act No. 32 of 2000)	• Provides a framework for planning by local government. • Describes contents of an integrated development plan and the process to be followed.	Air quality management plans are to be incorporated into integrated development plans.
Occupational Health and Safety Act, 1993 (Act No. 85 of 1993)	• Provides for the health and safety of persons at work, including atmospheric emission from workplaces. • Sets out certain general duties of employers and employees. • Empowers the Minister of Labour to make regulations regarding various matters. • Further require any employer to ensure that their activities do not expose non-employees to health hazards.	The air emissions from the workplace environment have atmospheric quality implications.
Promotion of Access to Information Act, 2000 (Act No. 2 of 2000)	• Facilitates constitutional right of access to any information whether held by the state or another person (if it is related to exercise or protection of a right). • Details the means to access records, whether public or private. • Does not detract from provisions in the NEMA section 1 and section 2. • Allows for denial of access based on defence, security or international relations.	Promotes access to information, including air quality information, although it has provisions for refusing access.
Promotion of Administrative Justice Act, 2000 (Act No. 3 of 2000)	• Details the administrative procedure to be followed when carrying out an administrative action, and the review process.	Formal interactions between government departments, the public and other stakeholders by informing due process in decision-making.
International Trade Administration Act, 2002 (Act No. 71 of 2002)	• Establishes the International Trade Administration Commission as an administrative body. • Regulates the import and export of controlled substances.	Import and export control related to ozone-depleting substances through the declaration of controlled substance.

Legislation	Air quality management links	Relevance
Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002)	• States that environmental authorisation is required for obtaining prospecting and mining rights. • For environmental authorisations, scoping, EIA, specialist reports (including air quality specialist report), and EMP are needed. The act states that it is necessary to submit an environmental management programme if applying for mining rights, and an environmental management plan if applying for reconnaissance permission. • The minister is required to consult with any state department which administers any law relating to matters that affect the environment and must request the comments of that department on the environmental plan or programme being considered. • Provisions are made for monitoring and auditing of environmental performance. • Regulation 64 of MPRDA regulations stipulates that, the holder of a mining right or permit must comply with laws relating to air quality management and control. • Stockpiles require compliance monitoring and decommissioning. • Closure certificate authorisation is dependent on approval from other environmental departments that potential environmental impacts have been addressed.	Grants the decision-making power on matters potentially affecting the air environment to the Minister of Minerals and Energy in the case of mining activities but includes the obligation to comply with the AQA.
National Health Act, 2003 (Act No. 61 of 2003)	• Makes reference to the performing of environmental pollution control by municipalities. • Municipal health services are defined as including the responsibility for environmental pollution control. • The responsibility for municipal health services rests with metropolitan and district municipalities. • National and provincial departments of health have the duty to perform environmental pollution control.	Air quality management falls within environmental pollution control.
Intergovernmental Relations Framework Act, 2005 (Act No. 13 of 2005)	• Determines a framework to facilitate interaction and coordination, in the implementation of legislation, between spheres of government. • Principles of participation, consultation and consideration are included. • Establishes structures for coordination at different spheres of government. • Establishes an implementation protocol mechanism as a tool for coordination. • Provides mechanisms for conflict resolution, including the appointment of a facilitator.	Provides mechanisms for coordination and conflict resolution across spheres of government in aspects of legislative implementation.
National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008)	• Promotes cleaner technology, cleaner production and consumption practices for pollution minimisation. • Addresses impacts of waste disposal on the environment, including air. • Provides for numerous measures related to waste disposal including standards, integrated waste management planning, municipal waste management, priority wastes, licensing, waste management information system.	Closely linked through issues of emissions to the air from thermal treatment activities and landfill sites.
Disaster Management Act, 2002 (Act No. 57 of 2002)	• Provides for the declaration of certain areas as disaster areas. • Disaster is defined as including the damage to the environment. • Provides for an integrated and co-ordinated disaster management policy that focuses on preventing or reducing the risk of disasters, mitigating the severity of disasters, emergency preparedness, rapid and effective response to disasters and post-disaster recovery. • Provides for the establishment of national, provincial and municipal disaster management centres.	Certain air pollution episodes can be disastrous. Inversely, certain disasters result in air pollution.

Legislation	Air quality management links	Relevance
Accreditation for Conformity Assessment, Calibration and Good Laboratory Practice, 2006 (Act No. 19 of 2006)	• Provides national and international recognition of the reliability of data produced by conformity assessment bodies involved in air quality management.	An accreditation service can be used to provide confidence to stakeholders regarding the reliability of data produced by conformity assessment bodies.

ANNEX B: DOCUMENTATION EVALUATION SHEET

<table>
<tr><td colspan="8">Documentation Evaluation Sheet and interview sheet</td></tr>
<tr><td colspan="4" rowspan="3">AQMP Project name:</td><td colspan="4">Evaluation date:</td></tr>
<tr><td colspan="4">Evaluator: Phathu Mukwevho</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td colspan="8">Documentation reviewed:</td></tr>
<tr><td colspan="8">Person/s interviewed (if applicable):</td></tr>
<tr><td>A = conformance</td><td>B = partly conformed</td><td colspan="2">NC = non-conformance</td><td>NE = not evaluated</td><td>NA = not applicable to the scope</td><td colspan="2">? = Status could not be established during the evaluation</td></tr>
<tr><td>KPIs</td><td colspan="3">Question</td><td>Value</td><td colspan="3">Comments</td></tr>
<tr><td colspan="8">A. INPUT COMPONENT (Transactive effectiveness)</td></tr>
</table>

	The following indicators are indicative of the substance quality of the AQMP and relevant supporting reports content.		
	Skills and competency:		
	To what extent do the skills and competencies of the consultants conform with relevant fields of study?		
	To what extent do the skills and competencies of the consultants reflect relevant experience?		
	To what extent do the skills and competencies of the specialists conform with relevant specialist registrations?		
	To what extent do the skills and competencies of the specialists conform with relevant fields of study?		
	To what extent do the skills and competencies of the officials conform with relevant fields of study?		
	To what extent do the skills and competencies of the officials reflect relevant experience?		
	Time:		
	To what extent are timeframes provided for the implementation of the AQMP intervention strategies?		
	Finance:		
	To what extent is the budget provided for the development of the AQMP?		
	To what extent is the budget provided for the implementation of the AQMP?		
	Data:		
	To what extent was the data accessibility to develop an AQMP?		
	To what extent was the accuracy and reliability of the data used to develop an AQMP?		
	Infrastructure (air quality monitoring system):		
	To what extent was monitoring performed in accordance with accepted standard methods through the ambient air quality monitoring network?		
	Cooperative governance exists between government stakeholders.		
	To what extent was the coordination and cooperation between the various spheres of government?		
B. ACTIVITY COMPONENT (Procedural effectiveness)			

	Stakeholders are established and are actively involved in the assessment or AQMP process.		
	Awareness campaign and communication		
	Engage the stakeholders		
	Stakeholders to participate in the AQMP development and implementation process		
	Workshops with interested and affected parties		
	Awareness raising and building capacity of the hindrances		
	Successful implementation of the AQMP		
	A gap and problem analysis conducted		
	Description of pressures and challenges		
	Problems associated with enforcement and compliance		
	Stakeholder consultation		
	Complaints data		
	Intervention Strategies		
	General intervention strategies available		
	Intervention strategies on policy implementation and legislative changes.		
	Intervention strategies on the use of international best practice.		
	Air pollution source identified alongside the existing emission reduction initiatives and effectiveness.		
	Potential reduction strategies – short-, medium- and long-term.		
	A description of each strategy (including technical feasibility and socio-economic impacts, and a statement on implementation).		
	Estimation of expected costs and benefits.		
	Roles assigned to implement the reduction strategy.		
	Measures to reduce emissions from mobile sources identified.		
	Implementation of intervention strategies		
	Implementation task teams		
	Short-, medium- and long term actions described.		
	Conducting awareness and educational campaigns.		
	Public-private partnership (municipalities collaborate with private sector to get financial assistance on air quality intervention strategies).		

