

Evaluating the contribution of ISO 14001:2015 towards enhancement of environmental performance: A mining case study

JS Wessels

 **orcid.org 0000-0002-9760-7700**

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Supervisor: Prof C Roos

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PREFACE AND ACKNOWLEDGMENTS

“In everything he did he had great success because the Lord was with him”.

Considering the limited research done on environmental performance evaluation within the mining industry of South Africa, this research aimed to evaluate the contribution of performance evaluation (as part of an ISO 14001:2015 Environmental Management Systems) towards the enhancement of environmental performance using the mining sector as a case study.

I could not have been supervised by a better supervisor than Prof. Claudine Roos and would like to express my sincere gratitude for her constant follow-up, support and advise with meaningful comments towards the research topic as well as the North-West University for providing the infrastructure to conduct research.

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ABSTRACT

Mining is one of the most important primary industries in many countries, providing raw materials for the construction, electricity, and manufacturing industries. However, mining and its associated anthropogenic activities, can have a significant environmental impact, due to its extractive nature. Mining processes causes pollution with adverse impacts, which include the destruction of habitats, loss of biodiversity, soil erosion and contamination, water and air pollution, the generation of hazardous waste, as well as impacts on air. Traditionally, command- and control approaches are used to mitigate the impacts of mining on the environment. However, voluntary instruments, such as management systems may also prove useful to mitigate or prevent the adverse impacts of mining. The ISO 14001:2015 standard EMS is regarded as a voluntary environmental governance approach and provides requirements for the management of activities, products and services, to ultimately avoid, minimise and mitigate adverse environmental impacts. One of the intended outcomes of this standard is to “enhance environmental performance”. In this context, the aim of this research is to evaluate the contribution of performance evaluation (as part of an ISO 14001:2015 EMS) towards the enhancement of environmental performance using the mining sector as a case study. Performance evaluation, within the framework of the ISO 14001:2015 standard, evaluates the effectiveness of implementation and the extent of requirements being fulfilled. It also facilitates managerial decision-making by determining indicators, collecting and analysing data, assessing it against environmental performance criteria, and reporting and communicating the results through regular review and improvement. A qualitative research approach was employed where the EMS documentation and related documented information from three diamond mines in South Africa were evaluated. Eight key performance areas (KPAs) with associated key performance indicators (KPIs) were developed to evaluate the contribution of ISO 14001:2015 performance evaluation towards enhancement of environmental performance. The best performing KPAs were KPA2 (provision for environmental compliance obligations) and KPA6 (provision for internal audits), while KPA 3 (provision for the setting of objectives) and KPA5 (provision for environmental compliance) were the poorest performing KPAs. Recommendations for improvement are recommended, which include - considering and addressing the results of analysis from environmental performance evaluation; consistently evaluating the extent to which environmental objectives have been achieved from the results of evaluation; and applying resources towards the fulfilment of compliance obligations and addressing non-compliances from the results from the evaluation of compliance.

Keywords: *ISO 14001, performance evaluation, mining industry, monitoring and measurement, evaluation of compliance, internal audits, management review.*

ABBREVIATIONS AND ACRONYMS

AEL	Atmospheric Emission License
BSI	British Standard Institute
CB	Certification Body
CH ₄	Methane
CO ₂	Carbon dioxide
CS	Case Study
DEA	Department of Environmental Affairs (now DFFE)
DEFF	Department of Environment, Forestry and Fisheries (now DFFE)
DFFE	Department of Forestry, Fisheries and Environment
DMRE	Department of Mineral Resources and Energy
DWS	Department of Water and Sanitation
ECA	Environmental Conservation Act
EIA	Environmental Impact Assessment
EMS	Environmental Management System
ESG	Environmental, Social and Governance
FNAS REC	Faculty of Natural and Agricultural Science Research Ethics Committee
GDP	Gross Domestic Product
GEO	Global Environmental Outlook Report
GMI	Gas Monitoring Instruments
HLS	High-level structure
IAF	International Accreditation Forum
ISO	International Organisation for Standardization
KPAs	Key Performance Areas

KPIs	Key Performance Indicators
MPRDA	Minerals and Petroleum Resources Development Act
NEMA	National Environmental Management Act
NEM: AQA	National Environmental Management: Air Quality Act
NEM: BA	National Environmental Management: Biodiversity Act
NEM: WA	National Environmental Management: Waste Act
NWA	National Water Act
NWMS	National Waste Management Strategy
NWU	North-West University
PDCA	Plan-Do-Check-Act
PM	Particulate Matter
UNEP	United Nations Environment Programme
VOCs	Volatile Organic Compounds
WUL	Water Use License
WML	Waste Management License

KEY DEFINITIONS

Compliance Obligation means legal requirements that an organisation has to comply with and other requirements that an organisation chooses to comply with. Compliance obligations are related to the EMS and can arise from mandatory requirements such as applicable laws and regulations, or voluntary commitments, such as organisational and industry requirements, contractual relationships, codes of practice and agreements with community groups or non-governmental organisations. (*ISO 14001 International Standard for Environmental Management Systems, ISO, 2015*).

Environment means the surroundings within which humans exist and that are made up of (i) the land, water and atmosphere of the earth; (ii) micro-organisms, plant and animal life; (iii) any part or combination of (i) and (ii) and the interrelationships among or between them; and (iv) the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well-being (*National Environmental Management Act, 107 of 1998, South Africa, 1998*)

Environmental Aspect means the element of an organisations activities, products or services that interacts or can interact with the environment. An environmental aspect can cause an environmental impact, A significant environmental aspect is one that has or can have one or more significant environmental impacts. Significant environmental aspects are determined by the organisation applying one or more criteria. (*ISO 14001 International Standard for Environmental Management Systems, ISO, 2015*).

Environmental Management means managing human activities in order to limit their impact on the natural environment (*King et al., 2018*).

Environmental Management System means part of the management system used to manage environmental aspects, fulfil compliance obligations and address risks and opportunities. (*ISO 14001 International Standard for Environmental Management Systems, ISO, 2015*).

Environmental Objective means objective set by the organisation consistent with its environmental policy (*ISO 14001 International Standard for Environmental Management Systems, ISO, 2015*).

Environmental Performance means performance related to the management of environmental aspects. For an EMS results can be measured against the organisations environmental policy, environmental objectives or other criteria, using indicators. (*ISO 14001 International Standard for Environmental Management Systems, ISO, 2015*).

Key Performance Area means the areas of performance that are essential towards achieving a specific outcome (*Dougall & Mmola, 2015*).

Key Performance Indicator means indicator of performance deemed by an organisation to be significant and giving prominence and attention to certain aspects of operations, management, conditions or impacts (*ISO 14031 Environmental Performance Evaluation Guidelines, ISO, 2021*).

Performance Evaluation means process to facilitate management decisions regarding an organisation's environmental performance by selecting indicators, collecting and analysing data, assessing information against environmental performance criteria, reporting and communicating, and periodically reviewing and improving this process. (*ISO 14031 Environmental Performance Evaluation Guidelines, ISO, 2021*).

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CHAPTER 1 INTRODUCTION

1.1 Introduction

Environmental performance evaluation is defined as a management tool to provide information on an organisation's environmental performance (Angelakoglou & Gaidajis, 2020). The international standard for Environmental Management Systems, ISO 14001:2015, is aimed at managing activities, products, services and infrastructure to ultimately enhance environmental performance. The ISO 14001: 2015 standard provides a framework for an organisation to evaluate their environmental performance through monitoring, measurement, analysis and evaluation (Da Fonseca, 2015). This research evaluates the contribution of ISO 14001: 2015, specifically the clauses focusing on *performance evaluation*, towards the enhancement of environmental performance. For this purpose, the research follows a case study approach, focusing on mining in the South African context. The sections below provide the introduction and background of this research, which focuses on "*Evaluating the contribution of ISO 14001:2015 performance evaluation towards enhancement of environmental performance: A mining case study*".

1.2 Background

Various anthropogenic activities have contributed towards environmental degradation through industrialisation and the associated activities thereof (Hayter & Patchell, 2017). Mining is one of the most important primary industries in many countries, providing raw materials for the construction, electricity, and manufacturing industries. It plays an important role in the economy of many African countries, contributing significantly to their Gross Domestic Product (GDP). For example, in 2018 minerals and mining accounted for 13.5% of GDP in South Africa, 8.4% of GDP in Zambia, and 3.6% of GDP in Ghana (Leonard, 2018). The mining sector also contributes to job creation in Africa and supports the development of regional economies (Hodge *et al.*, 2022).

However, mining and its associated anthropogenic activities, can have a significant environmental impact, due to its extractive nature and associated pollution (Kowalska, 2014). Adverse impacts may include destruction of habitats, loss of biodiversity, soil erosion and contamination, water and air pollution, the generation of hazardous waste, as well as impacts on air quality (Pretty & Odeku, 2017). Additionally, increased sense of insecurity, disruption of traditional ways of life, and exploitation of vulnerable individuals are common problems in mining-affected communities (Emmanuel *et al.*, 2018; Seloja & Ngole-Jeme, 2022).

According to the Global Environmental Outlook Report (GEO-6) for Africa (UNEP, 2016), mining is amongst the industrial activities leading to the most detrimental impacts contributing to land degradation in Africa. The report recognises that concerted “*environmental management efforts are necessary to address the impacts of mining to seek for opportunities for doing things better*”. (UNEP, 2016:8).

Environmental management is the concept for managing human behaviour towards minimising environmental degradation derived from human activities and is essential as it focuses on the consumption of natural resources and aims to mitigate the adverse impacts of industrial activities (Nel & Kotze, 2009). Identifying potential environmental impacts from activities, products, services and processes are essential to ensure that potential issues are foreseen and prevented or mitigated (Abdeljalil *et al.*, 2022).

The ISO 14001:2015 standard for Environmental Management Systems (EMS) is regarded as a voluntary environmental governance approach and provides requirements for the management of activities, products and services, to ultimately avoid, minimise and mitigate adverse environmental impacts (King *et al.*, 2018). The International Organization for Standardisation has defined the ISO 14001 as the standard to facilitate the manner in which organisations manage their environmental aspects, fulfil their compliance obligations and enhance environmental performance (Briggs, 2017; Mungai *et al.*, 2020). The standard provides a framework for *performance evaluation* with the ninth clause which focusses on monitoring, measuring and analysis, evaluation of compliance, internal auditing and management reviews (ISO, 2015; Wairon *et al.*, 2018).

Environmental performance evaluation aims to evaluate the effectiveness of the actions taken to prevent environmental degradation, the fulfilment of compliance obligations and the achievement of environmental objectives in accordance with the strategic initiatives of an organisation (Mungai *et al.*, 2020). Performance evaluation within the framework of the ISO 14001:2015 standard evaluates the effectiveness of implementation and the extend of requirements being fulfilled, it reviews the efficiency as well as demonstrating that planning actions have been carried out regarding the improvements of an environmental management system (Venter, 2019, Johnstone, 2020). Within the framework of ISO 14001:2015, the contribution of performance evaluation measures towards the enhancement of environmental performance can be evaluated.

1.3 Defining the concepts related to environmental performance evaluation

The following sub-sections provide an overview of the concepts “environmental performance”, “performance evaluation” and “enhancement of environmental performance” within the framework of environmental management systems.

1.3.1 Environmental performance

The ISO 14031:2021 guideline has defined environmental performance as the performance related to the management of environmental aspects (ISO, 2021). The core focus of environmental performance within the framework of ISO 14001:2015 considers operational improvements resulting in improved environmental and financial outcomes as well as the evaluation of external social performances (Johnstone & Hallberg, 2020). An organisation’s environmental performance is derived from the representational results of environmental impacts as well as the fulfilment of compliance obligations and objectives in correlation with the efficiency of operational activities (Boiral & Henri, 2012).

1.3.2 Performance evaluation

Environmental performance evaluation is defined as the process and mechanisms utilised for continual management of information to verify if the environmental management system meets the objectives and targets that have been set (Rohov *et al.*, 2021). Clause nine of the ISO 14001:2015 standard provides for performance evaluation, and outlines the requirements for monitoring and measurement, compliance evaluation, internal auditing, as well as management review (ISO, 2015). ISO 14031 focusses on key performance indicators with the comparison of previous and present results towards environmental performance, aligning an organisations targets and objectives. Performance evaluation may assist organisations with identifying trends in environmental performance as well as reviewing and improving the efficiency and effectiveness thereof (ISO, 2021).

1.3.3 Enhancement of environmental performance

Enhancement of environmental performance in ISO 14001:2015 refers to the systematic and ongoing improvement of an organisation's efforts to minimise its impact on the environment (Campos *et al.*, 2015). This involves a structured approach to: (1) identifying and understanding environmental aspects; (2) setting environmental objectives and targets; (3) implementing environmental management programmes, (4) monitoring and measuring performance; and (5) reviewing and continually improving. In essence, enhancement of environmental performance in ISO 14001:2015 is about creating a cycle of improvement, where an organisation strives to

minimise its negative environmental effects and make progress towards becoming more environmentally responsible over time (Avenant, 2020).

1.4 Problem statement and rationale for the study

The ISO 14001:2015 is a management system developed for achieving the intended outcomes of environmental management systems and aims to enhance and continually improve the environmental performance of an organisation (Da Fonseca, 2015; Allur *et al.*, 2018). Organisations that have adopted and implemented ISO 14001 EMS include sectors such as petrochemical, refractory, construction and mining, to name a few (Natalia *et al.*, 2019). ISO 14001:2015 implementation within the mining sector has increased over time (Lira *et al.*, 2021), and various mining companies have implemented environmental management systems as part of its environmental, social and governance (ESG) systems (ARM, 2022). Since not all mines in South Africa have released the information publicly, it is difficult to determine an exact number of mines in South Africa, which have implemented ISO 14001 EMS.

Presently, there are approximately 540 mines in South Africa, which are owned by 174 mining houses with 22 minerals and/or metals being prospected for, mined or extracted. South Africa is one of the leaders in platinum, coal, gold and diamonds production, and is home to a total of 48 diamond mines. The majority of diamond mines are located amongst the banks of the Orange River as well as off the shore of the country's North-Western coastline (AMIQ, 2023). Diamond mining companies operating in South Africa include the De Beers Group, Petra Diamonds, Trans Hex, Firestone Diamonds and Paramount Mining Corp. to name a few (AMIQ, 2023). Many of these diamond mining operations are globally managed through the ISO 14001:2015 standard (Oluleye, 2021).

The advantages of implementing an EMS in diamond mining may include increased efficiency, improved public image, better relationships with communities, reduced risk of regulatory fines- to name a few (Sayre, 2018). The critiques against the implementation of an Environmental Management System, however, is that it (i) the cost is not worth the outcomes, (ii) the standard is complex and hard to implement, (iii) there is a lack of understanding of the requirements of the standard and many times a lack of oversight and commitment from leadership, (iv) the standard is seen as a "box-ticking" exercise, rather than a process ensuring compliance with law and improvement of environmental performance (Camilleri, 2022; Svartson, 2017; Vélchez, 2017).

Given these criticisms towards EMS, the question arises as to whether the implementation of ISO 14001:2015 contributes to the achievement of its intended outcomes. In this case – does the

implementation of ISO 14001:2015 ultimately contribute to the enhancement environmental performance?

1.5 Research aim

The aim of this research is to evaluate the contribution of performance evaluation (as part of an ISO 14001: 2015 EMS) towards the enhancement of environmental performance using the mining sector as a case study. The research specifically focuses on a group of diamond mines in South Africa.

1.6 Scope of the research

The purpose of this research is *not* to evaluate the casual link between EMS arrangements and improved environmental performance. Evaluating the causal link between the implementation of ISO 14001 EMS arrangements and improved environmental performance can be challenging for several reasons:

- **Complexity of environmental performance:** Environmental performance is influenced by numerous factors, not just ISO 14001 implementation. External factors **such as** market conditions, regulatory changes, technological advancements, and consumer preferences can also play a significant role. It is, therefore, challenging to isolate ISO 14001 as the sole driver of improved performance.
- **Time lag:** The benefits of ISO 14001 implementation may take time to become evident. Environmental improvements might not be immediately observable, and it can be difficult to measure long-term impacts accurately.
- **Lack of baseline data and information:** In some cases, organisations may not have sufficient baseline data on their environmental performance before ISO 14001 implementation. Without this baseline data, it is challenging to assess improvements accurately.
- **Other business processes:** Other business processes or variables may confound the relationship between ISO 14001 and improved environmental performance. For example, if an organisation simultaneously invests in new, more efficient technologies, it can be challenging to attribute improvements in environmental performance solely to ISO 14001.
- **Quantification of environmental performance:** Environmental performance is not always easily quantifiable. Some aspects of sustainability and environmental responsibility may be better assessed qualitatively, making it harder to establish a direct causal link.

Despite these challenges, it is not impossible to evaluate the contribution of ISO 14001 EMS arrangements towards improved environmental performance. Researchers use various methodologies, including before-and-after studies, statistical analysis, surveys, and case studies, to assess the impact of ISO 14001 implementation (Ho & Law, 2015).

Instead of evaluating causality, this research evaluates the extent to which the ISO 14001: 2015 EMS (within a case study context) makes provision for improved environmental performance. For the purposes of this research, the 2015 version of the ISO 14001 standard for Environmental Management Systems is utilised to provide requirements for performance evaluation and contribution thereof to the enhancement of environmental performance. The research focuses on Clause Six, which contains the planning actions, Clause Nine that deals with performance evaluation and Clause Ten pertaining to improvements. Considering the factors of Clause Seven towards the effectiveness of actions taken to acquire competency, which is also a form of performance evaluation, did not form part of the scope of the research.

The case study is based on the diamond mining sector of South Africa associated with environmental impacts as well as compliance obligations. A total of three certified diamond mines belonging to the same mining group/house was included in this research. The research was conducted between 2020 and 2023.

1.7 Assumptions and limitations

Based on the scope of the study, the research is limited to the requirements of the international standard of the ISO 14001:2015 version as it is being utilised as a guideline. The study is also limited to the mining industry of South Africa as the main focus is based on the mining sector. Applicable South African legislation is a limitation to the study as the study is carried within the borders of South Africa. The sample size of the research is also a limiting factor as only three certified diamond mines voluntarily participated within the research as well as belonging to the same mining group/house the assumption of the development and implementation of the EMSs might be the same. The methodology and data analysis of the study is also potentially limited due to health and safety protocols which need to be applied in terms of the Mine Health and Safety Act No. 29 of 1996 and applicable regulations towards access to the sample base. The effective date of the Protection of Personal Information Act No. 04 of 2013 occurred during the research period as effective since 1 July 2021, which influences proclamation of the data analysis results obtained from the case studies.

1.8 Potential contribution of the research

The potential contribution of this research is recommendations for improvement in terms of environmental performance evaluation, considering the factors that should be monitored and measured within an environmental management system within an organisation's defined scope. Note can be taken from the study based on methods being employed for performance evaluation as well as the frequency for analysing data and reporting on information obtained. The study can

potentially contribute as part of the international standard requirements for taking results of analysis and compliance obligations into account for continual improvement purposes.

1.9 Structure and outline of the dissertation

This dissertation has five chapters.

- Chapter One is the introduction of the study, which focuses on research gap that has been identified within the mining sector and the justification for the need of the study based on the current international standard for environmental management systems from the International Organisation of Standardization. The introduction gives a broad background of the study as well as focusses on the main concepts and defines what is intended to be achieved throughout the study.
- Chapter Two of the study consists of the literature review that defines the ISO 14001:2015 standard focussing on the history and structure of the standard as well as the key benefits deriving from implementation measures towards the enhancement of environmental performance. The literature review emphasises the mining industry within South Africa and the proclamation of environmental impacts resulting in environmental degradation. The literature review also focusses on the ISO 14001:2015 standard and the utilisation as an environmental management tool within the mining sector of South Africa. Research is focussed on performance evaluation based on the requirements of clause nine from the ISO 14001:2015 standard.
- Chapter Three provides the methodology that is applied for the acquisition of data relevant to performance evaluation within the context of the ISO 14001:2015 standard focussing on the mining industry of South Africa. The methodology chapter also emphasises on the methods utilised for the analysis of data based on the inputs for the results and discussion chapter. Ethical considerations are also elaborated based on the research risk and the proclamation of information.
- Chapter Four outlines the results and discussions obtained from data acquisition and analysis.
- Chapter Five provides the conclusions and recommendations of the research.

1.10 Chapter summary

Chapter One of this dissertation outlined the background and problem statement for this research. It provided the research aim and objectives, as well as the scope of the research, its limitations and potential contribution to knowledge. The next chapter, Chapter **Two**, provides the literature review chapter, which aims to contextualise the research.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

The literature review aims to provide an overview of the research context. This chapter starts by providing background on the origin and evolution of the ISO 14001 standard. The literature review specifically focuses on the main areas related to the research topic, namely “performance evaluation” and “enhancement of environmental performance” within the ISO 14001: 2015 context. The literature review further, specifically, provides context of the diamond mining sector in South Africa, as the case study against which the research was conducted.

The literature review was informed by various resources that consists of strategic, informative and scientific resources of international standards and guidelines, as well as academic publications. Various platforms were used to search for relevant literature. These included Google Scholar, Scopus, Research Gate and the NWU Institutional Repository. The following keywords were used in different combinations “ISO 14001”, “ISO 14001: 2015”, “environmental performance”, “performance evaluation”, “evaluation of compliance”, “monitoring, measurement, analysis and evaluation”, “internal audit”, “management review”, “enhanced environmental performance” and/or “environmental performance indicators”. Literature from the international, African and South African contexts informed this chapter.

2.2 Overview of ISO 14001:2015 Environmental Management Systems

The International Organization for Standardisation is an internationally recognised non-governmental organisation consisting of national standard bodies and technical committees, which develop and publish an extensive series of international standards (Dupendant, 2016). The International Organisation for Standardisation has defined the ISO 14001 as the standard to facilitate the manner in which organisations manage their environmental aspects and fulfil their compliance obligations as well as to address the environmental risks and opportunities based on the interactions of their business processes (Briggs, 2017). This is based on the established “Plan-Do-Check-Act” approach, otherwise known as the PDCA cycle, that allows organisations to constantly improve their environmental performance (Edwards, 2016).

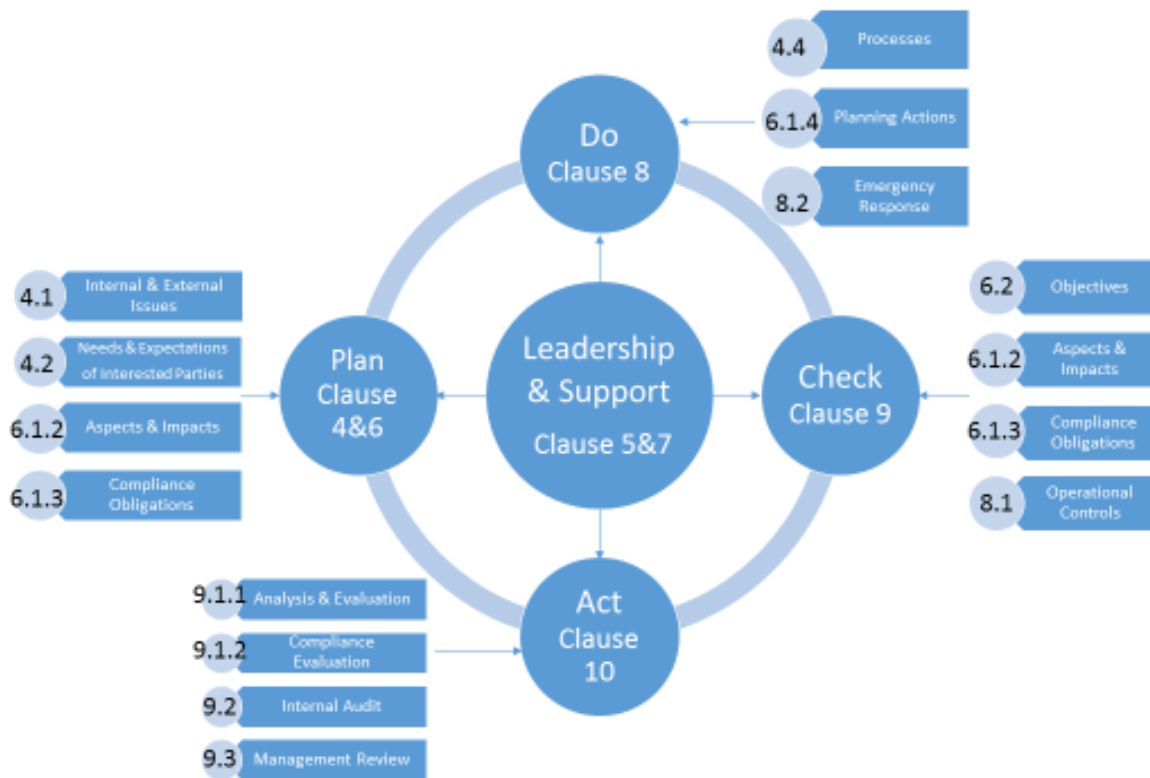


Figure 2-1: The Deming Cycle “PDCA” (adapted from Edwards, 2016)

In the 1970s, the world became increasingly conscious of environmental matters, leading the British Standard Institute (BSI) to establish principles in the European Community to promote environmental protection. Further, in 1993, the ISO family declared the ISO 14000 regulations to maximise environmental sustainability. As time has passed, the standard has been revised many times, and the most up-to-date edition is from 2015, which especially emphasises managerial commitment and a strategic direction for organisations. The EMS, which is voluntary and not obligatory in South Africa, is intended to encourage sustainable development holistically, by recognising, controlling, managing and monitoring environmental issues (ISO, 2015). Although Environmental Management Systems are not mandatory, organisations can potentially benefit from sustainable practices by adopting this system and enhance environmental performance through the results of evaluation. (Briggs, 2017).

2.2.1 Structure of the ISO 14001:2015 standard

The ISO 14001:2015 standard is designed based on a high-level structure (HLS) of international standards, consisting of ten clauses and their associated sub-clauses (ISO/IEC, 2020). The HLS of the ISO standards is a common framework that provides a comprehensive and consistent structure for all ISO standards. It allows any ISO standard to be understood and compared in relation to other standards, enabling an easier and more efficient understanding of related standards across technical and organisational boundaries.

The first three clauses of the ISO 14001:2015 standard provide an overview of its scope, normative references, and terms and definitions (ISO, 2015). No formal requirements are provided in these sections.



Figure 2-2: High-level structure for management system standards (ISO/IEC, 2020)

Clause 4 of the standard, known as the *Context of the Organisation*, provides a framework for understanding an organisation's context and the needs and expectations of relevant stakeholders. Moreover, organisations determine their scope of applicability towards the management system by considering their units, physical boundaries, operational functions, processes needed to achieve desired results, and their overall interactions (Maliwatu, 2018; ISO, 2015).

Additionally, Clause 5, which focuses on *Leadership* and the interactions of top management, outlines their commitments towards the management system, enabling them to draft an environmental policy to protect the environment and prevent any form of pollution resulting from their activities (Tomšič *et al.*, 2015; ISO, 2015). This clause also facilitates top management in assigning relevant roles and responsibilities, as well as delegate communication of performance details of the Environmental Management System to personnel.

Clause 6 of the standard provides a framework for *Planning*, which includes identifying potential risks and opportunities associated with the organisation's context, as well as considering environmental aspects and impacts deriving from operational functions. Planning is essential for understanding relevant compliance obligations and the actions needed to address them (Anandagir *et al.*, 2021; ISO, 2015). The clause also outlines the need for setting environmental

objectives for appropriate processes, taking into account the environmental aspects and impacts, compliance obligations, and risks and opportunities (Fura, 2013; ISO, 2015).

The seventh clause of the standard outlines the *Resources* necessary to achieve the intended outcomes of the EMS. This clause takes into account the resources and competencies required by personnel to influence the organisation's environmental performance, as competence and awareness training are essential for effective implementation (Venter, 2019; ISO, 2015). Additionally, it provides communication mechanisms to ensure that relevant personnel are aware of the EMS and associated environmental factors, both internally and externally. It also notifies relevant stakeholders of environmental performance and compliance obligations. Documented information is a key support function to demonstrate the effectiveness of the standard, as well as to ensure that document control measures are effective in guaranteeing confidentiality and suitability for use (Venter, 2019; ISO, 2015).

Clause 8 of the standard focuses on *Operational* functions and the implementation of planning actions to control processes within the Environmental Management System. Utilising established operating controls, these should be in line with a life cycle approach to prevent pollution (Agboola *et al.*, 2020; ISO, 2015). Additionally, potential emergency situations that may arise during operations should be determined by considering the environmental risks identified. Organisations should be prepared to respond to these emergency situations with adequate controls to mitigate and prevent environmental impacts (Seeger *et al.*, 2021; ISO, 2015).

The ninth clause of ISO 14001: 2015 provides the framework for organisations to identify environmental factors to be monitored and measured, and to implement methods for analysis to ultimately *evaluate* environmental *Performance*. Evaluations are conducted to verify whether organisations have fulfilled their compliance obligations, and internal auditing is used to evaluate performance through applying criteria of an internal audit programme. Finally, management review is the performance evaluation criteria used by top management to review the performance of the environmental management system considering the input and output requirements of the standard (Fahlén & Langell, 2014; Realyvásquez-Vargas *et al.*, 2018).

The final clause of the standard, Clause 10, is focused on *Improvement* of the Environmental Management System by recognising opportunities for improvement to meet the EMS's intended outcomes. The EMS provides a structure to identify non-conformities, respond to them, and investigate incidents to reduce environmental impacts by assessing the non-conformities and implementing corrective actions (Harbison, 2020; ISO, 2015). Furthermore, continual improvement of the EMS is necessary to ensure its acceptability and effectiveness in, ultimately, enhancing environmental performance (Martlhare, 2020; ISO, 2015).

2.2.2 Criticisms against ISO 14001:2015

Several factors come into play during the certification process for environmental management systems, especially concerning the ISO 14001:2015 standard. These factors significantly influence the decision to implement and maintain certification. Being an internationally recognised and certified organisation that demonstrates a commitment to enhancing environmental performance comes at a cost. Consequently, the expense of certification often outweighs the benefits of adhering to ISO 14001:2015, leading some stakeholders to question its value as an investment (Camilleri, 2022).

The ISO 14001:2015 standard necessitates the consideration of natural and physical scientific principles in conjunction with business processes. This requirement poses challenges and barriers to effective implementation, especially in complex industries where there may be insufficient knowledge to identify significant environmental aspects (Sorooshian & Yee, 2019). Failure to comprehend the standard's requirements and, at times, a lack of oversight and commitment from leadership can hinder organisations from achieving certification, as they may struggle to adapt to environmental management and protection (Kirschke & Newig, 2017).

Criticism regarding the misinterpretation and lack of understanding of the standard's requirements is not one-sided. Auditors also play a role in shaping certification outcomes by reporting non-conformities. It is important to note that, according to the guidelines for auditing management systems (ISO 19011:2018), technical expertise is not the sole competence requirement for auditors (Piek, 2019).

A certifiable standard like ISO 14001:2015 necessitates auditing to demonstrate compliance with international requirements (Da Fonseca, 2015). Clause 7.5 of the international standard stipulates the need for documented information to be established to a certain extent and not just maintained but retained for defined periods (Biswas, 2019; ISO, 2015). Documented information has been perceived as burdensome in certain industries, with concerns that it might impact production efficiency and result in excessive paperwork, potentially demotivating stakeholders from implementing and maintaining ISO 14001:2015 certification (Camilleri, 2022). However, a potential benefit arising from the transition process of the standard is that it requires less procedural documentation due to a clearer understanding of the requirements (Fonseca & Domingues, 2018).

2.2.3 Benefits of ISO 14001:2015

Despite facing criticisms, the ISO 14001:2015 Environmental Management System (EMS) offers numerous benefits when effectively implemented. It actively promotes sustainable development

and prioritises environmental sustainability (Waxin *et al.*, 2019). Over the years, the demand for ISO 14001:2015 certification has grown, primarily because of the standard's efficacy in managing environmental principles (Fonseca & Domingues, 2018). This standard can be seamlessly integrated with an organisation's strategic business objectives and environmental management goals, providing financial incentives through operational efficiency and cost reduction (Nawrocka *et al.*, 2009). According to the practical guide for ISO 14001:2015 Environmental Management Systems by Briggs (2017), the following benefits are associated with the implementation of this standard:

- Improved control over emissions, effluent and waste;
- Safe handling and disposal of hazardous or pollutant materials;
- Reduction in waste generation;
- Energy efficiency;
- Conservation of natural resources;
- Satisfying compliance obligations;
- Environmental initiatives aligned with business strategic directions; and
- Contributing to improvement of environmental performance.

The ISO 14001:2015 standard contributes to the effective management of emissions released into the atmosphere. Garrido *et al.* (2018) indicated, based on samples from fifty-three countries, that there is a correlation between ISO 14001 adoption and carbon dioxide emissions. Effluents can be effectively managed through the implementation of operational controls for wastewater treatment, setting objectives such as pathogen elimination, recycling, reusing water, and reducing nutrient concentrations released into the environment through effluent discharge (Amoatey & Bani, 2011).

The standard facilitates effective waste management practices, including evaluating waste, proper storage in designated facilities, labelling, correct transportation, emergency planning related to waste, personnel competency training, and maintaining records of waste management activities (Stojanovic, 2016). As an operational control measure to influence waste streams, waste separation methods can be utilised, aligning with the waste management hierarchy of the National Waste Management Strategy of 2020 (DEFF, 2020).

Despite the fact that there is an international standard for Energy Management Systems (ISO 50001:2018) for managing energy use and improving productivity, energy efficiency is another key benefit derived from the ISO 14001:2015 standard, achieved through effective management

of environmental aspects and impacts, as well as setting objectives for minimising environmental impacts and implementing cost-saving strategies (Szoke, 2021). The standard also contributes to the conservation of natural resources. Many production activities consume utilities such as water and electricity, and by applying effective engineering controls as part of the environmental aspects and impacts assessment methodology, environmental impacts can be mitigated (Hamman *et al.*, 2018).

Clause 6.1.3 of ISO 14001:2015 provides the framework for determining relevant environmental compliance obligations governed by law. Effective planning actions, as indicated within Clause 6.1.4, enable organisations to meet the requirements of statutory and regulatory obligations, including regulations and national standards (Marlhare, 2020).

Demonstrating leadership and commitment are requirements of the ISO 14001:2015 standard, signifying that top management is responsible for effective implementation aligned with business strategic directions. This involves delegating responsibilities and incorporating strategic objectives with environmental goals (Martins & Fonseca, 2018).

The ISO 14001:2015 standard offers various benefits for enhancing environmental performance, as well as associated incentives and disincentives. It allows organisations to build resilience toward more sustainable production activities (Carrillo-Labela *et al.*, 2020). Environmental management systems serve as motivational factors by analysing managers' and employees' perceptions regarding sustainability throughout production. The ISO 14001:2015 standard is highly popular as it is internationally recognised (Carrillo-Labela *et al.*, 2020).

ISO 14001:2015 not only benefits organisations in terms of enhanced environmental performance but also financially. Organisations unlock financial benefits through compliance and avoidance of fines (Dzomonda & Fatoki, 2020). It is considered an environmental investment, as organisations commit to sustainability initiatives. Compliance leads to better cost savings benefits, and industry reputation is enhanced, making it more attractive to stakeholders (Dzomonda & Fatoki, 2020).

Organisations benefit from improved environmental performance resulting from effective implementation and performance evaluation. ISO 14001:2015 provides the framework for evaluating environmental performance, contributing to trend determination, risk evaluation, strategic objective identification, and environmental performance reporting to demonstrate a commitment to continuous improvement (Kalyar *et al.*, 2019). Performance evaluation offers insights into effectiveness and needed improvements based on data gathered and analysed from defined environmental performance indicators. Environmental performance continues to improve through corrective and preventive actions (Stojanovic, 2015). This improvement in environmental

performance aligns with the three pillars of sustainability: environment, society, and the economy, ensuring present needs are met without compromising future generations' abilities to meet their needs (Bravi & Santos, 2020).