	By-laws (developed by the local municipalities aligned with national and provincial legislation. The purpose of the by-laws is to regulate air quality management in the municipalities. The AQMPs should indicate how by-laws will be enforced.)		
	Funding (is important to implement AQMP. Therefore funding mechanism for different interventions to be outlined in the case of government implementation.)		
	A summary of the entire AQMP. (The plan should detail how set targets and goals will be achieved and what resources will be required by the municipalities to implement the plan over the five years period.)		
	The implementation plan is feasible (practical, timeframes, verifiable).		
	Monitoring and evaluation		
	Air quality monitoring		
	Ambient air quality monitoring network		
	Location of monitoring stations		
	Source monitoring		
	Continuous meteorological monitoring		
	Atmospheric dispersion modelling conducted for the area		
	Atmospheric dispersion modelling conducted for the area		
	General monitoring		
	Communication and public participation (the communication plan indicating how the stakeholders will be informed and how the feedback regarding the progress of the AQMP will be communicated).		
	Financial plan. Annual budget allocation and medium-term finance and how funds were raised should be discussed.		
	Air quality management implementation programme. The delivery milestones; target; activities undertaken; municipalities' responsibilities and schedules of projects related to AQMP implementation should be included in the programme.		

	Review of AQMPs (to measure successful implementation of the AQMP, the plan should be reviewed. Therefore, the AQMP should be reviewed every five years aligned with the IDP requirements. Annual performance reports can also be considered as a reviewing mechanism.)		
	Reporting. The annual performance of the AQMP should be provided. The content should include: the extent of to which the AQMP was implemented; air quality management initiatives; compliance of the AQMP to the applicable standards; any amendments to the plan		
C. OUTPUT COMPONENTS (Completeness and substance quality)			
AQMP overview	The AQMP clearly set the goals and objectives of the AQMP:		
	1. The overall goals of the AQMP have been identified		
	2. The specific goals of the AQMP have been identified		
	3. The goals and objectives are linked to the specific air quality problems of the area		
	4. Objectives are SMART (specific, measurable, realistic and timeous)		
	5. Geographical area AQMP implementation		
	6. The geographical area is mapped out		
	7. Description of the area, land use, topography, landscape and natural resources		
	8. The description of demographics (gender, race, and age)		
	9. The description of socio-economic status (description of number of households distribution, poverty levels, education and employment status)		
	10. List of areas that use fossil fuels for domestic use.		
	11. Health status of persons living in areas of high fossil fuel use for domestic use		
	Identification of all industrial air pollution sources		
	12. Inventory of section 21 industries		
	13. Inventory of section 23 industries		
	14. Inventory of industries generating dust		
	15. Inventory of industries that may cause air pollution and not listed (e.g. controlled emitters)		

	16. International agreements		
	17. Best practice guidelines identified for air quality management and listed.		
	18. Description of relevant national, provincial and municipal government roles and responsibility in giving effect to the plan		
Air quality goal setting	**Identification of primary and secondary pollutants of concern**		
	19. Pollutants impacting health		
	20. Environmental impact related		
	21. Climate change-related		
	22. Assessment of impact of industrial activities		
	23. Assessment of regional issues such as acid rain, regional ozone and trans boundary issues		
	24. Assessment of greenhouse gases		
	25. Assessment of indoor exposure		
	26. Training, institutional building and information management		
	27. Reference is made to comply with legislative requirements		
Baseline air quality assessment	**A thorough baseline air quality assessment is done using current and relevant information and is sufficient to inform the gap and problem analysis.**		
	28. Area description and definition		
	29. Description of administrative boundaries		
	30. Description of region or municipality		
	31. Description of urban populated extension		
	32. Description of urban agglomeration boundary		
	Meteorology and climate description		
	33. Description of the climate of the area		
	34. Presentation of wind, temperature and precipitation data		
	35. Description of air stability and temperature inversions		
	36. Information about the population distribution and population density presented		
	Evaluation of baseline air quality data		
	37. Quality assurance and quality control (QA/QC) programme		

	38. Description of current air quality		
	39. National and provincial requirements		
	40. Adequacy of AQM structures (decision on whether the current air quality management and operational structures within the area are adequate)		
	41. Inventory of current procedures and methods adopted by authorities to combat air pollution		
	Identify sources and pollutants of concern		
	42. List pollutants and compounds and their main sources identified		
	43. Identification of types of sources – point, line, area		
	44. Evaluate existing emission inventories		
	45. Baseline assessment and priority air quality issues identified		
	Evaluate current management and tools available		
	46. Evaluation of the capacity at different spheres of government for air quality management		
	47. Assessment of available emission data and emission inventories		
	48. Existing air quality monitoring programmes		
	49. Consideration of other issues (climate change, future developments in the area, trans-boundary issues)		

ANNEX C: AQMP INTERVIEW DESIGN SHEET

<table>
<tr><th colspan="7">INTERVIEW DESIGN SHEET</th></tr>
<tr><td colspan="7">AQMP Name:</td></tr>
<tr><td colspan="7">Interview Date:</td></tr>
<tr><td colspan="7">Interviewer(s):</td></tr>
<tr><td colspan="7">Persons interviewed:</td></tr>
<tr><td>A = Conformance</td><td>B = partly conformed</td><td>NC = Non-Conformance</td><td>NE = Not evaluated</td><td>NA = Not Applicable to the scope</td><td colspan="2">? = Status could not be established during the evaluation</td></tr>
<tr><td>KPIs</td><td colspan="2">Question</td><td>Value</td><td colspan="3">Comment</td></tr>
<tr><td colspan="7">1. DESIGN COMPONENT</td></tr>
<tr><td colspan="7">The way that the AQMP is designed and legislated fits the overall objective for air quality governance in South Africa.</td></tr>
<tr><td>1.1</td><td colspan="2">To what extent is the current legislative framework for the development and implementation of AQMP fit for purpose?</td><td></td><td colspan="3"></td></tr>
<tr><td>1.2</td><td colspan="2">To what extent have different spheres of government (i.e Provincial, district, local) developed and implemented their AQMPs?</td><td></td><td colspan="3"></td></tr>
<tr><td colspan="7">The legislative framework provides guidance towards AQMP development and implementation.</td></tr>
<tr><td></td><td colspan="2">To what extent did the legislation provide guidance towards AQMP development and implementation?</td><td></td><td colspan="3"></td></tr>
<tr><td colspan="7">2. INPUT COMPONENT</td></tr>
</table>

Resources exist to develop and implement the AQMP			
	Skills and Competencies: (A complete list of participants and tasks should be presented and the relevance as well as the ability to perform a complete integrated air quality planning process needs to be assessed)		
1.1	To what extent do the skills and competencies of the consultants conform with relevant fields of study?		
1.2	To what extent do the skills and competencies of the consultants reflect relevant experience?		
1.3	To what extent do the skills and competencies of the specialists conform with relevant specialist registrations?		
1.3	To what extent do the skills and competencies of the specialists conform with relevant fields of study?		
1.4	To what extent do the skills and competencies of the officials conform with relevant fields of study?		
	Time:		
	To what extent are timeframes provided for the development of the AQMP?		
	To what extent are timeframes provided for the implementation of the AQMP?		
	Finance:		
1.5	To what extent is the budget provided for the development of the AQMP?		
1.6	To what extent is the budget provided for the implementation of the AQMP?		
1.7	To what extent was the AQMP delivered within budget specifications?		
	Data:		
1.8	To what extent was the data accessibility to develop an AQMP?		
1.9	To what extent was the accuracy and reliability of the data used to develop an AQMP?		
	Infrastructure (Air Quality Monitoring system)		
1.10	To what extent is monitoring performed in accordance with accepted standard methods through the ambient air quality monitoring network?		
1.11	To what extent are the locations of monitoring stations based on locations of main sources, topographical features and meteorological conditions, as well as urban featured and population distribution?		
1.12	To what extent does the monitoring cover all compounds of relevance in the area, based upon the sources in the area and their emissions of compounds relevant for air pollution and its effects?		