2.2.4 Intended outcomes of ISO 14001: 2015

The ISO 14001:2015 standard provides a framework for protecting the environment and responding to changing conditions, while considering the socio-economic needs of organisations. Its three key intended outcomes are the enhancement of environmental performance, fulfilment of compliance obligations, and achievement of environmental objectives, with a focus on lifecycle thinking (Mosgaard *et al.*, 2022). To demonstrate their commitment to environmental performance, leadership must integrate Environmental Management Systems into their business processes and strive for continual improvement. Best practice principles such as pollution prevention technologies and addressing environmental issues throughout production processes can help organisations to improve their environmental performance, and thus their profitability and competitiveness (Doorasamy, 2015).

Since this research focuses on the contribution of ISO 14001:2015 performance evaluation towards enhancement of environmental performance, the sections below will provide background on the intended outcome – *“enhancement of environmental performance”*.

2.3 Enhancement of environmental performance as part of ISO 14001:2015

The ISO 14001:2015 standard seeks to improve life cycle-based business processes through better environmental performance. Through effective management of environmental aspects and impacts, setting objectives and performance evaluation, aimed at minimising environmental impacts and cost savings, the standard contributes towards the conservation of natural resources (Szoke, 2021). Hamman *et al.* (2018) suggest that the standard also facilitates the implementation of engineering controls through the method used to assess environmental aspects and impacts, providing a framework to determine relevant environmental compliance obligations, with the help of planning actions, according to clause 6.1.4 of the ISO 14001:2015, allowing organisations to meet statutory and regulatory requirements such as regulations and national standards (Marlhare, 2020).

The ISO 14001:2015 standard has various benefits towards the enhancement of environmental performance, such as resource efficiency and waste reduction. It facilitates factors to ensure that emissions and effluents are managed effectively, while providing the framework to conserve natural resources and mitigate environmental impacts. According to Garrido *et al.* (2018), the ISO 14001:2015 standard contributes to the effective management of emissions released into the

atmosphere, as indicated by sampling of fifty-three countries, which found a correlation between ISO 14001 adoption and a reduction in carbon dioxide emissions. Amoatey and Bani (2011) also suggest that management of effluent can be effectively achieved by using operational controls for wastewater treatment, setting objectives, such as elimination of pathogens, recycling and re-use of water, and reducing nutrient concentration released in the environment through effluent discharge. Stojanovic (2016) highlights that effective waste management practices implemented through the ISO 14001:2015 standard, include evaluating and handling waste appropriately, storing it in the appropriate facilities, correctly labelling it, transporting it correctly, planning for emergency scenarios associated with waste, and training personnel for competency, while keeping records of evidence. Furthermore, energy efficiency is another key benefit of the ISO 14001:2015 standard.

Beyond environmental benefits, organisations can unlock financial benefits through compliance and avoiding fines, while also saving costs and achieving improved industry reputation and gaining stakeholder trust (Dzomonda & Fatoki, 2020; Carrillo-Labela *et al.*, 2020).

2.3.1 The role of performance evaluation towards enhancing environmental performance

Environmental performance evaluation (according to the ISO 14031 standard) is a process that facilitates managerial decision-making by determining indicators, collecting and analysing data, assessing it against environmental performance criteria, and reporting and communicating the results through regular review and improvement (ISO, 2021; Stojanovic, 2015). Evaluation of performance is vital to verify that objectives and targets towards improved environmental performance are met (Switzer *et al.*, 2021; Dzomonda & Fatoki, 2020; Rohov *et al.*, 2021).

The ISO 14001:2015 standard provides a framework for evaluating environmental performance through monitoring, measurement, analysis and evaluation; evaluation of compliance; conducting internal audits; and management review (ISO, 2015). Information gathered through the process of performance evaluation can be used to determine trends, evaluate risks, identify strategic objectives, and report on environmental performance in order to demonstrate a commitment to continual improvement (Kalyar *et al.*, 2019). Supplementing ISO 14001: 2015, the ISO 14031:2019 standard provides guidance on the design and use of environmental performance evaluation, focusing on the identification and selection of environmental performance indicators. Environmental performance indicators are measurable representations of the condition related to performance of an organisation's environmental aspects (Joseph *et al.*, 2021).

2.3.1.1 Monitoring, measurement, analysis and evaluation

The ISO 14001:2015 standard (ISO, 2015) requires organisations to determine what needs to be monitored and measured within their Environmental Management System. Annexure A to the standard provides guidance on factors which should be taken into consideration, such as: progress on environmental objectives, significant environmental aspects, compliance obligations, and operational controls (Housni *et al.*, 2021).

Determining methods to analyse the results of monitoring and measuring activities, as well as criteria for evaluation and appropriate indicators, is essential for effective performance of the Environmental Management System in accordance with the life cycle approach and estimating environmental footprints (Xu *et al.*, 2020). Furthermore, calibration of the equipment used to undertake monitoring and measuring activities should be regularly conducted to ensure accurate results (Winter, 2012; ISO, 2015).

2.3.1.2 Evaluation of compliance

As per the definition of environmental compliance obligations, mandatory requirements such as applicable laws and regulations, or voluntary commitments, such as organisational and industry requirements, contractual relationships, codes of practice and agreements with community groups or non-governmental organisations are applicable to be evaluated (Fitzmaurice, 2018; ISO, 2015). The ISO 14001:2015 standard provides the framework for organisations to consider the compliance obligations associated with the environmental aspects and determine the application and should be considered throughout the implementation of the environmental management system as the compliance obligations have risks and opportunities assigned to it (ISO, 2015). Environmental compliance evaluations involve the independent evaluation of environmental legal requirements and assessing compliance with them (Shamaileh, 2015). This is essential owing to the legal and economic risks such as criminal and civil liability, as well as penalties and fines associated with non-compliance (Davids, 2020). Diamond mines within South Africa form part of the Kimberley Process Certification Scheme which is the process to prevent conflict within the diamond mining industry (Borsky & Leither, 2022). These requirements were, however, excluded from the scope of the study.

The evaluation of environmental compliance is based on the compliance obligations associated with operational activities (i.e. water management, waste management, management of hazardous substances, etc.), which are regulated through the requirements of law and permits/licences/authorisations.

In South Africa, Section 26(e) of the Environmental Impact Assessment Regulations (GNR 982 of 2014, as amended in 2017 by GNR 326) states that the frequency of auditing of compliance with regards to the conditions of the environmental authorisation should not exceed intervals of five years (DEA, 2017). Furthermore, Section 53(1) of the National Environmental Management: Waste Act No. 59 of 2008 (NEM: WA) stipulates that the specified period for review of a waste management license should not exceed five years [as set out in section 51 subsection 1(k)], while Section 43 (1)(f) of the National Environmental Management: Air Quality Act No. 39 of 2004 states that the atmospheric emission licences (AELs) should specify the periods of review. The National Water Act No. 36 of 1998 (NWA) states in Section 28 (1)(f) that the reviews of water use licenses (WULs) in terms of Section 49, may not exceed intervals of five years (DWS, 1998). In terms of environmental compliance obligations within the mining sector of South Africa, the Minerals and Petroleum Resources Development Act No. 28 of 2002 (MPRDA) needs to be taken into account. The environmental compliance obligation to be evaluated is that of mining rights and permits, with Section 32(4) stating that a retention permit is valid for the period specified in the permit, which period may not exceed three years (DMRE, 2002).

The ISO 14001:2015 standard requires a process to evaluate the enactment of environmental compliance obligations and to determine and abide by the frequency for evaluating compliance (ISO, 2015). Furthermore, EA-7/04 M: 2017 specifies that the non-fulfilment of the environmental compliance obligations can affect the certification of the ISO 14001:2015 standard (Anon., 2017).

2.3.1.3 Internal Audit

The concept of internal auditing has evolved over time to include risk management and the control of governance processes (Mahdawi *et al.*, 2018). An internal audit is conducted either by an organisation's own personnel or by an external provider on its behalf. Such audits are essential as they add value to environmental management systems and help to reduce the risk of negative environmental impacts (Fura, 2013).

The ISO 14001:2015 standard provides a framework for conducting internal audits at planned intervals as part of performance evaluation (ISO, 2015). It serves as an evaluation instrument to verify that requirements of the Environmental Management System are being met and that it conforms with the ISO 14001:2015 standard (Wairon *et al.*, 2018). To this end, an internal audit programme must be developed. This programme should document the procedures that will be followed by the auditor to assess conformance with the criteria (ISO, 2015). It should also take into account the environmental significance of the processes, as well as the business-related consequences of changes and the outcomes of previous audits.

The ISO has drafted the guidelines for auditing management systems, and the latest version was released in 2018 as per ISO 19011:2018 (ISO, 2018). The guideline defines the principles for auditing, managing an audit programme as well as the process for conducting management system audits which applies to organisations which need to plan and conduct internal audits (Shandu & Saluja, 2023).

2.3.1.4 Management review

The process of management review, as employed by members of top management, facilitates communication regarding the performance of the EMS and evaluates its effectiveness towards achieving the intended outcomes of the system. Stakeholder involvement is essential, as management review is based on business decision-making principles for organisational sustainability with the aim of enhancing environmental performance, promoting resource development and identifying opportunities for economical profitability (Herghiligiu *et al.*, 2019).

The ISO 14001:2015 standard is of particular importance in relation to the strategic direction of organisations, promoting a stronger sense of leadership as top management is required to review the adequacy and suitability of the EMS at planned intervals. The standard has multiple requirements to be taken into account as part of the input and output of the discussion. During the evaluation of environmental performance, the standard requires consideration of the following trends: non-conformities and corrective actions, monitoring and measurement results, fulfilment of compliance obligations, and audit results (ISO, 2015).

2.4 ISO 14001:2015 and contribution towards environmental performance in the mining sector

The mining sector has significant impacts on both the physical and social environment (Kowalska, 2014). Managing environmental impacts is not only an ethical duty, but essential for sustainable development. The benefits of ISO 14001: 2015 implementation to the mining sector and mining houses include improved environmental performance and sound environmental practices (Sayre, 2018). The sections below discuss the contribution of ISO 14001: 2015 implementation towards enhancement of environmental performance in the mining context.

2.4.1 Mining and environmental aspects and impacts

Mining activities have long been linked to environmental degradation (Pretty & Odeku, 2017). Various environmental media can be affected by mining activities, including air, water, soil, fauna, and flora (Pokorná *et al.*, 2016; Yusuf, 2021). Environmental aspects are defined as the elements of an organisation's activities, products or services interaction with the environment and describes

the relevant issue that needs to be addressed (Flemström, 2003). The environmental aspects are assessed to identify the potential environmental impacts associated with the aspect originating from operational activities and based on the severity assign mitigation measures towards the potential environmental risks (Blinova & Ponomarenko, 2020). The ISO 14001:2015 standard requires organisations to determine the environmental aspects associated with its operational functions and defined scope of the environmental management system from a life cycle perspective, whilst determining environmental aspects, changing conditions as well as potential abnormal and emergency situations should be considered (ISO, 2015). The human factor of environmental ignorance is often disregarded as a risk (Erhabor & Don, 2016), and the standard provides the framework to mitigate the risk as it is stated that the significant environmental aspects need to be communicated and demonstrate awareness of potential environmental impacts (ISO, 2015).

Carbon emissions, resulting from the extraction and combustion of fossil fuels during mining processes, present a direct contribution to global climate change (Yusuf, 2021). Furthermore, emissions of particulate matter and volatile organic compounds from operational activities can influence air quality, with subsequent effects on nearby human communities (Pokorná *et al.*, 2016; Okello *et al.*, 2018). Noise pollution, which is regulated by the National Environmental Management: Air Quality Act No. 39 of 2004 (NEM: AQA), as well as the Environmental Conservation Act No. 73 of 1989 (ECA) (DEA, 1989, 2004) also has potential to affect the environment, including surrounding communities (Sordello *et al.*, 2019). Various types of organic and inorganic waste are generated in the mining process, which can lead to soil and water contamination (Ningbo *et al.*, 2015; Sibanda & Broadhurst, 2018). Decomposition of waste from landfills may result in increased levels of methane, carbon dioxide, and other greenhouse gasses, further contributing to climate change (Danthurebandara *et al.*, 2012).

Water resources, which are already scarce in South Africa, are vulnerable to pollution from acid mine drainage and process water discharge (Donnenfeld *et al.*, 2018; Gilsbach *et al.*, 2019). Additionally, the mining industry is one of the leading sectors in terms of water abstractions/withdrawals (Haggard *et al.*, 2015) impacting on the ecological and human reserve.

Soils are also affected by mining activities, with contamination and erosion resulting from altered landscapes, hazardous tailings, and polluted effluents (Benidire *et al.*, 2020; Sungur *et al.*, 2020; Wilson, 2019). As mining requires increased land usage, it involves the processes of deforestation and removal of vegetation. These processes drastically alter landscapes, with impacts on the biodiversity of the area, threatening faunal and floral life (Lowry *et al.*, 2019; Virah-Sawmy *et al.*, 2014). Additional obligations are placed on organisations within the industry by Section 28 of the

National Environmental Management Act No. 107 of 1998 (NEMA) to uphold the “Duty of Care” principle and prevent pollution and ecological degradation (DEA, 1998).

Mining operations may disrupt community activities due to environmental pollution factors. Communities are dependent on water sources such as rivers, streams and groundwater which is often polluted by nearby mines from discharging polluted effluents that are not within the specified potential hydrogen and conductivity levels of regulatory requirements (Pretty & Odeku, 2017). As minerals are prospected and explored, land is consecrated for mining activities which influences current agricultural activities due to displacement of land as well as influencing the likelihood of potential agricultural activities within the area as the fertility of soil is disrupted and some communities are reliant to local informal food sources (Assan & Muhammed, 2018). Mining activities generated harmful aerosols, polluting the atmosphere and decrease air quality levels resulting in communities being exposed to health-related issues and respiratory illnesses (Pretty & Odeku, 2017).

The negative effects of these activities are in conflict with the constitutional right of South Africa’s citizens to an environment that is “not harmful to their health and wellbeing”, as stated in Chapter Two of the Bill of Rights (RSA, 1996).

2.4.2 Brief overview of diamond mining in South Africa

South Africa is rich in mineral and resource reserves (Awolusi *et al.*, 2018). Mining activities in the country commenced in 1852 with the opening of a copper project in the Northern Cape Province, and twelve years later, commercial coal mining began in the Eastern Cape Province (Casey, 2019). The mining sector has played a significant role in South Africa's economic development, employing a substantial portion of the population (Awolusi *et al.*, 2018).

Diamond mining has been a prominent activity in South Africa since the discovery of the Eureka Diamond in 1867, particularly in the Orange River basin and along the country's North-Western coastline (AMIQ, 2023). From 2004 to 2017, South Africa was the world's fifth-largest diamond producer, accounting for 51% of the world's diamonds (McKechnie, 2019). Currently, South Africa boasts 48 diamond mines, with 15 of them operational. Nineteen mining houses have established a presence in South Africa, although some are on the verge of closure, and four mines are in the development phase. Notably, three mining houses dominate the diamond mining industry (AMIQ, 2023). Many of these diamond mining operations are managed globally through conformance with the ISO 14001:2015 standard (Oluleye, 2021).

Diamond mining encompasses three different types: primary deposits (pipe mining), secondary deposits (alluvial mining in various forms such as open-pit or underground activities), and marine

mining conducted offshore (Labudin *et al.*, 2019). After prospecting and exploration, primary processes are implemented for diamond exploitation, involving drilling, blasting, hauling, loading, and dumping (Anglo America, 2019). Secondary processes are required for diamond extraction, including crushing, scrubbing, cyclonic separation, recovery, cleaning, weighing, and packaging (McKechnie, 2019). Both the primary and secondary processes carry significant environmental aspects and impacts.

The environmental aspects associated with diamond exploitation may lead to various environmental impacts that affect the natural environment and surrounding communities. Drilling and hauling activities during the exploitation phase result in erosion as soil is displaced and relocated. Windy conditions can transport these soils aerodynamically, impacting air quality, causing community disturbance, and affecting fauna and flora (Sungur *et al.*, 2020; Lowry *et al.*, 2019). Drilling activities pose an environmental risk of penetrating subterranean water sources or aquifers, potentially contaminating these resources and impacting the ecological and human reserves (Gilsbach *et al.*, 2019). Blasting activities create noisy and dusty situations, affecting both fauna by disturbing natural habitats and communities with noise, as well as air quality with dust that can lead to health-related impacts and disrupt photosynthesis in plants due to reduced ultraviolet radiation (Kameswaran *et al.*, 2019). The residue from primary mining processes is loaded and transported to mine dumps, creating mounds or hills of mining waste referred to as mine dumps, residue deposits, or residue stockpiles. These mine dumps consist of hazardous by-products mixed with soil, referred to as tailings, which pose environmental risks such as leachate infiltration of the Earth's surface, contaminating underground water sources, and exposing communities to dust particles, affecting vegetation and health (Agboola *et al.*, 2020).

The mineral extraction processes associated with diamonds involve industrialised activities with significant environmental aspects. Crushing, the process of reducing larger ore pieces into smaller ones (McKechnie, 2019), generates environmental aspects related to noise pollution and dust generation, similar to blasting activities. Substantial amounts of inorganic waste in the form of waste rock are generated during scrubbing (Sibanda & Broadhurst, 2018), contributing to dust generation (McKechnie, 2019; Sordello *et al.*, 2019). Cyclonic separation involves mixing ferrosilicon powder and water to a specific density, which is poured onto the material and tumbled within a cyclonic figure to separate materials and minerals before the recovery process. Diamonds are also cleaned in an acid solution before washing (McKechnie, 2019). Water is required for extraction and processing, potentially leading to contamination and effluent discharge with hazardous tailings and polluted effluents, posing environmental risks such as soil and water contamination if not effectively controlled (Wilson, 2019).

Given the significant environmental aspects, impacts, and compliance obligations associated with diamond mining processes, both in terms of exploitation and extraction, it is crucial to evaluate environmental performance for environmental responsibility and management purposes."