	Stakeholders are established and are actively involved in the assessment or AQMP process.		
1.13	To what extent were the stakeholders been identified in the development and implementation of AQMP?		
1.14	To what extent was the coordination and cooperation between the various spheres of government?		
1.15	To what extent were workshops and forums with stakeholders conducted at the drafting of the AQMP?		
1.16	To what extent was the draft AQMP submitted for public comment?		
1.17	To what extent have the inputs/comments of stakeholders been incorporated into the AQMP?		
1.18	To what extent were stakeholders informed of the progress through regular media feedback (including governmental departments, industry and the public)?		
1.19	To what extent were awareness campaigns conducted?		
	Cooperative governance exists between governments stakeholders.		
	To what extent was the coordination and cooperation between the various spheres of government?		
3. ACTIVITY COMPONENT			
	A thorough baseline air quality assessment is done using current and relevant information and is sufficient to inform the gap and problem analysis		
	To what extent are a list pollutants and compounds included with the main sources identified?		
	To what extent have the existing emission inventories been evaluated?		
	To what extent are the main priorities and air quality issues stated?		
	To what extent are all the important the sources that contribute to ambient air quality identified?		
	To what extent are all the important the sources that contribute to ambient air quality prioritised?		
	To what extent has an evaluation been conducted on current management and tools available? (Air Quality Management Officials, emissions inventories & Existing air quality monitoring).		
	To what extent was atmospheric dispersion modelling conducted for the area?		
	To what extent have the of types of sources (point, line, area) been determined?		

2.2	To what extent has the annual report been submitted by Provincial or Local authorities?		
2.3	To what extent has the AQMP been implemented based on the following: • Air quality management initiatives?		
2.4	• Compliance of the AQMP to the applicable standards?		
2.4	• How the priority area performed in achieving the targets?		
	Monitoring:		
2.5	To what extent does the AQMP monitoring cover all compounds of relevance in the area, based upon the sources in the area and their emissions of compounds relevant for air pollution and its effects?		
2.6	To what extent does monitoring cover continuous measurement of wind speed and direction, temperature, radiation wind fluctuations, relative humidity, precipitation and atmospheric pressure?		
2.7	To what extent does the AQMP indicate how the stakeholders will be informed and how the feedback regarding the progress of the AQMP will be communicated?		
2.8	To what extent does the AQMP include annual budget allocation and medium-term finance and how funds were raised should be discussed?		
2.9	To what extent has the air quality implementation programme included the delivery milestones; target; activities undertaken; municipalities' responsibilities and schedules of projects related to AQMP implementation?		
2.10	To what extent does the AQMP get reviewed?		
2.11	Does the AQMP get reviewed every five years aligned with the IDP requirements?		
	Gap and problem analysis is done.		
	To what extent was a gap analysis conducted to evaluate whether the past and current monitoring, emission inventory and modelling information is sufficient to address air quality issues?		
	To what extent does the gap and problem analysis include the description of pressures and challenges faced as a result of rapid population growth and increase of industrialisation (new facilities, vehicle use etc.) activities that result in increased air pollution?		
	To what extent does the gap and problem analysis include the description of problems associated enforcement and compliance?		
	The intervention strategies are sufficient to achieve ambient AQ standards.		

	To what extent have the intervention strategies achieved ambient AQ standards?		
	The implementation plan is feasible (practical, timeframes, verifiable).		
	To what extent has the implementation plan been developed?		
	To what extent does the implementation plan meet the SMART criteria?		
4. OUTPUT COMPONENT			
	Stakeholder inputs have been incorporated in the final AQMP Report.		
	To what extent are the stakeholder inputs incorporated into the final AQMP?		
5. OUTCOMES COMPONENT			
	The AQMP is gazetted and legally enforceable (Immediate outcomes)		
3.1	To what extent did the AQMP get gazetted (i.e only for priority area AQMP)		
	To what extent has the AQMP been approved by council? (i.e only for priority area AQMP)		
	The AQMP is approved by local council/legislature and included in the IDP/ EMP/ EIP (immediate outcome).		
3.2	To what extent was the AQMP included in the IDP/ EMP/ EIP or gazetted by the minister?		
	The goal of an AQMP is to bring ambient air into compliance with the ambient air quality standards (Intermediate)		
	To what extent has the AQMP been in bringing ambient air into compliance with the ambient air quality standards?		
	The AQMP gives effect to chapter 3, section 16(1) of NEM:AQA requirements.(Intermediate)		
3.3	To what extent does the AQMP improve air quality?		
3.3	To what extent does the AQMP identify the negative impact on human health and the environment of poor air quality?		
3.4	To what extent does the AQMP reduce the negative impact on human health and the environment of poor air quality?		
3.5	To what extent does the AQMP address the effects of emissions from the use of fossil fuels in residential applications?		
3.6	To what extent does the AQMP address the effects of emissions from industrial sources.		

3.7	To what extent does the AQMP address the effects of emissions from any point or non-point source of air pollution other than fossil fuels and industrial sources?		
3.8	To what extent does the AQMP implement the Republic's obligations in respect of international agreements?		
3.9	To what extent does the AQMP to give effect to best practice in air quality management?		
3.10	To what extent does the AQMP describe how the relevant national department, province or municipality will give effect to its air quality management plan?		
3.11	To what extent does the AQMP comply with such other requirements as may be prescribed by the Minister?		
6. IMPACT COMPONENT			
4.1	To what extent does the AQMP realize an environment that is not harmful to health and well-being?		
4.2	To what extent did the AQMP achieve protection of the environment over the immediate and long term?		
4.3	To what extent did the AQMP succeed in preventing pollution and ecological degradation?		
4.4	To what extent did the AQMP secure ecologically sustainable development?		
4.5	To what extent did the AQMP promote justified economic and social development?		

ANNEX D: OFFICIALS SKILLS AND COMPETENCIES EVALUATION SHEET.

Responsible officials' designations and years of experience:			
Qualifications:			
Do the air quality officials responsible for implementing the AQMP currently have the following knowledge and skills?	**Yes**	**NO**	**Any comment**
Legislative framework	☐	☐	
Air pollution and its characteristics	☐	☐	
Engineering control	☐	☐	
Atmospheric chemistry	☐	☐	
Air pollution meteorology	☐	☐	
Air pollution risk assessment	☐	☐	
Air quality management principles	☐	☐	
Air pollution modelling	☐	☐	
Air pollution monitoring	☐	☐	
Identification and emission quantification	☐	☐	
Air quality management planning	☐	☐	
Comments:			

ANNEX E: INTERVIEW QUESTIONNAIRE RELATING TO THE DESIGN, OUTCOME AND IMPACT COMPONENTS

RE: Participant information sheet (survey questions)

Date: 2 November 2020

Good day,

My name is Phathutshedzo Mukwevho and I am a Doctor of Philosophy (PhD) student in the school of Unit for Environmental Management and Sciences at the North-West University, Potchefstroom. As part of my studies, I have to undertake a research project, and I am **Evaluating the effectiveness of air quality management plans (AQMPs) as a governance instrument in South Africa** under the supervision of Professor Roelof Burger and Professor Francois Retief. The aim of this research project is to evaluate the effectiveness of air quality management plans as a governance instrument in South Africa.