2.4.3 Environmental performance evaluation within the South African diamond mining context

Evaluating environmental performance in diamond mining activities in South Africa is essential for managing significant environmental aspects, impacts, and ensuring compliance obligations are met. Clause nine of the ISO 14001:2015 standard outlines the requirements for performance evaluation, including monitoring and measurement, compliance evaluation, internal auditing, and management review. The focus is on environmental performance improvements, resulting in enhanced environmental and financial outcomes, as well as the evaluation of external social performance (Johnstone & Hallberg, 2020; ISO, 2015). Most diamond mines globally adhere to the ISO 14001:2015 standard, which provides guidance on factors such as progress on environmental objectives, significant environmental aspects, compliance obligations, and operational controls (Oluleye, 2021; Housni *et al.*, 2021).

Diamond mining, with its associated anthropogenic activities, gives rise to various environmental aspects due to its extractive nature and pollution. These activities can have adverse impacts, including habitat destruction, loss of biodiversity, soil erosion and contamination, water and air pollution, the generation of hazardous waste, and degradation of air quality (Kowalska, 2014; Pretty & Odeku, 2017). Compliance with environmental regulations is crucial in diamond mining operations to mitigate legal and economic risks, including criminal and civil liability, penalties, and fines associated with non-compliance (Davids, 2020).

The mining sector, including diamond mining, is one of the leading water consumers in South Africa, involving water abstraction, storage, processing, and discharge (Haggard *et al.*, 2015). Water plays a vital role in diamond mining processes, particularly in extraction processes such as cyclonic separation, cleaning, and washing, requiring water withdrawal from a source (McKechnie, 2019; Wilson, 2019). To monitor raw water abstraction, flowmeters are typically employed to provide accurate and verifiable readings (Rahmat *et al.*, 2017). Calibrating flow meters is essential, aligning with the manufacturer's specified frequency, to ensure accurate and valid results for analysis and evaluation, as required by the ISO 14001:2015 standard (ISO, 2015). Compliance obligations related to water use licensing and authorisation under the National Water Act No. 36 of 1998 are evaluated according to Section 26(e) of the Environmental Impact Assessment Regulations (GNR 982 of 2014, as amended in 2017 by GNR 326) (DEA, 2017).

Anthropogenic activities within diamond mining operations contribute to atmospheric pollution, including global warming and climate change due to greenhouse gas emissions, as well as reduced air quality from particulate matter and dust (Yusuf, 2021; Okello *et al.*, 2018). Greenhouse gases are emitted through the combustion of fossil fuels for mining operations and energy consumption (Yusuf, 2021), while dust is aerodynamically transported from exploitation and extraction activities (Sungur *et al.*, 2020). To monitor atmospheric pollutants, instruments like greenhouse gas monitoring instruments and dust collection devices, known as “dust buckets,” are employed to collect data and samples for analysis (Zhang *et al.*, 2017; Paluchamy *et al.*, 2021). Calibration of air pollution monitors and analysers is essential to ensure the quality of results obtained from monitoring and measurement, as required by the ISO 14001:2015 standard (Woollatt, 2015). Compliance obligations regarding atmospheric pollutants are evaluated when thresholds are exceeded, triggering processes such as atmospheric emission licensing (AEL) and authorisations (DEA, 2004; DEA, 2019; DEA, 2013).

The excess materials generated during diamond mining operational activities contribute to various forms of waste. Waste generation is associated with numerous environmental aspects and impacts (Ningbo *et al.*, 2015; Sibanda & Broadhurst, 2018). Monitoring and measurement of waste generation and management, as prescribed in the *Waste Classification and Management Regulations* of 2013, require records indicating the quantity of waste in volumes or weight (DEA, 2013). Organisations typically use scales or weighbridges to measure waste generation, and it is essential to calibrate or verify these instruments to ensure accurate results in line with ISO 14001:2015 requirements (ISO, 2015). Compliance obligations related to waste may trigger the List of Waste Management Activities under the National Environmental Management: Waste Act No. 59 of 2008, requiring evaluation against licensed and authorised conditions (DEA, 2017).

Biodiversity, including fauna and flora, is influenced by diamond mining activities, leading to various environmental pollution factors (Sordello *et al.*, 2019) and habitat disruption due to expanding mining boundaries (McKechnie, 2019). Indigenous, invasive, and endangered species coexist within the natural environment, and mitigation control measures must be implemented and controlled, as required by biodiversity offset requirements defined within environmental impact assessments (Tsoku, 2022). Compliance obligations related to alien and invasive species are guided by the Alien and Invasive Species Regulations (Regulation 1020 of 2020) of the National Environmental Management: Biodiversity Act No. 10 of 2004 (DEA, 2020). Monitoring and evaluation of alien and invasive species, as well as compliance with eradication plans, are essential to meet these obligations (Terblanche *et al.*, 2013). ISO 14001:2015 standards provide guidance for evaluating significant environmental aspects and impacts related to biodiversity for performance evaluation purposes (Hammer & Hörmann, 2016).

As diamond mines in South Africa adhere to the ISO 14001:2015 standard, either as a best practice for environmental management or for certification, it is essential to evaluate environmental performance to ensure that the standard's intended outcomes are met through effective implementation.

2.5 Chapter summary

A comprehensive overview of the research topic was conducted during the literature review. The main focus was on the history, structure, and benefits of the ISO 14001:2015 standard. An examination of the South African mining industry, particularly diamond mining, in regard to its environmental impacts was conducted to meet the first objective of the study. The planning actions and performance evaluation factors relative to the ISO 14001:2015 standard was also explored. The methodology of research for the study, including the research design, data collection methods, and data analysis techniques, will be discussed in Chapter 3.

CHAPTER 3 METHODOLOGY

3.1 Introduction

The methodology section in this chapter is designed to provide the reader with insight into the research design, data collection, and analysis techniques employed to assess the contribution of ISO 14001:2015 performance evaluation towards improving environmental performance within the context of a mining case study. This chapter provides the research approach and design, aligning it with the methods employed for data collection and the techniques applied for data analysis to derive meaningful results. Additionally, ethical considerations and the methodological assumptions and limitations of the research are discussed.

3.2 Research design and approach

The research design employed in this study represents the chosen research strategy, outlining and orchestrating the actions taken to address the established research questions concerning the collection, interpretation, analysis, and discussion of data (Creswell & Clark, 2017). The research approach refers to the systematic method chosen by the researcher for the acquisition, analysis, and interpretation of data, aligned with the research aim. Various research approaches exist to facilitate researchers in their investigative endeavours. These include qualitative, quantitative, and mixed methods approaches (Taherdoost, 2022). The chosen approach for this research is qualitative. This decision is grounded in the understanding that the concept of environmental performance evaluation, rooted in the principles of environmental management, is best apprehended through qualitative, explorative methods (Roudgarmi, 2011).

3.2.1 Qualitative research methods

The qualitative research approach is defined as the type of research in which the researcher investigates and examines a phenomenon in order to gather and analyse non-numerical data to answer research questions and to achieve research objectives (Aspers & Corte, 2019; Swain & King, 2022.). The purpose of a qualitative research method is to directly address the factors of how the research is conducted and the reason for conducting the research as well as to develop a testable hypothesis (Haradhan, 2018; Doyle *et al.*, 2009). Nevertheless, it is crucial to acknowledge that qualitative research has its disadvantages, with the potential influence of sample size being one of them, as noted by Daniel (2016).

The rationale for adopting a qualitative methods approach in investigating the contribution of ISO 14001:2015 performance evaluation towards the improvement of environmental performance within the context of a mining case study lies in the research design, which facilitates a

comprehensive document review and evaluation. This involves scrutinising and evaluating documented information related to the ISO 14001: 2015 environmental management system of the selected case studies (Roudgarmi, 2011). Qualitative research designs tend to be more subjective than objective, focusing on uncovering insights into reasons and methods. This is particularly relevant as the research's findings are non-numerical and presented in written format (Aspers & Corte, 2019).

A variety of documented information was obtained for review, specifically concerning the environmental management systems of the case studies. These documents were evaluated to determine the contribution of ISO 14001:2015 performance evaluation towards the enhancement of environmental performance within the context of a mining case study.

3.2.1 Document review and evaluation

Document review and evaluation entail the assessment of existing, secondary reports or documents to extract information pertinent to the research objectives (Sileyew, 2019). This research method is systematically conducted to collect documented information and can be applied for various purposes, including ensuring compliance or verifying quality and progress in research methodologies (Bowen, 2009). The fundamental aim document review and evaluation is to assess the documents against specific criteria (or key performance areas/indicators) to evaluate whether the document meets the criteria. Conducting a document review demands meticulous attention to detail and analytical skills, as precision and consistency are crucial for accurate application (Cardno, 2018).

3.3 Case study selection

The utilisation of case studies within research generates an in-depth understanding of a target group or phenomena with limitations assigned in terms of time or physical boundaries towards the research aim and topic (Harling, 2012). The evaluation for the contribution of ISO 14001:2015 performance evaluation towards enhancement of environmental performance was carried out based on a case study context, focussing on diamond mining activities within South Africa (as explained in Section 1.6 of this dissertation).

The selection of diamond mines in South Africa as a case study for investigating the impact of ISO 14001:2015 environmental performance evaluation on enhanced environmental performance is motivated by several factors. Firstly, the mining industry, especially diamond extraction, is known for its significant environmental footprint, making it imperative to assess and improve environmental practices. Diamond mining involves complex operations that pose potential environmental challenges, including habitat disruption and water and soil contamination.

Additionally, the ISO 14001:2015 standard, focusing on environmental management systems, is relevant for industries with substantial environmental impacts. Lastly, diamond mines in South Africa have garnered a reputation for comparatively robust implementation of ISO 14001:2015 standards, setting them apart from other industries and other types of mining in the country.

By examining diamond mines in South Africa, this research can contribute valuable insights into the practical application of ISO 14001:2015 in a context where environmental considerations are paramount. The case study's findings may have broader implications for refining environmental performance evaluation strategies in industries facing similar challenges, ultimately contributing to sustainable and responsible mining practices.

3.3.1 Case study selection criteria

For the selection of specific diamond mines for inclusion in the research, the following case study selection criteria was applied:

- The case study should consist of *diamond mining* activities.
- **ISO 14001: 2015 certification status:** Inclusion criteria should prioritise diamond mines that have obtained ISO 14001 certification, ensuring that the study focuses on facilities actively engaged in environmental management practices. Accredited certification gives rise to the assurance of reliable and trustworthy results as third-party conformity assessments ensure compliance of products and services as well as systems pursuant to specified requirements (IAF, 2021). Accredited certification against ISO 14001: 2015 for the case studies played a significant role in the selection criteria (Waxin *et al.*, 2019).
- **Operational scale:** Consideration was given to diamond mines of varying operational scales to capture a diverse range of environmental management challenges and practices.
- **Geographical diversity:** Diamond mines situated in different geographical areas within South Africa were considered to account for potential variations in environmental regulations, climates, and ecosystems, which may influence environmental performance.
- **Historical environmental performance:** Include mines with sufficient records of historical environmental performance to explore how ISO 14001: 2015 performance evaluation has influenced improvements over time.
- **Willingness to voluntarily participate in the research:** The mines should be willing to share information and agree to participate in the research.

3.3.2 Description of the case study

Presently, there are approximately 540 mines in South Africa and is home to a total of 48 diamond mines (AMIQ, 2023).

Due to the nature of the non-disclosure agreement, the exact location and details of the case study cannot be disclosed. The mining case study consists of three underground diamond mines falling under one holding's organisation. The mines are located in three different provinces (Gauteng, Free State and Northern Cape) of South Africa. All three the diamond mines are ISO 14001:2015 certified.

Separate certification is granted to each of the three mines included in the case study by the Accredited Certification Body (CB) as the organisation is not eligible as a "Multi-Site Organisation" as defined within the IAF Mandatory Document (IAF, 2018). The case study has adopted the best practice principles of environmental management based on the guidelines of the ISO 14001 standard.

Certification for the three underground diamond mines commenced between the years of 2008 until 2013, against the ISO 14001: 2004 version of the standard. The mines started transitioning to the ISO 14001: 2015 standard in 2018, following a phased approach. The Gauteng and Northern Cape diamond mines were certified against the transitioned ISO 14001: 2015 standard in 2021 with valid certification until 2024; and the Free State diamond mine was certified in 2022 with valid certification until 2025.

3.4 Data collection

Data collection is defined as the process for obtaining and considering information on variables of interest with regards to a research topic and to answer the research questions related to the research gap identified. The objective of data collection is capturing quality and appropriate evidence related to the research to ensure accurate results obtained from the analysis of data (Kabir, 2016). For this research, document review and evaluation were employed to investigate the contribution of ISO 14001:2015 performance evaluation towards enhancement of environmental performance based on a mining case study.

3.4.1 Documented information obtained for document review and evaluation

Various documented information (processes/procedures, records, reports, etc.) related to the ISO 14001: 2015 environmental management system of the three mines were obtained for document review and evaluation purposes. Table 3-1 below outlines the documented information obtained and the justification for the documents being considered for the purposes of this research. While the three mines shared group-wide systems processes (such as process for developing an environmental policy, determining the scope of the environmental management system, identifying aspects and impacts, identifying compliance obligations, assessing risk and opportunities, etc.), each of the three mines had their own (site-specific) arrangements and

documented information as far as *implementation* of systems processes are concerned – namely: individual aspects and impacts registers, individual compliance obligations registers, etc. At an operational level, an environmental management system is in place for each mining licence, which sets out detailed processes for the identification of environmental risks and implementation of action plans to mitigate the impacts of their activities.

3.4.2 Document review and evaluation

No published, existing criteria could be found to evaluate the contribution of ISO 14001: 2015 performance evaluation towards improved environmental performance – neither in South Africa nor elsewhere in the world. Specific criteria had to be developed by the researcher for the purposes of this study. The following steps were followed as part of the document review and evaluation process:

- **Step 1:** Defining and developing key performance areas (KPA's) to evaluate the extent to which EMS arrangements make provision for enhanced environmental performance (Section 3.4.2.1);
- **Step 2:** Develop key performance indicators (KPI's) for each of the KPA's (Section 3.4.2.2);
- **Step 3:** Review EMS documentation of the different case studies and evaluate performance against the KPI's (Section 3.4.2.3).

Table 3-1: Documented information included in the document review and evaluation for this research

Environmental Performance Considerations	Methodology	Justification
Environmental Aspects and Impacts	Environmental aspects and impacts registers were obtained for the three diamond mines to verify the scope of the activities in order to gain an understanding of what the organisation has considered to be of significant to potential environmental impacts.	An environmental aspects and impacts register is a record of features associated with the activities of an organisation to evaluate the significance of potential impacts (Abdeljalil <i>et al.</i> , 2022).
Environmental Compliance Obligations	Access was granted to the database of compliance obligations which is externally stored with an outsourced service provider, the review of the compliance obligations considered to be applicable towards the diamond mining industry provided an overview of how the legal requirements apply to the processes of the environmental management system as well as how and what should be monitored and measured. The requirements of the Kimberley Process Certification Scheme were not considered.	Developing a database or documenting the legal requirements which are legislative, statutory and regulatory is the process of determining compliance obligations (Salca Rotaru, 2019). The Kimberley Process Certification Scheme which is the process to prevent conflict within the diamond mining industry (Borsky & Leither, 2022).
Environmental Objectives	The environmental objectives for the three diamond mines were obtained to verify the strategic to be familiarised with the strategic direction of the organisation and verify the commitments whether it is aligned with the intended outcomes of the ISO 14001:2015 standard.	Documented environmental objectives eases the process of taking action and drive results to improve environmental performance (Hammer, 2014).
Monitoring, Measurement and Evaluation	A “KPI Register” was obtained which refers to the factors that the mine has considered to be monitored and measured to evaluate environmental performance for the three diamond mines, the factors within the register illustrated to the areas of	Environmental key performance indicators (KPIs) are quantitative measures of assigned values and used as a tool for measurement towards the environmental performance of an

Environmental Performance Considerations	Methodology	Justification
	<p>significance towards the effectiveness of the environmental management system.</p> <p>Records and reports of monitoring more specifically pertaining to the environmental aspects were obtained indicating the progression of sequential monitoring and measurement.</p>	<p>organisation (Zarzycka & Krasodomska, 2021).</p>
Compliance Evaluation	<p>Legal audit reports were perused to verify the compliance obligations that the diamond mines were audited against as well to identify the areas of concern in terms of environmental compliance.</p>	<p>The independent assessment and evaluation of legal compliance from an environmental perspective is commonly known as an environmental compliance audit that gets reported on (Hakim & Yunus, 2017).</p>
Internal Audit	<p>Internal audit reports for the three diamond mines on the environmental management system based on ISO 14001:2015 standard was reviewed to verify the non-conformances that have occurred as well as to examine the techniques utilised by the auditors and the samples that were taken for auditing purposes.</p>	<p>Internal audits of an environmental management system serve as an evaluation instrument to verify that requirements are being met and that it conforms with the ISO 14001:2015 standard (Wairon <i>et al.</i>, 2018).</p>
Management Review	<p>Minutes of the management review meetings were obtained to examine the factors that were considered to be reviewed as well as the decisions that were made based on the considerations and the actions taken.</p>	<p>The review of an environmental management system usually occurs in the form of a management review meeting that is conducted by members of top management with the representatives (Herghiligi <i>et al.</i>, 2019).</p>

3.4.2.1 Defining and developing key performance areas (KPA)s

Key performance areas (KPA)s are defined as the areas of performance that are essential towards achieving a specific outcome (Dougall & Mmola, 2015). The assessment of performance against KPA)s is important as a measure of the extent to which a specific outcome/output may be achieved (Usmani, 2022). The KPA)s developed for the research is based on the requirements of the ISO 14001:2015 standard, specifically aimed towards performance evaluation (Rohov *et al.*, 2021; ISO, 2015). The following KPA)s were developed to evaluate the extent to which EMS performance evaluation arrangements make provision for enhanced environmental performance:

- Key Performance Area 1: Provision for environmental aspect identification and evaluation;
- Key Performance Area 2: Provision for environmental compliance obligations;
- Key Performance Area 3: Provision for objective setting and planning;
- Key Performance Area 4: Provision for performance monitoring and measurement;
- Key Performance Area 5: Provision for evaluation of compliance;
- Key Performance Area 6: Provision for internal auditing;
- Key Performance Area 7: Provision for management review; and
- Key Performance Area 8: Provision for improvement.