As part of this project, I would like to invite you to take part in a questionnaire survey. In order to comply with social distancing measures to minimise the spread of the Coronavirus, this activity will involve answering questionnaire survey made available to you though electronic means such as email and the internet; you may then complete the questionnaire and thereafter relay a completed questionnaire back to me using your preferred electronic means. It is estimated that the questionnaire will take about 10-20 minutes of your time. There will be no personal costs to you if you participate in this project. You will not receive any direct benefits from participation, but there are no disadvantages or penalties if you do not choose to participate or if you withdraw from the study. You may withdraw at any time or not answer any question if you do not want to. The survey will be confidential and anonymous as I will not be asking for your name or any identifying information, and the information you give to me will be held securely and not disclosed to anyone else. If you experience any distress or discomfort at any point in this process, you can stop completing the survey or resume at another time.

If you have any questions during or afterwards about this research, feel free to contact me on the details listed below. This study will be written up as a research thesis which will be available online through the university library website. If you wish to see a summary of this report, I will be happy to send it to you. If you have any concerns or complaints regarding the ethical procedures of this study, you are welcome to contact the Senate Committee for Research Ethics.

Yours sincerely,

Researcher: Phathutshedzo Mukwevho **Supervisor: Professor Roelof Burger**

Thank you for taking time to complete this survey. Before you start, kindly take time to read the instructions below:

- There are 2 sections to be completed which are section 1 (demographic information) and section 2 (questionnaire).
- Kindly complete all the questions carefully.
- Completion of all the questionnaire should take you about 10-20 minutes to answer.
- After completing the survey, kindly submit it to the researcher

SECTION 1: Demographic information

Kindly complete demographic information in the table below:

Participant's institutional association (e.g. Government (department/municipality), academia, industry. NGO/civil Society, other)	
Designation/Position	
Related experience (Years and months)	

SECTION 2: Questionnaire

1. Strongly disagree	2. Do not know (neutral)	3. Agree

No	Statement	Disagree ◄—► Agree		
1	The legislation provide sufficient guidance towards the development and implementation of AQMP.	1☐	2☐	3☐
Comments:				
2	Stakeholders are actively involved in the development and implementation AQMPs.	1☐	2☐	3☐
Comments:				
3	An AQMP is legally enforceable.	1☐	2☐	3☐
Comments				
4	AQMP does influence decision making once included in the IDP, EMP or EIP.	1☐	2☐	3☐
Comments:				
5	AQMP does bring ambient air into compliance with the ambient air quality standards (NAAQS).	1☐	2☐	3☐
Comments:				

1. Strongly disagree	2. Do not know (neutral)	3. Agree

No	Statement	Disagree ◄—► Agree		
6	AQMP address the effects of emissions from the use of fossil fuels in residential applications.	1☐	2☐	3☐
Comments:				
7	AQMP address the effects of emissions from industrial sources.	1☐	2☐	3☐
Comments:				
8	AQMP does improve air quality to give effect to chapter 3, section 16(1) of NEM:AQA requirements.	1☐	2☐	3☐
Comments:				
9	AQMP does realise an environment that is not harmful to health and well-being.	1☐	2☐	3☐
Comment:				
10	AQMP does achieve protection of the environment over the immediate and long term.	1☐	2☐	3☐
Comment:				

1. Strongly disagree	2. Do not know (neutral)	3. Agree

No	Statement	Disagree ◄—► Agree		
11	AQMP does succeed in preventing pollution and ecological degradation.	1☐	2☐	3☐
Comment:				
12	AQMP does secure ecologically sustainable development.	1☐	2☐	3☐
Comment:				
13	AQMP does promote justified economic and social development.	1☐	2☐	3☐
Comment:				

ANNEX F: CASE STUDY EVALUATION RESULTS META METRIX SHOWING AREAS OF PERFORMANCES:

Key Performance Indicators					Case studies									A	B	NC	N
					Priority Area	Provincial		metros		District		Local					
					WBPA	Gauteng Province	Limpopo Province	City of Johannesburg	Buffalo City	John Taolo Gaetsewe	West-Coast	Langeberg	Steve Tshwete				
			KPI 1.1	To what extent does the legislation provide guidance towards AQMP development and implementation?													
2. Input components	Skills and competencies	Consultants/Specialists	KPI 2.1	To what extent do the skills and competencies of the consultants/specialits conform with relevant fields of study?	A	A	A	A	A	N	A	N	A	7	0	0	2
			KPI 2.2	To what extent do the skills and competencies of the consultants/specialists reflect relevant experience?	A	A	A	A	A	N	A	N	A	7	0	0	2
			KPI 2.3	To what extent do the skills and competencies of the consultants/specialists conform with relevant specialist registrations?	A	A	A	A	NC	N	A	N	A	6	0	1	2
		Administrators/officials	KPI 2.4	Do the Air Quality Officials responsible for implementing the AQMP currently have the following knowledge and skills?													

Key Performance Indicators				Case studies: Priority Area	Provincial		metros		District		Local		A	B	NC	N
				WBPA	Gauteng Province	Limpopo Province	City of Johannesburg	Buffalo City	John Taolo Gaetsewe	West-Coast	Langeberg	Steve Tshwete				
	Time	KPI 2.5	To what extent are timeframes provided for the implementation of the AQMP intervention strategies?	A	A	A	A	A	A	A	A	A	9			
	Budget/Finance	KPI 2.6	To what extent is the budget provided for the development and implementation of the AQMP? i.e Financial plan - budget allocation and medium-term finance and how funds will/were raised should be discussed.	A	A	B	A	B	B	B	B	B	3	6		
	Data and Information	KPI 2.7	To what extent was the data accessibility, accuracy and reliability to develop an implement the AQMP?	B	B	B	B	B	B	B	B	B		9		
	Infrastructure	KPI 2.8	How efficient is ambient air quality monitoring network?	B	B	B	B	B	B	B	B	B		9		
	Cooperative governace	2.9	To what extent was the coordination and cooperation between the various spheres of government?	B	A	B	A	A	B	B	A	?	4	4		1

Key Performance Indicators				Case studies									A	B	NC	N
				Priority Area	Provincial		metros		District		Local					
				WBPA	Gauteng Province	Limpopo Province	City of Johannesburg	Buffalo City	John Taolo Gaetsewe	West-Coast	Langeberg	Steve Tshwete				
3. Activity components	Stakeholder involvement	KPI 3.1	To what extent were the stakeholders identified and included in the AQM planning process? I.e., this includes workshops, awareness campaigns etc.													
	Gap and Problem Analysis (Manual for Air Quality Management Planning)	KPI 3.2	To what extent was a gap analysis conducted to evaluate the following: • whether the past and current monitoring, emission inventory and modelling information is sufficient to address air quality issues • description of pressures and challenges faced as a result of rapid population growth and increase of industrialisation (new facilities, vehicle use etc.) activities that result in increased air pollution • problems associated enforcement and compliance	A	A	A	A	A	A	A	NC	A	8		1	