Associated key performance indicators (KPI)s were developed for each KPA (Section 3.4.2.2).

3.4.2.2 Developing key performance indicators (KPI)s

Holistically, key performance indicators (KPI)s are defined as indicators comprised of a selection criterion, essential for measuring, utilised by organisations to fortify and estimate success derived from previous objectives (Velimirović *et al.*, 2011). For the purposes of this research, key performance indicators were developed to directly address the key performance areas (see Section 3.4.2.1) in order to evaluate the contribution of ISO 14001:2015 performance evaluation towards enhancement of environmental performance (Lo-Iacono-Ferreira *et al.*, 2018; Mathew, 2014). As mentioned in Section 1.6 of this dissertation, the purpose of this research is not to evaluate the casual link between EMS arrangements and improved environmental performance. Instead of evaluating causality, this research evaluates the extent to which the ISO 14001: 2015 EMS (within a case study context) makes provision for improved environmental performance. Therefore, the KPI)s were developed to determine the extent to which EMS arrangements provide for improved environmental performance. KPI)s were based on the requirements of ISO 14001: 2015 as well as academic literature, where relevant (Table 3-2).

Table 3-2: Key performance areas (KPAs) and associated key performance indicators (KPIs) developed to evaluate the contribution of ISO 14001: 2015 performance evaluation towards improved environmental performance

Key performance indicator (KPI)		Source/reference	Description
KPA 1: Provision for environmental aspect identification and evaluation			
KPI 1.1	To what extent does the EMS arrangements provide for the identification of significant environmental aspects?	Blinova & Ponomarenko, 2020 and ISO, 2015	Measure the effectiveness of identifying key environmental aspects that can impact the organisation's environmental performance.
KPI 1.2	To what extent does the EMS arrangements provide for frequent environmental aspect evaluations?	Flemström, 2003	Track how often environmental aspects are reviewed and assessed for their significance and potential impact.
Key Performance Area 2: Provision for environmental compliance obligations			
KPI 2.1	To what extent does the EMS arrangements provide for the identification of environmental compliance obligations?	Anandagir <i>et al.</i> , 2021 and ISO, 2015	Measure the effectiveness of identifying environmental compliance obligations that can impact the organisation's environmental performance.
KPI 2.2	To what extent does the EMS arrangements provide for frequent environmental compliance obligation updates?	Fitzmaurice, 2018	Track how often the compliance obligations have been updated/notified of amendments for environmental compliance.
Key Performance Area 3: Provision for objective setting and planning			
KPI 3.1	To what extent does the EMS arrangements provide for the establishment of environmental objectives?	Fura, 2013 and ISO, 2015	Evaluate how well the organisation sets clear and measurable environmental objectives to address significant aspects and compliance obligations.
KPI 3.2	To what extent does the EMS arrangements provide for the alignment of objectives with significant aspects and compliance obligations?	Switzer <i>et al.</i> , 2021; Dzomonda & Fatoki, 2020 and Rohov <i>et al.</i> , 2021	Assess the extent to which environmental objectives align with the identified significant environmental aspects and compliance obligation.

Key performance indicator (KPI)		Source/reference	Description
Key Performance Area 4: Provision for performance measurement and monitoring			
KPI 4.1	To what extent does has EMS arrangements considered the factors to be monitored and measured?	Housni <i>et al.</i> , 2021 and ISO, 2015	Evaluate how well the organisation sets clear indications of what should be monitored and measured.
KPI 4.2	To what extent does the EMS arrangements provide for frequent performance monitoring?	Xu <i>et al.</i> , 2020	Measure how often the organisation monitors its environmental performance, which indicates its commitment to ongoing improvement.
Key Performance Area 5: Provision for evaluation of compliance			
KPI 5.1	To what extent does the EMS consider compliance obligations to be evaluated and the frequency of evaluation?	Shamaileh, 2015 and ISO, 2015	Assess the compliance obligations which require to be evaluated and what has been considered as part of the evaluation of compliance.
KPI 5.2	To what extent does the EMS arrangements provide for monitoring of compliance with regulatory requirements?	Davids, 2020	Track the organisation's compliance with environmental laws and regulations as an indicator of its commitment to legal and ethical standards, especially those that could influence environmental performance.
Key Performance Area 6: Provision for internal auditing			
KPI 6.1	To what extent does the EMS arrangements provide for frequent management system internal auditing?	Shandu & Saluja, 2023 and ISO, 2015	Measure the regularity and effectiveness of internal audits for the management system.
KPI 6.2	To what extent does the EMS arrangements provide for monitoring of conformity with the standards requirements?	Fura, 2013	Track the organisation's conformity with management system as an indicator of its commitment to effective implementation and continual improvement.

Key performance indicator (KPI)		Source/reference	Description
Key Performance Area 7: Provision for management review			
KPI 7.1	To what extent does the EMS arrangements provide for frequency and attendance of management reviews?	Herghiligiu <i>et al.</i> , 2019 and ISO, 2015	Measure how often management/leadership reviews environmental performance and the level of participation from top management.
KPI 7.2	To what extent does the EMS arrangements provide for closure of action items from management reviews?	Tomšič <i>et al.</i> , 2016 and Harbison, 2020	Evaluate how effectively action items identified in management reviews are addressed and closed.
Key Performance Area 8: Provision for Improvement			
KPI 8.1	To what extent does the EMS arrangements provide for the analysis of environmental performance?	Kalyar <i>et al.</i> , 2019 and ISO, 2015	Assess the trend in environmental performance data to determine if the organisation is continuously improving.
KPI 8.2	To what extent does the EMS arrangements provide for innovations or initiatives for environmental improvement?	Martlhare, 2020	Track the number of new ideas or initiatives aimed at enhancing environmental performance.

3.4.2.3 Evaluation of performance against KPAs and KPIs

An evaluation is a structured interpretation and systematic process of judgement by critically examining a phenomenon to provide information on performance (Akinci & Kose, 2022). Utilising key performance indicators, whilst conducting an evaluation, adds value to the inquiry of a process or phenomenon as the measure is used to define progression and represent a status of success based on clearly defined criteria (Dorcak *et al.*, 2017).

Quantitative scoring systems utilise numerical indicators for the assessment or evaluation of a feature or an event, whereas qualitative scoring systems employs descriptive or alphabetical indicators, providing a result for a feature or event through assessment or evaluation (Hasan & Huq, 2010). Assigning numerical indicators for evaluation provides a rating of achievement rather than determining the extent of addressing certain requirements of a specified criteria (Hiwase & Hajare, 2018; Mohajan, 2020; Cain *et al.*, 2022).

Qualitative analysis, relying on descriptors and alphabetical numerals, can offer several advantages over quantitative descriptors using numerical values for document evaluation. Qualitative methods allow for an in-depth understanding of the subject matter, enabling researchers to capture subtle nuances, context, and the richness of information that numbers might overlook (Hasan & Huq, 2010). This approach is particularly valuable when assessing complex, multi-faceted documents or when dealing with subjective content, as it permits a more holistic interpretation. Qualitative analysis also encourages flexibility and adaptability in the evaluation process, accommodating unexpected insights and unanticipated findings (Cain *et al.*, 2022). In contrast, quantitative descriptors can oversimplify the complexities of a document, potentially leading to an incomplete or skewed understanding. Therefore, depending on the research objectives and the nature of the documents being evaluated, qualitative analysis can provide a more comprehensive and contextually rich assessment, making it a preferred method for document evaluation (Sandham *et al.*, 2020).

In South Africa, evaluating effectiveness of environmental processes, such as environmental impact assessments, have adopted a qualitative scoring system based on the Lee & Colley review package (Van Schalkwyk, 2012; Sandham & Pretorius, 2008; Sandham *et al.*, 2020). The Lee and Colley review package is based on a six-symbol scoring system to evaluate the quality of environmental reports from “A to F”, whereas A is defined as “relevant tasks well performed, no important tasks left incomplete” and F is defined as “very unsatisfactory, important task(s) poorly done or not attempted” (Lee & Colley, 1991).

For the evaluation pertaining to the contribution of ISO 14001:2015 performance evaluation towards enhancement of environmental performance based on a mining case study, a three-symbol scoring system was developed (see Table 3-3) to determine the extent to which each of the KPIs were met. This simplified three-symbol (A to C) scoring system has been extensively used for similar research in the South African context (Alberts *et al.*, 2021; Alberts *et al.*, 2022; Claassens *et al.*, 2022; Sandham *et al.*, 2020; etc.).

Table 3-3: Evaluation criteria for key performance indicators (based on qualitative criteria developed by Lee & Colley, 1991 as adapted by Claassens *et al.*, 2022 and various other authors)

Colour Coding	Symbol	Score Description	
Green	A	KPI adequately addressed	All or most of the aspects considered pertaining to the KPI.
Orange	B	KPI partially addressed	Some aspects considered but not all pertaining to the KPI.
Red	C	KPI inadequately addressed	Aspects not considered or very poorly considered pertaining to the KPI.

In short, the documented information (see Table 3-1) was evaluated against the KPIs (see Table 3-2) and based on the extent to which the documented information addressed the KPI, a performance score (see Table 3-3) was allocated.

3.5 Data analysis

The analysis of data is the interpretation of gathered information through analytical and logical reasoning to summarise the data collected in the form of determining patterns, comparisons and trends (Ibrahim, 2015). To evaluate the contribution of ISO 14001:2015 performance evaluation towards enhancement of environmental performance from a mining case study, a cross-case matrix was developed to indicate the performance (A to C) of documented information of each of the case studies against the KPIs. A cross-case analysis is the analysis technique for the in-depth exploration of similarities and differences of different factors to support research objectives (Miles *et al.*, 2020).

For each of the KPAs, a graph with the performance of the three case studies against the KPIs were provided to supplement the cross-case analysis, whereas one graph was provided based on the extent of addressing the KPAs towards performance evaluation.

3.6 Ethical considerations

The design and practice of the study has been carried out based on a set of principles of informed consent and confidentiality as the organisation participating within the research voluntarily participated. As ethical considerations are essential factors which should be taken into account when planning a research project, it is defined as the practice being applied during research to ensure that the examinee remains protected and safe from harm based on the findings of research (Cacciattolo, 2015).

As per the requirements of the NWU, a code of conduct for research was signed on 29 October 2020 to guide the research based on the principles of honesty, accountability, professional courtesy and fairness as well as good stewardship. The research proposal was reviewed by the Faculty of Natural and Agricultural Sciences Ethics Committee (FNASREC) in accordance with the risk level descriptors for human participants and regarded the study as a minimal risk category (NWU-01740-20-A9).

As part of the conditions to participate in the research, a non-disclosure agreement was signed between the researcher and the liaison officer at the three diamond mines included as part of the case study. A non-disclosure agreement is a legally binding document between two or more parties agreed upon not to make information known to other internal or external parties (Nichols & Natsoulis, 2016). Prior to the acquisition of documented information as data for the research project, a non-disclosure agreement was signed with the organisation who voluntarily participated. The agreement is based on the fact that the information provided contains sensitive information which could cause harm to the organisation as the diamond mining industry operates within a competitive market. As part of the non-disclosure agreement, the names and locations of the three diamond mines had to remain confidential.

3.7 Methodological assumptions and limitations

By aiming to describe and justify the methodology for the research, is the assumption being made by the researcher (Ahmed, 2008). This research is based on a qualitative approach, with the justification that the research does not involve numerical information to understand the concept of environmental performance evaluation as the principle of environmental management is based on qualitative methods in preparation of professional assessments, statements and reports (Roudgarmi, 2011).

Methodological limitations are the constraints encountered during the data collection and analysis phases of a project (Miles, 2017). The scope limitations (as mentioned in Section 1.6) of this dissertation needs to be taken into account. The research findings are based on a case study of

three diamond mines located in South Africa. A larger sample size would have been beneficial for the purposes of this research, however, when the researcher approached potential participants (from diamond mines), they were reluctant and unwilling to participate in the research. Similarly, when the researcher attempted to approach other mines (coal mining) for inclusion in the research, the participants were unwilling to participate in the research.

Evidence-based research is essential as it ensures that the research is valuable and worthwhile relating to the research aim and topic (Brunnhuber *et al.*, 2020). The availability of documentation for the review of performance evaluation was limited, especially at one of the case study areas, potentially resulting in misleading information from actual implementation of the case studies. In these cases, the researcher worked with the documentation that was available to him. In cases where no documented information was available, a C-rating was provided, indicating that the aspect was poorly considered, or not considered at all.

3.8 Chapter summary

A description of the methodology utilised for the study was provided in this chapter. A qualitative research approach, which included document review and evaluation, was followed. Key performance areas (KPAs) and associated key performance indicators (KPIs) were developed to evaluate the extent to which EMS arrangements make provision for enhanced environmental performance. A qualitative three-symbol scoring system (A to C) was developed to score the extent of performance of documented information against the KPIs. The chapter also provided the ethical considerations, and assumptions and limitations of the research. Chapter 4 provides the results and discussion of findings.

CHAPTER 4 RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the findings based on data gathered and analysed (as explained in Chapter 3). With the aim to evaluate the contribution of ISO 14001: 2015 performance evaluation towards the enhancement of environmental performance using the diamond mining sector in South Africa as a case study, document review and evaluation, as explained in Chapter 3.

The diamond mining entity/group, which voluntarily participated in the research, consisted of three underground diamond mines. All three mines (CS1, CS2 and CS3) met the requirements of the case study selection criteria. The case studies are located in three different provinces of South Africa (CS1-Gauteng; CS2-Northern Cape and CS3-Free State).

The results related to the review and evaluation of EMS documentation of the different case studies and performance evaluated against the KPIs are discussed in Section 4.2.

4.2 Contribution of ISO 14001:2015 performance evaluation towards enhancement of environmental performance

The performance of each of the case studies (CS1 to CS3) representing the contribution of ISO 14001:2015 performance evaluation towards enhanced environmental performance, were evaluated against the eight KPAs and their corresponding KPIs. The performance of each case study (A–C) against each KPI is indicated in Table 4-1.

Table 4-1: Performance of the three case studies (CS1 to CS3) evaluated against the KPAs and KPIs

Effectiveness evaluation criteria		Case Study		
		CS1	CS2	CS3
KPA 1: Provision for environmental aspect identification and evaluation				
KPI 1.1	To what extent does the EMS arrangements provide for the identification of significant environmental aspects?	B	B	B
KPI 1.2	To what extent does the EMS arrangements provide for frequent environmental aspect evaluations?	A	A	A
KPA 2: Provision for environmental compliance obligations				
KPI 2.1	To what extent does the EMS arrangements provide for the identification of environmental compliance obligations?	A	A	A
KPI 2.2	To what extent does the EMS arrangements provide for frequent environmental compliance obligation updates?	A	A	A
KPA 3: Provision for objectives setting and planning				
KPI 3.1	To what extent does the EMS arrangements provide for the establishment of environmental objectives?	A	B	A
KPI 3.2	To what extent does the EMS arrangements provide for the alignment of objectives with significant aspects and compliance obligations?	C	C	C
KPA 4: Provision for performance monitoring and measurement				
KPI 4.1	To what extent does has EMS arrangements considered the factors to be monitored and measured?	A	B	A
KPI 4.2	To what extent does the EMS arrangements provide for frequent performance monitoring?	A	C	B
KPA 5: Provision for evaluation of compliance				
KPI 5.1	To what extent does the EMS consider compliance obligations to be evaluated and the frequency of evaluation?	A	B	B
KPI 5.2	To what extent does the EMS arrangements provide for monitoring of compliance with regulatory requirements?	C	C	C
KPA 6: Provision for internal auditing				
KPI 6.1	To what extent does the EMS arrangements provide for frequent management system internal auditing?	A	A	A
KPI 6.2	To what extent does the EMS arrangements provide for monitoring of conformity with the standards requirements?	A	A	A
KPA 7: Provision for management review				
KPI 7.1	To what extent does the EMS arrangements provide for frequency and attendance of management reviews?	A	C	A
KPI 7.2	To what extent does the EMS arrangements provide for closure of action items from management reviews?	B	C	B
KPA 8: Provision for improvement				
KPI 8.1	To what extent does the EMS arrangements provide for the analysis of environmental performance?	A	C	B
KPI 8.2	To what extent does the EMS arrangements provide for innovations or initiatives for environmental improvement?	B	C	A

The performance of the three case studies against the key performance areas (KPAs) are addressed in the sub-sections below.

4.2.1 KPA 1: Provision for environmental aspect identification and evaluation.

The first key performance area (KPA 1) focusses on the provision for environmental aspect identification and evaluation. KPI 1.1 assesses the extent to which the EMS arrangements provide for the identification of significant environmental aspects; while KPI 1.2 assesses the extent to which the EMS arrangements provide for frequent environmental aspect evaluations (Table 4-1; Figure 4-1).

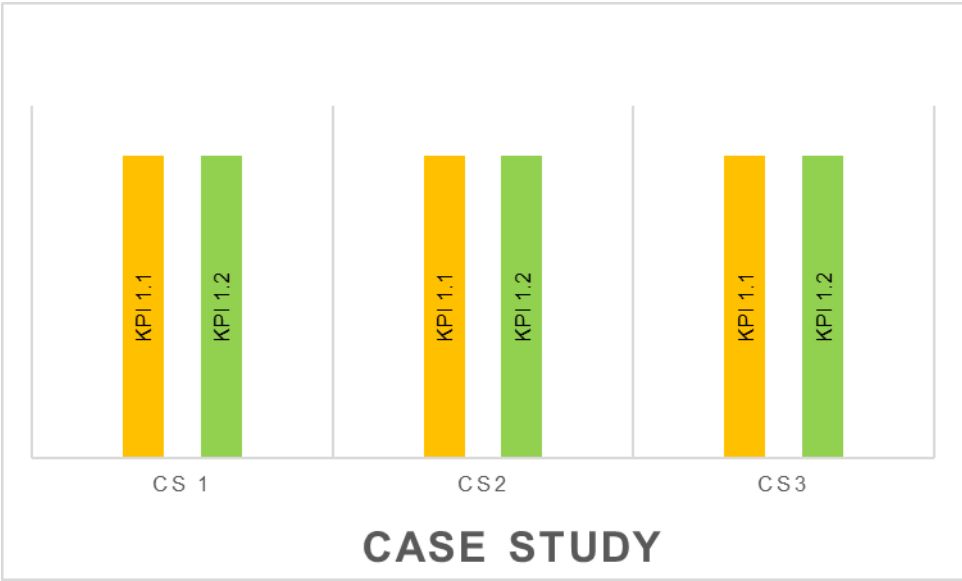


Figure 4-1: Overall performance evaluation scores for KPA 1 of the three diamond mines evaluated.