Key Performance Indicators					Case studies									A	B	NC	N
					Priority Area	Provincial		metros		District		Local					
					WBPA	Gauteng Province	Limpopo Province	City of Johannesburg	Buffalo City	John Taolo Gaetsewe	West-Coast	Langeberg	Steve Tshwete				
	Intervention Strategies (Manual for Air Quality Management Planning)	Intervention strategies relating to air quality	KPI 3.3	To what extent do the Intervention strategies include strategy (ies) on policy including by-laws implementation and legislative changes? (The purpose of the By-Laws is to regulate air quality management in the municipalities. The AQMPs should indicate how By-laws will be enforced)	A+17:25	A	A	A	A	NC	A	A	A	8		1	
			KPI 3.4	To what extent do the intervention strategies include strategy (ies) on the use of international best practice?	A	A	A	A	A	A	A	NC	NC	7	0	2	
			KPI 3.5	To what extent do the intervention strategies include strategy (ies) on Air pollution source including the identification of existing emission reduction initiatives and their effectiveness?	A	A	A	A	A	B	A	NC	A	7	1	1	

Key Performance Indicators					Case studies									A	B	NC	N
					Priority Area	Provincial		metros		District		Local					
					WBPA	Gauteng Province	Limpopo Province	City of Johannesburg	Buffalo City	John Taolo Gaetsewe	West-Coast	Langeberg	Steve Tshwete				
			KPI 3.6	To what extent do the intervention strategies include strategy (ies) on the Identification of all potential reduction strategies – short, medium and long term?	A	A	A	A	A	A	A	A	A	9			
			KPI 3.7	To what extent do the intervention strategies include strategy (ies) on technical feasibility and socio-economic impacts, and a statement on implementation?	A	A	A	A	A	A	A	A	A	9			
			KPI 3.8	To what extent does the AQMP (intervention strategies) include strategy (ies) on the estimation of expected costs and benefits?	B	A	B	B	NC	B	NC	NC	B	1	5	3	
			KPI 3.9	To what extent do the intervention strategies include strategy (ies) on determining parties and allocate responsibility to implement the reduction strategy? This include implementation of	A	A	A	A	A	B	A	A	A	8	1		

Key Performance Indicators					Case studies									A	B	NC	N
					Priority Area	Provincial		metros		District		Local					
					WBPA	Gauteng Province	Limpopo Province	City of Johannesburg	Buffalo City	John Taolo Gaetsewe	West-Coast	Langeberg	Steve Tshwete				
				task teams comprising of relevant government departments and multi stakeholder groups.													
			KPI 3.10	To what extent do the intervention strategies include strategy (ies) on the measures to reduce emission from mobile sources identified?	A	A	A	A	B	A	B	NC	A	6	2	1	
			KPI 3.11	To what extent do the intervention strategies include strategy (ies) on community based organizations assisting the municipalities with conducting awareness and educational campaigns?	A	A	A	A	NC	A	A	A	A	8		1	
			KPI 3.12	To what extent do the intervention strategies include strategy (ies) on municipalities collaborating with private sector to get financial assistance on air quality intervention strategies?	A	A	B	A	NC	B	NC	NC	B	3	3	3	

Key Performance Indicators				Priority Area	Provincial		metros		District		Local		A	B	NC	N
				WBPA	Gauteng Province	Limpopo Province	City of Johannesburg	Buffalo City	John Taolo Gaetsewe	West-Coast	Langeberg	Steve Tshwete				
		KPI 3.13	To what extent do the intervention strategies include strategy (ies) on the funding mechanism for different interventions being outlined in the case of government implementation?	A	A	B	A	B	A	B	NC	B	4	4	1	
		KPI 3,14	To what extent do the intervention strategies include indicators monitor progress towards achieving the intervention?	A	A	B	A	B	A	A	NC	A	6	2	1	
	Implementation plan	KPI 3.15	To what extent does the implementation plan meet the SMART criteria?	A	A	B	A	B	A	A	NC	A	6	2	1	
Monitoring and Evaluation (Air Quality Management System)	Air quality Monitoring	KPI 3.16	To what extent does the AQMP cover the following requirements on monitoring: • Ambient air quality monitoring network: monitoring is performed in accordance with accepted standard methods;	A	A	A	A	A	NC	B	NC	A	6	1	2	

Key Performance Indicators					Case studies: Priority Area – WBPA	Provincial – Gauteng Province	Provincial – Limpopo Province	metros – City of Johannesburg	metros – Buffalo City	District – John Taolo Gaetsewe	District – West-Coast	Local – Langeberg	Local – Steve Tshwete	A	B	NC	N
			KPI 3.17	Location of monitoring stations is based upon locations of main sources, topographical features and continuous meteorological conditions, as well as urban featured and population distribution.	A	A	A	A	B	NC	NC	NC	A	5	1	3	
		Atmospheric Dispersion Modelling	KPI 3.19	Atmospheric Dispersion modelling conducted for the area	A	A	A	A	B	B	NC	NC	A	5	2	2	
		AQMP Review and inclusion in the IDP	KPI 3.20	Review of AQMPs (to measure successful implementation of the AQMP the plan should be reviewed. Therefore, the AQMP should be reviewed every five years aligned with the IDP requirements. Annual performance reports can also be considered as a reviewing mechanism)	NC	A	NC	A	A	A	A	NC	A	6		3	
4. Output component	Description of relevant	goals and objectives of the AQMP	KPI 4.1	The goals and objectives have been identified and are SMART (specific,	A	A	A	A	A	A	A	A	A	9	0	0	0

Key Performance Indicators					Case studies									A	B	NC	N
					Priority Area	Provincial		metros		District		Local					
					WBPA	Gauteng Province	Limpopo Province	City of Johannesburg	Buffalo City	John Taolo Gaetsewe	West-Coast	Langeberg	Steve Tshwete				
				measurable, realistic and timeous)													
		Geographical area	KPI 4.2	The geographical area is described, land use, topography, landscape and natural resources and mapped out	A	B	B	B	A	A	A	B	B	4	5	0	0
		Socio-economic status	KPI 4.3	The description of demographics (gender, race, and age, population distribution and population density presented)	B	B	B	B	B	B	NC	B	B	0	8	1	0
			KPI 4.4	The description of socio-economic status (description of number of households distribution, poverty levels, education and employment status)	B	B	B	A	NC	B	B	B	B	1	7	1	0
		Fossil Fuels Use	KPI 4.5	List of areas that use fossil fuels for domestic use	A	A	NC	NC	A	A	NC	NC	A	5	4	0	0
			KPI 4.6	Health status of persons living in areas of high fossil fuel use for domestic use	NC	B	NC	NC	NC	NC	NC	NC	B	0	2	7	0
		all industrial air pollution sources	KPI 4.7	Inventory of section 21, 23 and dust generating industries	B	B	B	B	B	NC	B	NC	B	0	7	2	0

Key Performance Indicators					Case studies: Priority Area	Case studies: Provincial		Case studies: metros		Case studies: District		Case studies: Local		A	B	NC	N
					WBPA	Gauteng Province	Limpopo Province	City of Johannesburg	Buffalo City	John Taolo Gaetsewe	West-Coast	Langeberg	Steve Tshwete				
			KPI 4.8	Inventory of industries that may cause air pollution and not listed (e.g. controlled emitters)	B	B	A	A	A	NC	B	NC	B	3	4	2	0
			KPI 4.9	International agreements and Best practice guidelines identified for air quality management and listed.	NC	NC	B	A	NC	NC	B	NC	NC	1	2	6	0
	Air Quality goal setting (Manual for Air Quality Management Planning)	Identification of primary and secondary pollutants of concern	KPI 4.10	Pollutants impacting health, environmental impacts and climate change related	B	B	B	B	A	B	A	NC	A	3	5	1	0
		Asessment of gassess and impacts	KPI 4.11	Assessment of impact of industrial activities, greenhouse gases, indoor exposure and other regional issues including as acid rain, regional ozone and trans boundary issues	B	B	B	B	B	B	B	B	B	0	9	0	0
		Training	KPI 4.12	Training, institutional building and information management	A	A	A	A	A	A	A	NC	A	8	0	1	0
	Baseline air quality	Area description and definition	KPI 4.13	Description of Administrative boundaries, Region or Municipality, Urban populated extension, and urban	A	A	A	A	A	A	A	NC	A	8	0	1	0