The intent of KPI 1.1 is to assess whether significant/key environmental aspects were identified, which can impact on the organisation’s environmental performance. All three case studies partially addressed the requirements (C1 to C3 = B). While the environmental aspects were identified as a whole for the three case studies by considering environmental conditions and aspects pertaining to the group (issue prompter) and environmental hazards affecting the group, significant issues relating to environmental performance was not addressed at an individual, site-specific level.

According to Pretty & Odeku (2017), mining activities consists of various aspects contributing to environmental degradation and the process for identifying environmental aspects result in relevant issues that need to be addressed based on the organisations activities, products or services interacting with the physical environment (Flemström, 2003). ISO 14001:2015, which

was used as a guideline for the evaluation the key performance indicator (KPI 1.1), has set out specific requirements which need to be considered when determining environmental aspects. The scope of the management system is essential as it defines the processes and activities under its control as well as taking changing- and abnormal conditions into account by considering a life cycle perspective of associated environmental impacts (ISO, 2015).

Furthermore, the three case studies have not consistently considered changing environmental conditions of the geographical locations from the three different provinces of South Africa and their climatic ecological differences (Kapuka & Hlasny, 2021) as part of their assessment. It could also not be verified from which activities the aspects have been derived, as a process-based approach has not been applied within the identification process as prescribed within the group level procedure for determining the contexts and risks of the organisation.

The second key performance indicator (KPI 1.2) addressed the extent to which the EMS arrangements provide for frequent environmental aspect evaluations by tracking how frequently environmental aspects are reviewed and assessed for their significance and potential impact. All three case studies adequately addressed the requirements (scoring an A). The issue prompter used for the group, environmental hazards affecting the organisation/system, and the group-level process for determining issues and strategic risks, was consistently utilised by all three case studies. Housni *et al.* (2021) posit that it is essential that significant environmental aspects are considered as they relate to performance evaluation (ISO, 2015). Based on the document review and evaluation conducted for the evaluation of KPI 1.2, it was evident that the organisation conducted reviews of aspect, impact and risk registers, and applies a review process every two years as per the group requirements for creating and updating the EMS. ISO 14001:2015 specifies that established criteria must be used for the assessment of the significance of the environmental aspects and impacts (ISO, 2015). All of the case studies applied the significance determination criteria suggested by the group (extent, duration, likelihood), as well as an established hierarchy of controls for the mitigation of risk (terminate, treat, tolerate, transfer, allocate, maintain, get more information).

Aspects as well as risk and opportunity planning actions were assigned in the form: setting of objectives, adding to emergency response plans, assigning additional controls, allocating resources, training and communication mechanisms and utilising performance evaluation. Thus, frequent environmental aspect evaluations have been adequately provided for, addressing the requirements of KPI 1.2.

4.2.2 KPA 2: Provision for environmental compliance obligations

The second key performance area (KPA 2) evaluated the provision for environmental compliance obligations. KPI 2.1 assessed the extent to which the EMS arrangements provide for the identification of environmental compliance obligations, while KPI 2.2 evaluated the extent to which EMS arrangements provide for frequent environmental compliance obligation updates (Table 4-1, Figure 4-2). Ultimately, the extent to which environmental obligations are identified, implemented, and updated, contributes to the environmental performance of an organisation. Both KPI 2.1 and KPI 2.2 were adequately addressed (scoring A) for all three of the case studies.

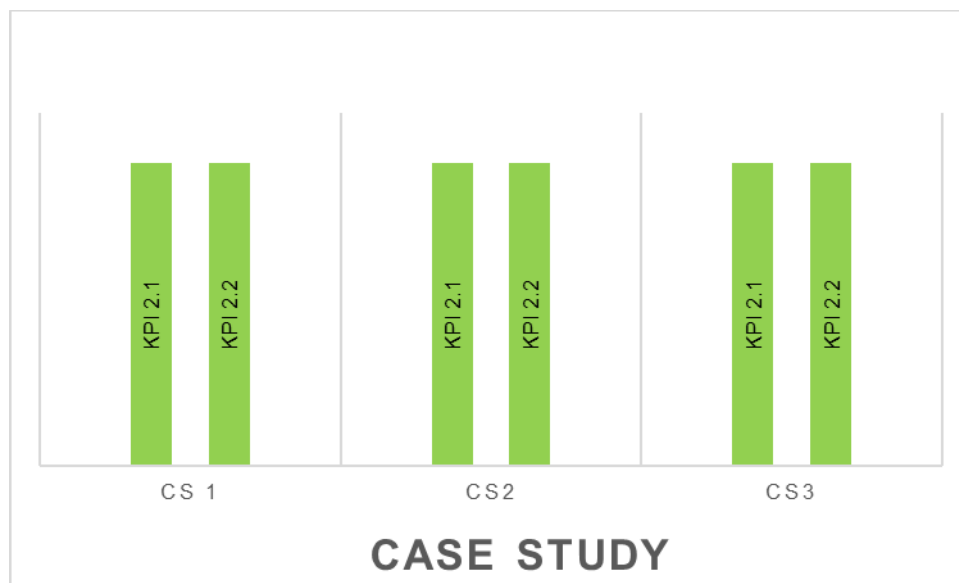


Figure 4-2: Overall performance evaluation scores for KPA 2 of the three diamond mines evaluated.

Based on the document review and evaluation process, it was noted that the legal services were outsourced to an external legal service provider and each case study was dealt with separately. Blanchard (2016) has indicated that environmental services, especially pertaining to legislative scopes of work, are generally outsourced based on lower operational and labour costs, legal expertise not falling within an organisation's expertise, professional competence and trustworthiness, as well as decreasing the risk of non-compliances.

Developing a database or documenting the legal requirements which are statutory and regulatory forms the basis of the process of determining compliance obligations (Salca Rotaru, 2019). Environmental laws and regulations, as well as agreements related to environmental requirements, and adopted needs and expectations of interested and affected parties are regarded as the *environmental compliance obligations* which need to be identified, implemented and maintained as part of the environmental management system (Fitzmaurice, 2018).

During the evaluation process conducted for this research, access to a compliance obligations portal was obtained through external legal service providers. It was evident that individual/separate environmental legal registers are drafted for each of the three case studies. The legal requirements identified relate to the environmental aspects of each of the case studies. The individual legal registers each addressed provincial and local (municipality) regulations and by-laws applicable to the area where the mine is located.

The site-specific compliance obligations/legal registers of the three case studies also outlined the applicability of the legislation to each site’s processes, and requirements pertaining to a specific site/operations, and needs of interested parties (which was unique for each case study’s compliance obligations register). The registers also made specific reference to environmental related permits and licences (see examples in Table 4-2) and provided a framework against which the compliance obligations are required to be evaluated for performance evaluation purposes. These compliance obligations which were identified provides an appropriate foundation to contribute towards environmental performance.

Viljoen (2022) has indicated that environmental legislation is complex within South Africa, and due to its complexity, organisations end up inadvertently contravening aspects of the law. South African environmental obligations and liabilities differ in accordance with geographical settings and thus, creating the margin for error when identifying applicable environmental compliance obligations. However, by delineating the geographic location, it is simpler to determine the environmental obligations and liabilities for national, provincial and local legislation and regulations (Tomsana *et al.*, 2020).

Table 4-2: Environmental compliance obligations pertaining to specific activities.

Case Study 1 (CS1)	Case Study 2 (CS2)	Case Study 3 (CS3)
<ul style="list-style-type: none"> • Mining Right • Environmental Authorisations • Water Uses Licenses and Registration • Atmospheric Emission Licence Exemption Letter for Burning • Waste Management Licences and Waste Tyre Stockpile Owner Registration Certificate 	<ul style="list-style-type: none"> • Prospecting Rights • Converted Mining Right • Water Uses Licenses and Registration • Water Services Agreement • Waste Management Licences for Temporary Storage of Hazardous Waste and Landfill Site • SAWIC Registrations for Hazardous Waste Generator and Disposal of Waste to Landfill 	<ul style="list-style-type: none"> • Mining Right • Zoning Certificate • Environmental Authorisation for Pit Expansion • Integrated Water Use Licence • Biodiversity, Including Weeds and Invaders Certificate of Adequate Fencing • Phase Out of Polychlorinated Biphenyls (PCBs) Registration

Case Study 1 (CS1)	Case Study 2 (CS2)	Case Study 3 (CS3)
<ul style="list-style-type: none"> • Heritage Permit for Decommissioning of Old Plant • Permit for Veldfires • Certificate of Registration for Selling of Fertilizer • Biodiversity, Including Weeds and Invaders Approval to Transport E. Crassipes Plants for Research and Testing Purposes 		

KPI 2.2 addressed the extent to which the EMS arrangements provide for frequent environmental compliance obligation updates, by tracking how often the compliance obligations register have been updated or whether notifications/amendments were made due to new or changed compliance obligations. South Africa is known for its continuously changing legislation. Over the past ten years, significant changes have been made to the National Environmental Management Waste Act (59 of 2008), for example as amended 2014 by the National Environmental Management: Waste Amendment Act (26 of 2014). Similarly, the National Environmental Management Laws Amendment Act (02 of 2022) took effect in June 2023, which effected changes to various environmental management-related legislation in South Africa. These changes may have far-reaching implications at an operation level. It is, therefore, essential to have processes in place to remain updated on environmental legal requirements and amendments that have been made (Mngoma *et al.*, 2011).

During the document review and evaluation related to KPI 2.2, it was evident that that the external legal service provider keeps the organisation updated by distributing “newsletters” (via e-mail) that contain information on new or changed environmental legislation, and draft legislation for comment. For example, in 2023, a total of seventeen newsletters were distributed, which communicated information related to legal updates. These legal amendments were also appropriately reflected in all three of the case studies’ legal registers. For instance, the most recent “newsletter” with a notification of the published National Water Resources Strategy (NWRS-3) in GN 3855 of 01 September 2023, was incorporated in the environmental legal registers of all three case studies. Such updates ensure that compliance obligations remain up to date, and is important, especially where compliance obligations are linked to enhancement of environmental performance.

4.2.3 KPA 3: Provision for objectives setting and planning

The third key performance area (KPA 3) focussed on the provision for objectives setting and planning, consisting of two key performance indicators (KPIs) as illustrated by Table 4-1. These indicators consist of: arrangements provided for the establishment of environmental objectives (KPI 3.1), as well as the alignment of objectives with significant aspects and compliance obligations (KPI 3.2). The evaluation process reviewed the objectives set at group-level as well as at site-specific (case study) level. The performance of the three case studies against KPA 3 is indicated in Table 4-1 and Figure 4-3.

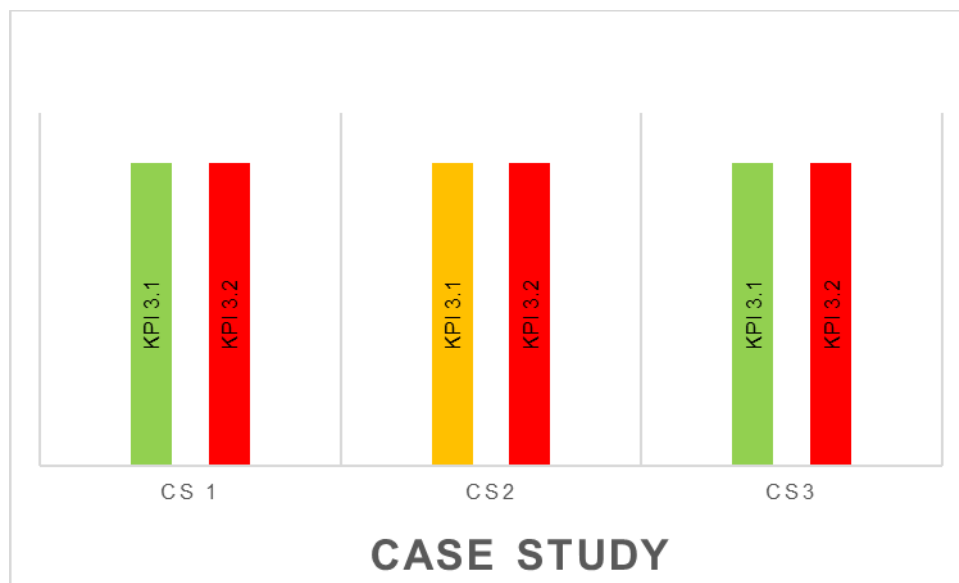


Figure 4-3: Overall performance evaluation scores for KPA 3 of the three diamond mines evaluated.

KPI 3.1 addressed the extent to which EMS arrangements provide for the establishment of environmental objectives by evaluating how well the organisation sets clear and measurable environmental objectives to address significant aspects and compliance obligations. According to Hammer (2014), documented environmental objectives eases the process of taking action and driving results towards improving environmental performance. Mosgaard *et al.* (2022) further state that the setting of environmental objectives is essential for the performance of an EMS, as one of the intended outcomes of ISO 14001:2015.

Based on the document evaluation process, it was evident that clear environmental objectives were set at group level. Site-specific objectives could, however, only be verified for CS1 and CS3. Both of these case studies had measurable and appropriate, site-specific environmental objectives (CS1 and CS3 = A). These objectives were aimed towards environmental compliance, environmental assurance and environmental performance. For CS2 (KPI 3.1 = B), group-level

environmental objectives were set, however, no evidence of site-specific objectives could be verified at the time of the research. Research by Almgren and Hjelm (2021) on objectives to improve environmental performance, reflected that 90% of the large organisations included in their research committed themselves to achieving sustainable development goals, and a large majority of these organisations have adjusted their activities, thereby enhancing their environmental performance.

KPI 3.2 addressed the extent to which environmental objectives align with the identified significant environmental aspects and compliance obligations. ISO 14001:2015 requires the setting of environmental objectives that relate to significant environmental aspects, environmental compliance obligations and risks and opportunities (ISO, 2015). During the document evaluation process, a comparison was made between the objectives set at group- as well as site-specific level, with the environmental aspects and environmental compliance obligations (based on environmental legal registers, compliance obligations registers, and/or compliance obligations frequency registers).

KPI 3.2 was not adequately addressed in any of the case studies, resulting in a score of a C for all three case studies (Table 4-1, Figure 4-3). This outcome is based on the fact that objectives were mainly based on preventing the occurrence of non-compliance (specified percentages) to legislation, rather than demonstrating or encouraging compliance towards permitted or authorised environmental conditions (refer to Table 4-2). Smit (2020) motivates that NEMA section 23(2) provides for the achievement of environmental objectives (related to law) by promoting the utilisation of environmental management mechanisms to regulate and ensure compliant behaviour. However, recent studies have shown that the setting of environmental objectives within the framework of an ISO 14001:2015 management system has several challenges. Key stakeholders are rarely involved, and many environmental objectives do not adequately consider a life cycle approach, and do not focus on aspects such as biodiversity management, heritage management and other “softer” environmental issues (Mosgaard *et al.*, 2022).

The link between aspects (KPA2) and the setting of objectives (KPA3) was also evaluated. Since KPI 1.1 (identification of environmental aspects) were only partially addressed (scoring B), the relationship between environmental aspects and environmental objectives that were taken into consideration, included only limited aspects, such as: water use and water recycling, waste generation, energy management, and carbon footprint (with impacts focusing on loss of biodiversity, droughts and floods, business reputation and financial implications). The study by Mosgaard *et al.* (2022) emphasised that organisations most commonly consider the environmental aspects of energy- and water consumption as well as waste generation, many times missing other crucial issues. His research further revealed that organisations do not always

consider the significance of environmental aspects when setting environmental objectives, and that environmental objectives often lack the integration of an organisation’s strategic direction.

4.2.4 KPA 4: Provision for performance monitoring and measurement

The fourth key performance area (KPA 4) evaluated the provision for performance monitoring and measurement as part of EMS arrangements. KPI 4.1 evaluated the extent to which EMS arrangements considered the factors to be monitored and measured, whereas KPI 4.2 evaluated the extent to which EMS arrangements provide for frequent performance monitoring. Documented information related to monitoring and measurement included various processes (procedures) and registers outlining the requirements for monitoring and measurement, as well as records/evidence of monitoring being conducted (i.e. air quality-, water quality-, biodiversity-, waste-, flood monitoring reports) at group- and organisation/site-specific levels. Other documented information, such as environmental objectives, minutes of meetings and performance reports, were also considered.

The outcome of the evaluation of EMS arrangements of the three case studies against KPA4 is reflected in Table 4-1 and Figure 4-4.

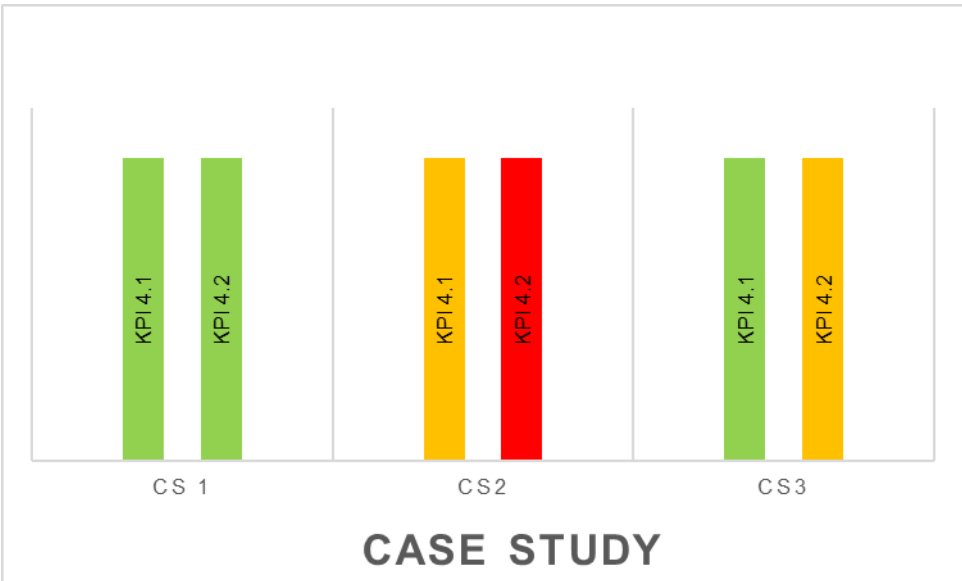


Figure 4-4: Overall performance evaluation scores for KPA 4 of the three diamond mines evaluated.

KPI 4.1 was adequately addressed in CS1 and CS3 (KPI 4.1 = A), while it was only partially addressed (KPI 4.1 = B) in CS2. Results related to performance against KPI 4.2 differed for each of the three case studies, with CS1 demonstrating adequate performance (KPI 4.2 = A) and CS3 demonstrating partial conformance (KPI 4.2 = B), while C2 did not address KPI 4.2 (scoring a C).

ISO 14001:2015 requires that organisations determine what needs to be monitored and measured within the defined scope of the environmental management system (ISO, 2015). Kalyar *et al.* (2019) argue that - in order to demonstrate a commitment to continual improvement of performance, monitoring and measurement can be used to determine trends, evaluate risks, identify strategic objectives, and report on environmental performance through the process of performance evaluation. Annexure A of ISO 14001: 2015 (ISO, 2015) guides organisations on factors which should be taken into consideration as part of monitoring and measurement. These factors include progress on environmental objectives, significant environmental aspects, compliance obligations and operational controls. Housni *et al.* (2021) highlight that monitoring and measurement are essential towards improved environmental performance.

When reflecting on the performance of the cases against KPI 4.1, it was evident that a group-level monitoring and measurement register was developed, which consider the factors to be monitored and measured for all mines belonging to the group (i.e. all three case studies) (See Table 4-3). The register specifically provided significant environmental aspects and operational controls, defining the frequencies, arrangements, methods and criteria for the monitoring and measurement related to the aspects. Site/organisation-specific monitoring and measurement measures provided for the three case studies are outlined in Table 4-4 below.

Table 4-3: Group-level monitored and measured arrangements considered.

Aspect	Factor/s to be monitored/measured	Frequency
Ground Water	Water levels, inorganic chemical analysis, organic chemical analysis and dewatering amounts.	Quarterly
Stormwater Management	Volumes of water entering dams.	Monthly
Water Use License Quantity	Quantities of abstracted water from water resources or total water used on mine.	Daily Readings and Monthly Reporting
FDM Activities (Mining, Plant, Services, Technical Services, Contractors)	Compliance to mine procedures, EMS and environmental inspection checklist.	Monthly, Quarterly and Bi-annually
Fall-Out Dust Monitoring	Fall-out dust concentrations (Residential areas: D less than 600mg/m ² /day Non-residential areas: 600mg/m ² /day less than D less than 1200mg/m ² /day)	Monthly
Environmental Dust	Particulate matter of PM10 & PM2.5 (PM10: 75µg/m ³ limit and PM2.5: 25µg/m ³)	Real Time Monitoring and Daily
Environmental Noise	Ambient noise level (Daytime 60dBA, Nighttime 50dBA)	Real Time Monitoring and Daily
Green House Gasses	Fuel consumption (diesel, petrol and LPG gas), electricity usage, disposal of waste and consumption of paper.	Monthly
Waste Management	Waste landfilled (general and hazardous), waste recycled	Monthly
Rehabilitation Monitoring	Erosion control; Vegetation establishment (Land Stability)	Quarterly
Invasive Plant Species Regrowth Monitoring	Alien and invasive plant species growth	Following up eradication or Annually
MRD Inspections and Failures	Mine residue deposits	Quarterly
Flood Events	Rainfall rate and water ingress into the pit	Daily
Seismic Monitoring	Open pit stability	Daily
Bulk Storage Tanks for Oil and Diesel Pipelines	Integrity of the tanks	Daily

Table 4-4: Site/case study specific monitoring and measurement arrangements considered

Case Study 1 (CS1)	Case Study 2 (CS2)	Case Study 3 (CS3)
<ul style="list-style-type: none"> • Water Consumption results for portable water consumption, raw water use and underground to surface • Trends on total water use against recycled water • Diesel Consumption results • Electricity Consumption results • Water Balance Diagram for water abstraction and effluent discharge • Ground Water Monitoring for Water Quality in conductivity (mS/m), sodium (mg/l), chlorine (Cl), sulphate (SO4) and nitrates • Surface Water Quality for potential hydrogen (pH), electrical conductivity, suspended solids, dissolved oxygen, turbidity, oil and grease • Effluent and Wastewater statistics • Waste Management statistics for total waste to landfill, waste recycled, waste generated versus waste recycled. • Dust Fall-Out trends for residential- and non-residential action levels • Air Quality statistics for PM10 and PM2.5 • Internal Audit Reports • External Legal Compliance Report 	<ul style="list-style-type: none"> • Internal Audit Reports • External Legal Compliance Report 	<ul style="list-style-type: none"> • Environmental Aspect Analysis and HSE Statistics on: <ol style="list-style-type: none"> 1. Waste Management 2. Energy Saving 3. Green File Statuses 4. Chemical Storage and Management 5. Environmental Awareness 6. Spill Kits and Spillages 7. Incident Reporting • Internal Audit Reports • External Legal Compliance Report

CS1 and CS3 demonstrated sufficient arrangements related to KPI 4.1 (with an evaluation score of A). Both the group- (Table 4-3) and site-specific (Table 4-4) arrangements clearly specified the factors to be monitored and measured. Monitoring and measurement registers outlined monitoring and measurement requirements that were linked to environmental compliance obligations, provision of environmental assurance, and demonstration of environmental performance. The objectives set (as discussed in Section 4.2.3) had related key performance indicators and monitoring and measurement requirements towards demonstrating improved environmental performance.

CS2 only partially addressed KPI 4.1 (scoring B). While group-level monitoring and measurement arrangements were identified, no evidence of site-specific arrangements for monitoring and measurement existed (apart from internal and external audit reports). As discussed in Section 4.2.3 above, there was also no site-specific objectives set for CS2.

Monitoring and measurement of environmental performance over time assesses the effectiveness of environmental initiatives and management measures by providing information on performance through objectively observable and quantifiable variables (Albertini, 2016). KPI 4.2 evaluated the extent to which the EMS arrangements provide for frequent performance monitoring by specifying how often the organisation monitors its environmental performance, which indicates its commitment to ongoing improvement. Reporting on environmental performance, through monitoring and measurement, is essential to determine if the environmental management system meets its objectives and environmental performance indicators (Rohov *et al.*, 2021).

CS1 demonstrated frequent performance monitoring against the aspects identified in Table 4-3 and Table 4-4, and therefore scored an A for KPI 4.2. The aspects outlined in Table 4-3 were discussed and reported on in management review meetings, also focusing on trends of performance over time. The EMS arrangements of CS2 did not address or inadequately addressed the requirements of KPI 4.2. Insufficient documented information existed for monitoring and measurement, and no site-specific requirements were identified as it relates to monitoring and measurement. Lastly, CS3 demonstrated partial conformance to KPI 4.2, and obtained a B evaluation score. Documented evidence of site-specific monitoring and measurement arrangements existed (i.e., environmental aspect analysis and HSE statistics) and performance evaluation results were reported. However, the aspects that were monitored and measured and reported on were not aligned with the aspects identified at a group-level (see Table 4-3). Furthermore, trends and statistics related to monitoring and measurement that were reported as part of performance evaluation (i.e., management review), largely related to waste management, and did not adequately report on other significant aspects that were monitored and measured (i.e. energy efficiency, carbon emissions, water use, etc.). Environmental monitoring is

essential, especially where monitoring is linked to compliance obligations (i.e. water quality monitoring as part of WUL conditions) (Taza-Asaba, 2013; Okarma *et al.*, 2022). Inadequate monitoring and reporting of environmental aspects pertaining to factors which require to be monitored result in environmental ignorance, developing a lack of commitment, and may result in environmental non-compliance (Baierl *et al.*, 2021).

4.2.5 KPA 5: Provision for evaluation of compliance

The fifth key performance area (KPA 5) evaluated the provision for evaluation of compliance as part of the documented EMS arrangements of the three case studies. KPI 5.1 assessed the extent to which the EMS provides for compliance obligations to be evaluated and the frequency of evaluation, while KPI 5.2 evaluated the extent to which EMS arrangements provide for monitoring of compliance with regulatory requirements. Environmental compliance evaluations involve the independent evaluation of environmental legal requirements and assessing compliance with it (Shamaileh, 2015). ISO 14001:2015 specifies that action needs to be taken to retain compliance evaluation results as documented evidence (ISO, 2015). As indicated in Table 4-2, and discussed in Section 4.2.2 above, while there are similar national environmental laws and regulations applicable to the three sites, each case study has unique provincial and local regulations, as well as site-specific environmental authorisations.

Overall, the three case studies performed better in KPI 5.1 than KPI 5.2 (Table 4-1, Figure 4-5).

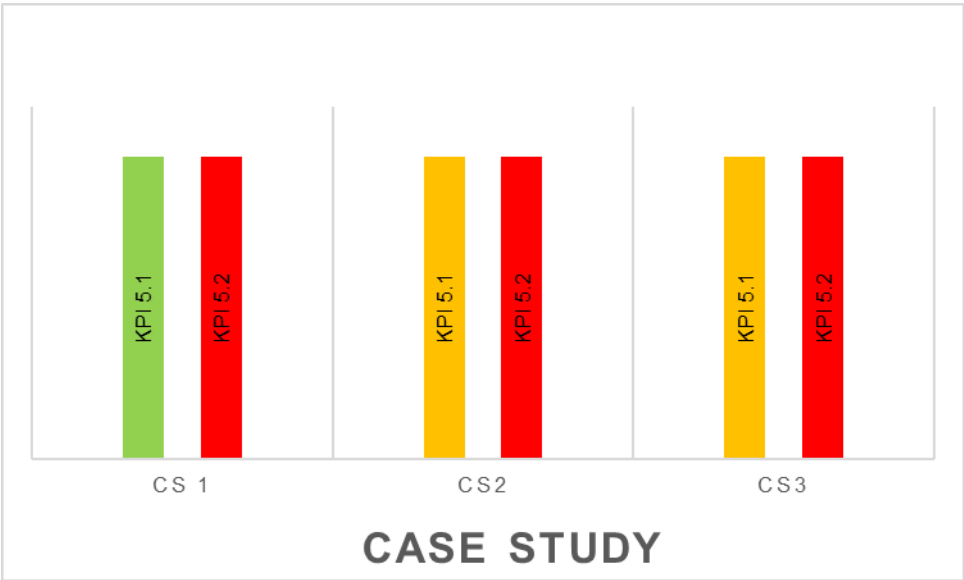


Figure 4-5: Overall performance evaluation scores for KPA 5 of the three diamond mines evaluated.

KPI 5.1 addressed the extent to which compliance obligations are to be evaluated and the frequency of evaluation. ISO 14001:2015 requires that the organisation must implement and maintain the process to evaluate environmental compliance at specified frequencies (ISO, 2015). The evaluation of environmental compliance is based on the compliance obligations associated with operational activities (i.e. water management, waste management, management of hazardous substances, etc.), which are regulated through the requirements of law and permits, licences, and/or authorisations. Compliance evaluation is essential owing to the legal and economic risks related to non-compliance, such as criminal and civil liability, as well as penalties and fines associated with non-compliance (Davids, 2020).

CS1 adequately addressed the requirements of KPI 5.1 (performance score: A). All of the compliance obligations which requires evaluation are recorded in the compliance obligation register and compliance obligation frequency register. Frequencies for evaluation of compliance were specified. CS1 has, further, developed a compliance audit schedule for biennial EMP site assessments. Based on the importance of compliance audits, Gutterman (2023) indicates that it is essential to develop processes and procedures for environmental compliance audits as it defines the guidelines and controls for compliance with standards and legal requirements.

The EMS arrangements of CS2 and CS3 only partially provided for KPI 5.1 (performance score: B). The EMS arrangements of these two mines consisted of a compliance portal, which is managed by an external service provider, with no internal applications by the organisations. This compliance portal made provision for the compliance obligations that require evaluation but did not contain the frequencies of evaluation or any other detailed arrangements related to the evaluation of compliance.

KPI 5.2 evaluated the extent to which the EMS arrangements provided for monitoring of compliance against regulatory requirements by tracking the organisations' compliance with environmental laws and regulations. According to Shamaileh (2015), tracking of compliance against regulatory requires is regarded as an indication of an organisation's commitment to legal and ethical standards, especially those that could influence environmental performance. Based on the document review and evaluation process, it was evident that compliance obligations were periodically evaluated by external auditors for all three case studies. While the registers for the evaluation of compliance (at group level) mention the requirements for evaluation of compliance, these requirements were not conformed to by the three case study mines. For instance, while it is a requirement to evaluate the compliance to site-specific environmental authorisations (i.e. water use licences and/or waste management licences), compliance evaluations were not conducted at the frequencies specified in the registers and/or the licences. The waste management licences, water use licences, and environmental authorisations issued in terms of

NEMA, all specify requirements for evaluating compliance to licence conditions. Section 26(e) of the Environmental Impact Assessment Regulations (GNR 982 of 2014, as amended in 2017 by GNR 326) states that the frequency of auditing compliance (to licence conditions) is specified within the conditions of the environmental authorisation and should not exceed the intervals provided for in the authorisations (DEA, 2017). The document review process could not confirm that the three case studies had mechanisms in place to identify the frequency of compliance audits specified in authorisations/licence conditions. None of the three sites addressed the requirements related to KPI 5.2, and performance evaluation scores of “C” were assigned for this reason. The lack of mechanisms to evaluate compliance with compliance obligations (law, regulations, licences/permits/authorisations, needs and expectations of interested parties) may lead to organisations missing opportunities towards enhancing environmental performance.

4.2.6 KPA 6: Provision for internal auditing

KPA 6 focusses on the provision of internal auditing within the documented EMS arrangements. Key performance indicators have been assigned to evaluate the extent to which the EMS have contributed to performance evaluation (and, ultimately, enhanced performance) through arrangements for frequent management system internal auditing (KPI 6.1) and arrangements provided for monitoring of conformity with the standards requirements (KPI 6.2). Based on the findings from the document review process, it was evident that internal audits are planned at a group-level perspective and implemented at a site-specific level. Compared to the other KPAs, KPA6 generally performed well, with all three of the case studies addressing the requirements related to KPI 6.1 and KPI 6.2.

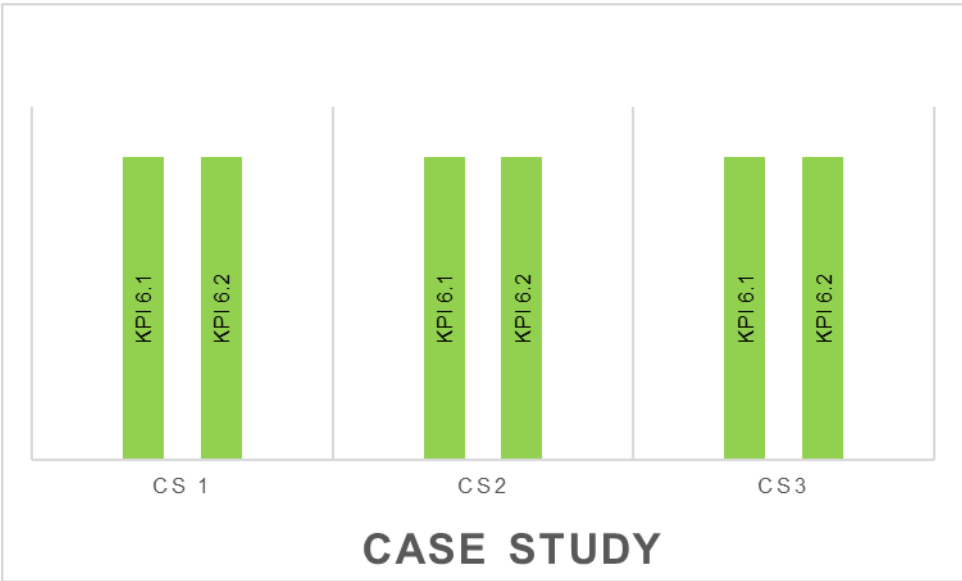


Figure 4-6: Overall performance evaluation scores for KPA 6 of the three diamond mines evaluated.

KPI 6.1 addressed the extent to which the EMS arrangements provide for frequent management system internal auditing by measuring the frequency and regularity of internal audits for the management system. The International Organisation of Standardisation has drafted guidelines for the internal auditing of management systems, ISO 19011, and the latest version was released in 2018. This standard defines the principles for auditing, managing an audit programme, as well as the process for conducting internal management system audits (Shandu & Saluja, 2023; ISO, 2018).

All three case studies have adequately addressed KPI 6.1 (KPI 6.1 = A) as the environmental management systems arrangements of all three cases have provided adequate arrangements for frequent internal auditing of the EMSs. A three-year audit programme is established at group-level which aligns with the certification cycle of the EMS. Internal audit plans are developed and implemented for each site-specific internal audit in accordance with the ISO 19011:2018 guideline. Documented evidence was available of internal audits being conducted, as specified in the audit programme. Frequent internal audits have the benefit of providing knowledge on the conformance status of the EMS, while improving the organisation's ability to enhance environmental performance (Nolan, 2016). However, research by Wairon *et al.* (2018) has revealed that the willingness and ability of organisations to implement an EMS has in many cases been problematic due to cost, which involves costs of performance evaluation, which includes internal and external audits. The need to frequently "check" conformance and performance of the EMS has, thus, been regarded as a "hurdle or obstacle" towards implementing an ISO 14001:2015 EMS (Wairon *et al.*, 2018).