Key Performance Indicators					Case studies									A	B	NC	N
					Priority Area	Provincial		metros		District		Local					
					WBPA	Gauteng Province	Limpopo Province	City of Johannesburg	Buffalo City	John Taolo Gaetsewe	West-Coast	Langeberg	Steve Tshwete				
				agglomeration boundary													
		Meteorology and climate description	KPI 4.14	Meteorology and climate description: Description of the climate of the area	A	A	A	A	A	A	A	A	A	9	0	0	0
			KPI 4.15	Presentation of wind, temperature stability inversions and precipitation data	A	A	A	A	A	A	A	B	A	8	1	0	0
		Evaluation of baseline air quality data	KPI 4.16	Quality assurance and quality control (QA/QC) programme	A	A	B	A	NC	NC	B	NC	B	3	3	3	0
		Identify sources and pollutants of concern	KPI 4.17	Identify sources and pollutants of concern: List pollutants and compounds and their main sources and types (point, line, area) identified	A	A	A	A	A	A	A	NC	B	7	1	1	0
		Evaluate current management and tools available	KPI 4.18	Evaluate current management and tools available Evaluation of the capacity at different spheres of government for air quality management	A	A	B	A	A	A	A	B	A	7	2	0	0
			KPI 4.19	Assessment of available emission	A	A	A	A	A	B	B	NC	A	6	2	1	0

Key Performance Indicators					Case studies: Priority Area	Provincial		metros		District		Local		A	B	NC	N
					WBPA	Gauteng Province	Limpopo Province	City of Johannesburg	Buffalo City	John Taolo Gaetsewe	West-Coast	Langeberg	Steve Tshwete				
				data and emission inventories													
			KPI 4.20	Existing air quality monitoring programmes	A	A	A	A	B	B	A	A	A	7	2	0	0
5. Outcomes (immediate)	The AQMP is gazetted and legally enforceable and is included in the IDP/EMP/EIP		KPI 4.21	To what extent is the AQMP included in the IDP/ EMP/ EIP or gazetted by the minister?	A	A	A	B	A	A	A	A	NC	6	1	1	1

ANNEX G: CONTENT ANALYSIS RESULTS SHOWING RESPONSES FROM DIFFERENT STAKEHOLDER GROUPS:

KPI Category	Description	Theme	Key Responses	Reponses				
				Officials	Consultants	Industry	Civil society	Total across all groups
A	The legislation provides sufficient guidance towards the development and implementation of AQMP	(A1) Sufficient legislation and implementation	*"Tools are available to develop AQMP such as the manual, legislation is fine".."yes the legislation provides guidance on the Development of the AQMP"…"Legislation provides sufficient guidelines on the development and implementation of AQMPS"…".Legislation (including regulations is clear, guidance documentation is provided by DFFE)"...."the guidelines are clear".*	9	6	7	6	**28**

		(A2) Sufficient legislation but no implementation	**Since th promulgation of the _AQA there have been at least 10 revisions, and/or regulations to give effect to the meaningful implementation of AQMP."..''Sufficient framework for the development of the AQMP. The challenge is on the skill sets from the government's end particularly with the implementation"..."Yes, for development of AQMPs. Unsure about implementation of AQMPs"...."There certainly is guidance towards the development but I don't think guidance for implementation is clear."..."an AQMP compiled as per the framework and other related legislation does not provide the user adequate information to implement any actions. Details on the formulation of an implementation plan that is usable for the end user is required to promote consistency in AQMPs"..."Yes; however, the regulatory department (DEFFE) lack administrative capability to ensure effective implementation of the AQMP."*	1	3	3	0	**7**

		(A3) Legislation is not sufficient for both development and implementation	*"I do not think the legislation is clear enough on the development and implementation."…."The legislation requires what must be done but not how it must be done"…"implementation of AQMP. Particularly in communities where air quality monitoring stations are situated"..."legislation does not provide any sufficient guidance especially for local communities as most communities are not informed about the AQMP process."*	1	2	0	3	**6**
		(A4) Difficult to say	*"Not yet sure as is early to be sure of what really the income will be"*	0	0	0	1	**1**

B	Stakeholders are actively involved in the development and implementation AQMPs.	(B1) Certain stakeholders are actively involved	*"Stakeholders such as institutions of higher learning, government departments and NGO do participate in the development of AQMP. But ordinary members of the community don't seem to be interested in the development of AQMPs."…"Yes they are actively involved but its mostly academics and government institution, other stakeholders don't understand or have limited interest on Air Quality therefore attendance to public meetings is always poor"..."In my experience there is typically stakeholder engagement – never really sure though to what extent it 'shapes' the final document."..." Stakeholder were involved in the development and implementation of the AQMP through the public participation process to begin with and the subsequent MSRG's established in the South Durban Basin, VTAPA and the HPA's - also including the various ITT's in the HPA. However the active involvement does not necessarily imply the successful achievement of the AQMP's goals and milestones - largely because the AQMP lacked the necessary legal requirements for implementing and enforcing the AQMP's thus essentially rendering*	7	5	6	4	**22**

			them paper Tigers!"..."Yes, I&AP should be part of the development process.".					

		(B2) Lack of stakeholder involvement	*"not getting the buy in and participation of the main role players when Brendan was drafting the District's AQMP and it not being identified in our IDP".. "Mining sector is the second source of air pollution in the area, however their participation in air quality structures in the region is very minimal."..."In a City like Johannesburg there is minimal stakeholder engagement. It is not clear if this is due to lack of awareness or something else. The current AQMP for the City went to public participation together with the by-law but very few stakeholders attended the public participation".."not everyone is actively involved, especially the marginalised communities."..."Because they don't consult the most affected community they do the short cut by putting it on internet for comment and most people are vulnerable and illiterate"..."Not really some are still not involved yet".*	3	1	3	6	**13**

		(B3) stakeholders are involved only at the beginning	*"Stakeholders are mostly involved in the development of AQMP but less involved in the implementation thereof."..''Stakeholders have been actively involved in the development of the AQMPs I have been involved in but has not been active in the implantation thereof.".....''Development of AQMP's have been successfully led by consultants. Implementation is led by municipalities and provincial departments and have not been successfully implemented"*	1	2	0	0	**3**
		(B4) Difficult to say/Not Sure/Do not know	*I'm not sure about this. The AQMPs for Priority areas had several workshops when being drawn up. AQMPs for municipalities are oftern drawn up by consultants and the "public participation" box is always ticked. The question is about the efficiency of the latter process*	0	1	1	0	**2**

C	AQMP does influence decision making once included in the IDP, EMP or EIP.	(C1) AQMP does influence decision making	*"Most definitely. It influences budgeting and boost in terms of debates with and for politicians as we interact with the public".."Yes, If the AQMP are represented in the IDP, budget can be allocated to air quality projects and can be measured against the performance system) SDBIP."..."yes they do influence decision making".."This would vary from place to place. In Richards Bay for example it certainly would but not sure for other places"...."It will influence it in municipalities having EMIs, and Environmental Compliance Officers/ Managers with good knowledge and credibility".*	6	5	5	1	**17**

		(C2) It is not clear what inclusion in the IDP mean/ Do not know/Im not sure	*"As different practitioners, we still struggle to understand what this integration means."..*"many municipalities are still struggling to develop AQMPs because it is not prioritised at IDP level, there is no budget for it."…."Very little".."Not really, the process to integrate AQMP in the IDP is not clear and the City of Johannesburg has never done it except asking the approval by the council. The budgeting process doesn't allow it."…"Disagree, currently the gap is very wide between AQMP, the IRP, IEP, EMP, IDP etc. these plans are all suppose to be interlinked but currently they are not. e.g. The IDP does not say anything about air quality, but rather infrastructure development in local communities".."It doesn't implement decision making because of the corruption". ."In view of the other pressing problems that beset local authority, I'm not sure that AQMPs play a significant role."..*	4	4	4	8	**20**

D	AQMP is legally enforceable	(D1) AQMP is legally enforceable	*"I believe so yes. If it is approved by authorities then I would expect that it is legally enforceable"…"If developed at Priority Area, District, or Local level, non-compliance with the intervention strategies set out in an AQMP, could result in legal enforcement. However, it could be difficult to enforce strategies involving sources such as road emissions, and domestic fuel burning which could represent large sources with large impact, but address several non-air quality related issues (such as poverty, employment, and clean transport alternatives)."..."I agree; in this regard I find it difficult to see the reason for the recent draft regulations on enforcement of AQMPs"..."At this stage, AQMP might be treated as a lesser and unimportant tool since most facilities are having license. For me it looks like more like a duplicate of Air quality Act, and site AEL.".*	1	8	9	5	**23**

		(D2) NOT legally enforceable	*"It is not absolutely true. Standards and the Air quality Act are enforceable. The AQMP is only a guiding document."..."Not really, within the City this is also difficult due to competing needs."…"No it doesn't have time frames from development to implementation, some AQMPs are being implemented with an approval from council simply because the process takes too long."...."Currently AQMPs are not enforceable but in near future owners will be accountable for unsuccessful set milestones. At the other hand public, may misuse their rights against AQMP owners, while at other side it could help developers to set realistic gaols and time for implementation"..."Development of AQMP is a legal requirement but the implementation of the interventions in the AQMP is not legally enforced."...."Some of the goals of some AQMPs couldn't possibly be legally enforceable"....."The requirement to have an AQMP is legally enforceable. However, an AQMP may be described as a business plan for the implementing municipality to address AQM. It is designed to guide the municipality to fulfil the requirements of their AQM*	7	2	0	5	**13**

			mandate in a coordinated and structured way. It is not a legally enforceable document"..."Only if air quality officers take their job serious, and implement the Air Quality Act."..''No penalties have ever been imposed on any jurisdiction nor industry for not meeting the requirements or commitments set out in an AQMP since their inception"..."Disagree, especially with the recent Eskom's exemption and postponement of the Minimum Emission Standards application on some of its coal fired power stations and; also a complete failure to compel compliance in a lot of coal mines and power stations that are failing to always exceeding pollution limit. The AQMP is there in paper, but is not enforced"..."The industries breaks the AQMP because of the law that says the polluters must pay and the corruption from DMRE and the law ***ENFORCEMENT "***					

		(D3) Not sure	*"Although AQMPs are developed as a result of the Air Quality Act, the Enforcement is dependent on whether councils have adopted them or not. If not adopted and included in the IDP they are not legally enforceable. Therefore the response is not definite it depends on circumstances"*	2	1	1		**4**
D	AQMP does bring ambient air into compliance with the ambient air quality standards (NAAQS)	(D1) Does	*"yes through implantation strategies"…."The baseline report in the AQMP identify all sources of pollution in the area and the intervention strategies are developed to address those"…."It certainly is a step forward towards managing air quality. Even if just creating awareness of management possibilities"..."Durban's South Industrial Basin is a great example of an AQMP bringing air quality into compliance. Otherwise it is very difficult to say that an AQMP has achieved this. There are examples where the implementation of Minimum Emission Standards have brought about noticeable reductions in ambient concentrations, Richards Bay is one"..."to a certain extent it does but not to its full capacity."....."We are in compliance from January up*	4	4	3	2	**13**

			to march the winter kicks in then we are in non-compliance again"					

		(D2) DOES NOT	*"Not always, but it serve as a road map towards achieving compliance standards. It cannot absolutely be enforced on polluters"…"I have never experienced a circumstance where this has happened. Least of all in the priority areas"…"The AQMP as a document will not achieve compliance with NAAQS. The intention of an AQMP is to develop realistic implementation strategies that will help reduce emissions from problem sources, which in turn should move air quality in a specific area towards compliance with NAAQS."..."Looking at the statistics, I must disagree"..."there is no certainty that it can necessarily bring ambient air quality into compliance."...."I think conditions embedded in the Atmospheric Emissions Licences for various facilities is serving the purpose to reduce the ambient air quality pollution. AQMP alone may not be effective due to administrative in capabilities by the regulator to enforce the plan outside the AEL."Z..."it provides standards, but it is not enough to ensure compliance"...."The DFFE is not doing enough of what they are supposed to do. When most of the time they don't listen to the affected*	2	5	4	6	**17**

			communities. They failed the communities."..."The basic premise of an AQMP is to bring a priority area out of compliance with National ambient Air Quality standards into compliances and to progressively lead to a reduction of air pollution that can affect the receiving environment and ultimately public health. This has largely not happened."..."The state of the environment reports by the NAQO speak for themselves. The ambient AQ in the VTAPA and the HPA remain out of compliance with our ambient air quality standards and even so our NAAQS are not sufficient to protect public health. The WHO has recently reviewed their ambient AQ guideline limits and we remain way above these limits for the most important public health criteria pollutants (Particulate matter PM10 and PM2.5, O3, NOx, TVOC's, etc."					

		(D3) If only the AQMP was effectively implemented	*"It does if it is well implemented"…"This is the main objective of an AQMP, and if implemented and enforced should achieve the set objective. However, this has not been the case in the VTAPA or HPA and is in my opinion because of a lack of resources and implementation"..."Only implementation can bring about air quality improvements. A document does not guarantee results"..."No, the AQMP per se will not. The successful implementation of the improvement strategies should bring the ambient air into compliance".......''No, the AQMP per se will not. The successful implementation of the improvement* ***STRATEGIES SHOULD BRING THE AMBIENT AIR INTO COMPLIANCE"..."PROVIDED THAT IMPLEMENTATION PLAN IS ADHERED TOO AND BUDGET IS AVAILABLE FOR PROPER IMPLEMENTATION"...***	2	2	2	2	**8**

		(D4) Not sure	*"In theory yes but the fact that is not implementable and cross-cutting nature of air pollution problems makes it difficult to say"..."Emission Reduction programmes on the AQMPs should be evaluated against ambient air results."…."In view of the other pressing problems that beset local authority, I'm not sure that AQMPs play a significant role."*	2		1		**3**
D	AQMP does improve air quality to give	(D1) AQMP does improve air quality		5	2	2	3	**12**

	effect to chapter 3, section 16(1) of NEM:AQA requirementst	(D2) AQMP does NOT improve air quality	*"Most Authorities do AQMP for compliance and not fund or resource the AQMP."…"I have never seen this happen "…."In theory yes. I am yet to see it in practice – measurable outcomes that will improve the actual AQ in a region will have to be included in AQMPs and compared over a period of time for this to be true. "...."AQMPs all have the goal to improve air quality, but I don't think that they do. They rather improve the enforcement of AQM regulations"..."Disagree - there is no certainty that it will improve ambient air quality."..it's just a piece of paper"...."because the WHO released a study showing more than 2000 deaths as a result of Eskom's power stations emissions, this is evidence enough that the air quality is bad."*	2	6	3	3	**14**

		(D3) If only the AQMP was effectively implemented	*"It depends on how effective the implementation process is, otherwise the AQMP is meant to give guidance and bring cooperative engagement amongst relevant stakeholders to implement the plan"…"It suppose to but priority is not given to Air Quality issues in municipality and hence no tangible outcome so far as a result of AQMP"..."yes if implemented correctly"..."If implemented right but implementation is always a challenge due to budget constraints"..."The effectiveness of the AQMP is only realised when it is implemented in the sources of emissions. So, I would say that the plan is improving the air quality as it encourages the execution of projects to minimize high emissions from big industries."..."It can once is implemented "..."It can once is implemented "...."The AQMP will not realise anything. It's just a plan (roadmap) to compliance. The successful implementation of the improvement strategies should improve air quality, if properly addressed.".*	4	1	3	4	**12**
		(D4) Not sure		0	1	2	0	**3**

D	Realize an environment that is not harmful to health and well-being.	(D1) Agree		6	2	2	1	**11**
		(D2) Disagree	*"I believe that AQMP on its own will never improve AQ"…"Comparing ambient air quality to local standards (which have not in all cases followed recent guidelines from WHO and other international guidelines) I must again disagree."..."there is no certainty that it will realize an environment that is not harmful to health and well-being."......"Not currently - potentially if enforceable with strong criminal and administrative penalties."*	1	5	4	2	**12**

		(D3) If only the AQMP was effectively implemented	*"It could if implemented"…"When the ambient results are below the national ambient air quality standards "…"Good and reasonable AQMP is developed but no implementation at all."…"This will depend on the successful implementation of intervention strategies"..."It does work towards this goal, but progress is always slow"...."it does in paper, but in a practical form its not."..."In paper not through implementation".."The AQMP will not realise anything. It's just a plan (roadmap) to compliance. The successful implementation of the improvement strategies should bring the ambient air into compliance, if properly addressed"....."if the plan is effective".*	4	2	2	6	**14**
		(D4) Not sure	*"It is hard to say whether this goal is achieved through any AQMP"*	0	2	2	1	**5**

D	Achieve protection of the environment over the immediate and long term.	(D1) Agree	*"to a certain extent"…."The AQMP may achieve protection of the environment more so over the long term than the immediate"…"Yes, projects and technologies which are implemented to solve a current emissions problem as aligned with the AQMP, are effective for a long term. "*	5	2	5	2	**14**
		(D2) Disagree	*"In principle yes but I have not yet seen it happen in practise"…"Not currently - potentially if enforceable with strong criminal and administrative penalties"…"More than 10 years on and AQMP proved wholly inadequate to achieve protection of the environment over the immediate and long term"..."despite the poor air quality conditions in south Africa, particularly in Mpumalanga and Limpopo; to date coal mining authorisation is granted which has long term impact."*	1	5	2	5	**13**

		(D3) If only the AQMP was effectively implemented	*"When the ambient results are below the national ambient air quality standards"….."If AQMP were correctly implemented by competent personnel and resourced there could be a substantial achievement. The AQMPs are done for ticking the box and compliant purposes."..."It is the intent of AQMPs to maintain or improve air quality. The success thereof depends on the success of implementation strategies"...."Only if law can be enforced and corruption being stopped"..."The AQMP will not realise anything. It's just a plan (roadmap) to compliance. The successful implementation of the improvement strategies should achieve protection of the environment over the immediate and long term, if properly addressed."..."Provided that funds are available to implement proposed projects"..*	5	3	2	3	**13**
		(D4) Not sure	*"This would certainly be an intention of an AQMP, but don't have any input on the extent of the AQMP achieving this."…."Do not know"*	0	1	1	0	**2**

D	Succeed in preventing pollution and ecological degradation	(D1) Agree	*"It does but it's a long journey"…"the mandate of the implementing AQO considers industrial emissions and regulation through AELs and the associated regulations. Reducing emissions from industry has had some success"*	5	3	4	0	**12**
		(D2) Disagree	*"No AQMP does not prevent pollution and environmental degradation. It contributes towards minimizing the impacts of pollution and ecological degradation"…"Way too ambitious for an AQMP – if it were to happen, it would have to be way more than an AQMP"…" it may assist with monitoring of pollution, but is not preventing it"..."More than 10 years on and AQMP proved wholly inadequate in preventing pollution and ecological degradation."..."Disagree, failure to compel compliance and monitoring of SOE's like Eskom and other mining companies, lot of companies get away with a lot of damage behind"*	2	4	3	7	**16**

		(D3) If only the AQMP was effectively implemented	*"Once it has been reviewed and updated, it will certainly be successful"…"When the ambient results are below the national ambient air quality standards, then legislation could achieve secure ecologically sustainable development."…"The available AQMPs were done for compliance purposes only and were never properly implemented due to lack of capacity within the relevant institutions."..."If implemented, it should succeed. Bit to date the main limitation was the implementation of these AQMPs"..."This will depend on the successful implementation of intervention strategies that focus on environmental protection and ecological degradation."..."The AQMP can assist in pollution prevention as long as the requirements of the AQMP are known by all stakeholders that need to ensure that its implemented."..."most of the municipalities does not implement the measures identified on the AQMP"..."The AQMP will not realise anything. It's just a plan (roadmap) to compliance. The successful implementation of the improvement strategies should prevent pollution and ecological degradation, if properly addressed."..."There is not a strong focus*	4	4	3	3	**14**

			on ecologically sustainable development of AQMP's in SA"..."only if everything goes according to plan"..					

D	secure ecologically sustainable development and Economic and social development	(D1) Agree	*Most definitely, the AQMP seeks to address the right to a sustainable environment which automatically promote a justified economic and social development"…"it is my opinion that an AQMP does to a certain extent, secure ecologically sustainable development and promote justified economic and social development."*	4	3	3	1	**11**
		(D2) Disagree	*"Some essential development, like the provision of electricity, is not always ecologically sustainable."…"it seems to me that, in view of other societal problems, the political will to enforce AQMP requirements is lacking".."There should be better instruments that leverage economic and social development and impacts to the environment"..."More than 10 years on and AQMP proved wholly inadequate to secure ecologically sustainable development and promote justified economic and social developmen"...."Disagree, It does not, the plan has gaps which allows industries to continue polluting, making profit at an expense of people's health and the environment."....*	2	4	3	4	**13**

		(D3) If only the AQMP was effectively implemented	*"It could if implemented".."Once the ambient results is below the national ambient air quality standards, then focus of the legislation seek to achieve justified economic and social development"…."These gains could only be achieved or realized when there is capacity and skills to implement the air quality. In most cases the authorities appoint good consultants to do AQMP for them and not implement it"..."AQMP is intended to promote justified economic and social development but it is not considered in most decision-making processes relating to development."..."If implemented correctly, this should be the case"..."There is not a strong focus on economic and social development of AQMP's in SA"*	5	3	2	3	**13**
		(D4) Not sure	*"Hard to say, but probably not significantly."…."AQMPs are still fairly new in our district Nkangala /Highveld, and some questions need a 10 years old established AQMP, to assess it effectiveness"*	0	1	2	2	**5**