KPI 6.2 addressed the extent to which the EMS arrangements provide for monitoring of conformity with the standards requirements by tracking the organisation's conformity with management system as an indicator of its commitment to effective implementation and continual improvement. An internal audit serves as an evaluation instrument to verify that requirements of the EMS are being met and that it conforms with the ISO 14001:2015 standard's requirements (Wairon *et al.*, 2018). Internal audit reports were verified for all three case studies, and an evaluation score of "A" was allocated to all three case studies. The EMS arrangements for all three cases provided mechanisms to identify non-conformities, investigate causes of non-conformities, respond to them, and to implement corrective actions to address non-conformities (Harbison, 2020; ISO, 2015). Non-conformities were consistently recorded in all of the internal audit reports of all three case studies. Based on the most recent internal audit reports (2021/2022) the following number of non-conformities were recorded at each of the case studies:

- CS1 = Seven non-conformities recorded;
- CS2 = Five non-conformities recorded; and

- CS3 = Thirteen non-conformities recorded.

The causes for non-conformity were described in all of the internal audit reports, and corrective actions to address the non-conformities were also indicated. KPA 6 were, therefore, regarded as being appropriately addressed towards enhanced environmental performance.

4.2.7 KPA 7: Provision for management review

The seventh KPA (KPA 7) evaluated the provision for management review in the documented EMS arrangements of the three mines. KPI 7.1 evaluated “To what extent does the EMS arrangements provide for frequency and attendance of management reviews?”, while KPI 7.2 evaluated “To what extent does the EMS arrangements provide for closure of action items from management reviews?” Document review and evaluation concluded that a group-level procedure exists, which outlines the requirements for the management review process. This procedure addresses all of the requirements related to management review (clause 9.3) as outlined in ISO 14001: 2015. Implementation of the management review process happens at an organisation/site-specific level. Figure 4-7 provides the outcome of the evaluation process of the three case studies’ EMS documented arrangements against KPI 7.1 and KPI 7.2.

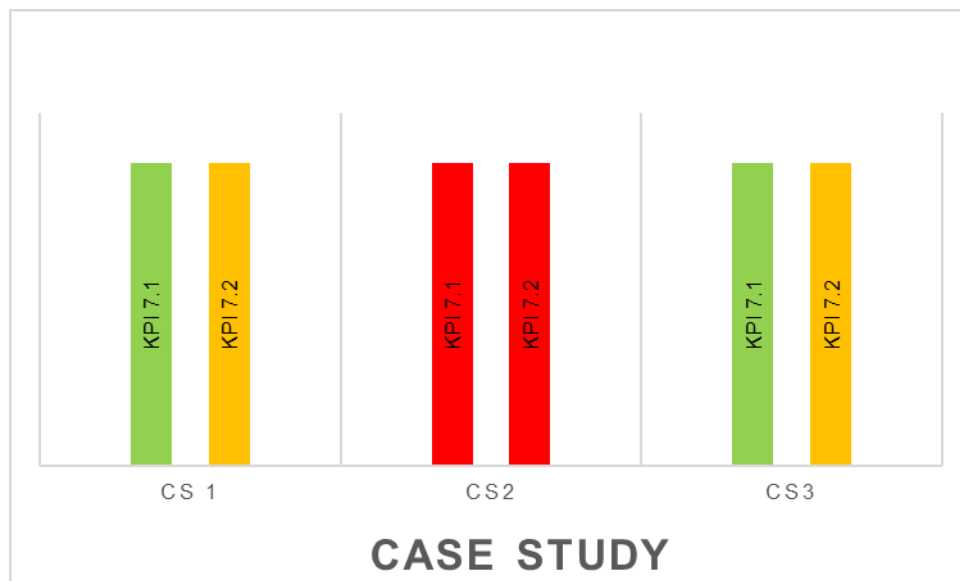


Figure 4-7: Overall performance evaluation scores for KPA 7 of the three diamond mines evaluated.

As indicated in Table 4-1 and Figure 4-7, CS1 and CS2 performed satisfactory (evaluation score: A) against the requirements of KPI 7.1, while CS2 performed unsatisfactory (evaluation score C). Performance against KPI 7.2 was comparatively poorer, with CS1 and CS3 scoring “Bs” (partially addressed) and CS2 scoring a “C” (not addressed).

KPI 7.1 addressed the extent to which the EMS arrangements provide for frequency and attendance of management reviews. This KPI evaluates how frequently management or leadership reviews environmental performance of the EMS, and the level of participation from top management/leadership. According to Herghiligi *et al.* (2019), appropriate participation from leadership is essential, as management review is based on business decision-making principles for organisational sustainability with the aim of enhancing environmental performance, promoting resource development and identifying opportunities for economical profitability (Faure, 2022). During the management review process, ISO 14001:2015 requires the evaluation of environmental performance as it relates to non-conformities and corrective actions, monitoring and measurement results, fulfilment of compliance obligations, and audit results (ISO, 2015).

CS1 and CS3 have adequately addressed KPI 7.1. Documented evidence of management review meetings (presentations, minutes, agendas) indicates the effective implementation of the management review process. The minutes provided accurate reflections of what was presented at the meeting (when compared to the content of the presentations) and addressed all of the requirements of the ISO 14001:2015 standard (inputs and outputs required for management review). No documented information was, however, available to verify that CS2 adequately addressed KPI 7.1. Therefore, a performance score of “C” was allocated.

KPI 7.2 evaluated the extent to which the EMS arrangements provide for closure of action items from the management review process. The evaluation considered how effectively action items identified in management reviews are addressed and closed out. One of the outputs of a management review process required by ISO 14001: 2015 is the consideration of actions needed to address environmental objectives that have not been met, as well as actions needed towards the improvement of environmental performance (ISO, 2015). CS1 and CS3 have partially addressed KPI 7.2, since the actions to address and close-out non-conformities and/or improvement of performance did not adequately address all of the areas reported on during the management review process. For instance, the management review minutes of CS1 only addressed close-out actions related to noise levels which did not meet legal requirements (i.e. noise attenuation measures assigned to the occupational hygienist), while other issues/impacts/non-conformities related to water use, energy efficiency, and waste management did not receive any attention in terms of close-out actions. Similarly, the management review minutes of CS2 included close-out actions, such as better housekeeping, installation of water meters with calibration certificates, reduction in external raw water use, while close-out of more serious non-compliances to legal requirements were not addressed. Again, no documented information of the management review process of CS2 was provided, and this case was therefore assigned a “C”.

The ISO 14001:2015 standard requires, in Clause 9.3, that the suitability, adequacy and effectiveness of the management system should be reviewed by top management at planned intervals (ISO, 2015). Sorooshian and Yee (2019) investigated the demotivating factors affecting ISO 14001:2015 implementation. One of their findings was that the lack of top management's commitment and efforts to close-out non-conformities and non-compliances have contributed to barriers to the implementation of environmental management systems and have limited the enhancement of environmental performance (Sorooshian & Yee, 2019).

4.2.8 KPA 8: Provision for improvement

The eighth and final key performance area, KPA 8, focussed on the provision for improvement, with the main focus being improvement of environmental performance. KPI 8.1 evaluated the extent to which EMS arrangements provide for the analysis of environmental performance, while KPI 8.2 scrutinised whether EMS arrangements provide for innovations or initiatives towards environmental improvement. The final clause of the ISO 14001:2015 standard, Clause 10, is focused on improvement by recognising opportunities for improvement to meet the intended outcomes (Mosgaard *et al.*, 2022). Fura (2013) has described that the opportunities pertaining to an EMS is not only focussed on enhancing environmental performance by mitigating environmental impacts, but also by gaining on reputational improvements, process efficiency, supplier and customer trust, as well as improvement in economic measures through reduction in insurance fees and increased market shares.

The extent of conformance of KPA 8 was evaluated at a group-level and site-specific level, and included the evaluation of environmental objectives, risk registers and meeting minutes, amongst others. Figure 4-8 provides the results of the evaluation of the three case studies against KPA 8.

KPI 8.1 addressed the extent to which the EMS arrangements provide for the analysis of environmental performance. For this purpose, trends in environmental performance data were assessed to determine if the organisation is continually improving or exerting effort towards continually improving its environmental performance. According to Martlhare (2020), continual improvement of the EMS is necessary to ensure its acceptability and effectiveness in, ultimately, enhancing environmental performance. The analysis of environmental performance (KPI 8.1) is adequately addressed by CS1 (performance score: A), with the justification that the results of analysis presented within the management review meetings, internal audits, evaluation of compliance and monitoring and measurement reports, all focusing on continual improvement of environmental performance. All of the factors outlined in the monitoring and measurement register, audit programme and management review agenda are consistently addressed, with the ultimate goal of continual improvement being evident in all of these processes.

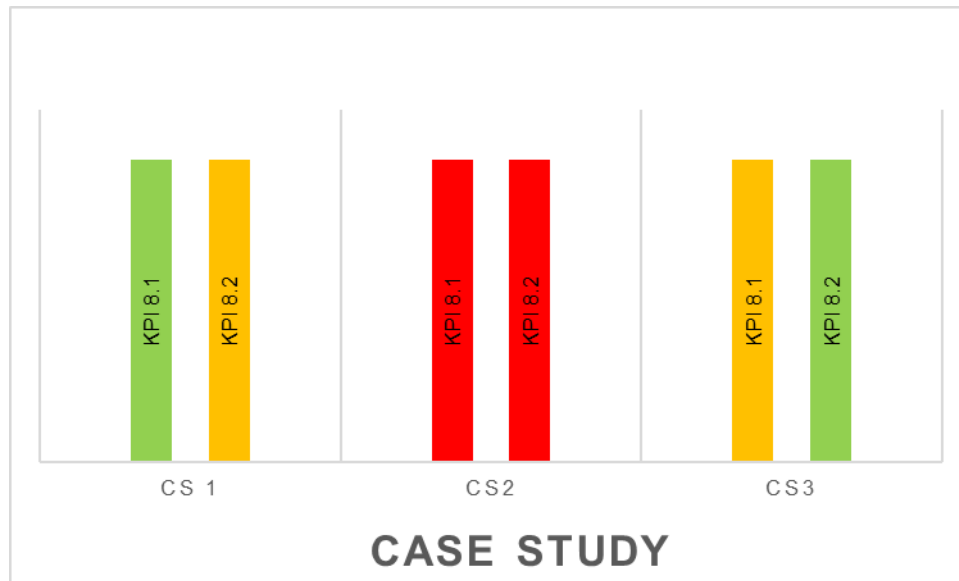


Figure 4-8: Overall performance evaluation scores for KPA 8 of the three diamond mines evaluated.

KPI 8.1 was inadequately addressed (performance score of C) in the EMS arrangements of CS2, as no information pertaining to analysed results from factors/aspects monitored and measured could be verified, internal audit reports did not adequately link back to continual improvement, and results of management reviews were not available. As previously discussed in Section 4.2.7, when reflecting on the extent that CS2 addressed KPI 7.2, challenges and barriers of management reviews are derived from the lack of top management’s commitment or inadequate provision of evidence-based information (Brunnhuber *et al.*, 2020; Sorooshian & Yee, 2019).

CS3 partially addressed KPI 8.1 (and scored a B), based on the fact that management reviews, internal audits, and monitoring and measurement registers and results addressed some (but not all) of the aspects identified by the mine. Not all aspects were consistently addressed, and the link to continual improvement and enhancement of environmental performance was not always clear.

Finally, KPI 8.2 addressed the extent to which the EMS arrangements provide for innovations or initiatives towards enhanced environmental performance/improvement. This KPI evaluated the number of new ideas or initiatives aimed at enhancing environmental performance. Choongo *et al.* (2016) argue that identifying opportunities to enhance environmental performance, contribute to the setting of new environmental objectives and strategies resulting in enhanced environmental performance.

At a group-level, environmental opportunities were identified such as the innovation to improve and optimise resource use efficiency, as well as the use of alternative energy sources such as

PV solar to address the energy crises. The implementation of these initiatives could, however, not be linked to any of the three case studies.

CS1 partially addressed KPI 8.2 (performance score: B) as site-specific objectives were set towards enhancing environmental performance from a compliance, assurance and performance perspective (as discussed in Section 4.2.3). No new ideas or initiatives towards enhanced environmental performance were, however, identified. CS2 inadequately addressed KPI 8.2 (scoring a C) as no site-specific objectives were set and no information on opportunities/initiatives were identified towards enhanced environmental performance. CS3 adequately addressed KPI 8.2, receiving an evaluation score of A. It was evident that site-specific objectives were set as discussed in Section 4.2.3 and opportunities/initiatives towards improved environmental performance was identified as part of the management review process (see Section 4.2.7). Initiatives towards improved environmental performance included cost saving and re-use of material from waste removal initiatives, energy saving and reduction in external raw water use, ensuring water meters have calibration certificates, developing an inventory of all the site materials and equipment, better housekeeping as well as continual improvement of environmental files ("green files"). These measures all provide improved opportunities towards contributing to enhanced environmental performance.

4.3 Summary: Extent of EMS performance evaluation contributing to enhanced environmental performance

Enhancement of environmental performance in ISO 14001:2015 is about creating a cycle of improvement, where an organisation strives to minimise its negative environmental effects and make progress towards becoming more environmentally responsible over time (Avenant, 2020). The research evaluated the contribution of ISO 14001:2015 performance evaluation (as outlined in the EMS arrangements of three case study diamond mines) towards enhancement of environmental performance, by applying specific KPAs with related KPIs.

Based on the cross-case analysis, as outlined in Table 4-1, CS1 was the best performing case with eleven As, three Bs and two Cs; followed by CS3 with nine As, five Bs and two Cs. CS2 was the poorest performing case study, with five As, four Bs and seven Cs. The poor performance of CS2 was mostly due to the unavailability of documented evidence to demonstrate conformance to some of the KPAs.

When considering the performance against the specific KPAs, all of the cases generally performed well in KPA2 (provision for environmental compliance obligations) and KPA6 (provision for internal auditing). These two KPAs relate to the essence of legal compliance evaluation, which

is one of the core environmental responsibilities of organisations performing activities, which may have a detrimental impact on the environment. Mining is one of the processes which is consistently on the radar of environmental authorities, such as DFFE and DWS. It is, therefore, not surprising that resources are spent on identifying applicable compliance obligations. The poor performance to KPA 5 (provision for evaluation of compliance) is, however, unexpected, given the fact that compliance to legal requirements play such an important role in maintaining a social and legal licence to operate.

KPA3 (provision for the setting of objectives) and KPA 5 (provision for evaluation of compliance) were the two poorest performing KPAs. These two KPAs are both linked to the intended outcomes of the ISO 14001:2015 standard towards the enhancement of environmental performance and play an important role towards the factors considered for continual improvement. For KPA 3 it is noteworthy that the objectives for the three case studies were not aligned with significant environmental aspects or compliance obligations as it is required by the international standard. As the standard is based on the PDCA cycle, which allows organisations to constantly improve their environmental performance, and the fact that KPA2 (provision for environmental compliance obligations) was adequately addressed demonstrates that documenting certain elements pertaining to the requirements of the standard, does not effectively address the requirements without implementation and abiding by the specified frequencies from the result of KPA 5.

4.4 Chapter conclusion

Chapter 4 presented the results related to the research aim, which was to evaluate the contribution of performance evaluation (as part of an ISO 14001: 2015 EMS) towards the enhancement of environmental performance using the mining sector as a case study. Documented EMS arrangements of three diamond mining case studies were evaluated. As mentioned in Section 1.6 of this dissertation, the purpose of this research was not to evaluate the casual link between EMS arrangements and improved environmental performance. Instead of evaluating causality, this research evaluates the extent to which the performance evaluation arrangements of the ISO 14001:2015 EMS (within a case study context) makes provision for enhanced environmental performance. Chapter 5 presents the conclusions and recommendations related to the research.

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The researched aimed to evaluate the contribution of performance evaluation (as part of an ISO 14001:2015 EMS) towards the enhancement of environmental performance using the mining sector as a case study by specifically focussing on a group of diamond mines in South Africa. The mining case study consists of three underground diamond mines falling under the same holding/group, located in three different provinces (Gauteng, Free State and Northern Cape) of South Africa. All of the mines are ISO 14001:2015 certified.

Section 5.2 outlines the conclusions related to the research aim, while Section 5.3 provides recommendations for improvement, and Section 5.4 suggests areas for future research.

5.2 Conclusions

Based on the results of analysis the aim of the research has been achieved by evaluating the contribution of performance evaluation (as part of an ISO 14001:2015 EMS) towards the enhancement of environmental performance using the mining sector as a case study. The requirements of the international EMS standard (ISO, 2015) in combination with results from literature review were used to develop eight KPAs (section 3.4.2.1) and associated KPIs (section 3.4.2.2) to evaluate the extent to which ISO 14001: 2015 EMS performance evaluation arrangements make provision for enhanced environmental performance. Document review and evaluation was employed to investigate the extent to which the documented EMS arrangements of three diamond mining case studies provide for enhanced environmental performance.

Overall, the best performing KPAs were KPA2 (provision for environmental compliance obligations) and KPA6 (provision for internal audits), while KPA 3 (provision for the setting of objectives) and KPA5 (provision for environmental compliance) were the poorest performing KPAs.

KPA 1 focussed on the provision for environmental aspect identification and evaluation. The three case studies addressed KPI 1.2 (As) and partially addressed KPI 1.1 (Bs). All three case studies identified the environmental aspects as a whole and the significant issues relating to environmental performance was not addressed at an individual, site-specific level. This finding was supported by Pretty and Odeku (2017) as well as Flemström (2003) as the various aspects of mining activities that interact with the physical environment need to be addressed. The three case studies evidently applied a review and assessment processes thereof. This leads to the

case studies not deviating from the scope of their EMS but affects the control of the aspects which they can influence.

All three case studies adequately addressed KPA2 (provision for environmental compliance obligations (As for KPI 2.1 and KPI 2.2). All of mines demonstrated documented arrangements for the identification of compliance obligations and the frequent update thereof. All of the case studies also demonstrated adequate arrangements for determining local by-laws and site-specific legal requirements. Tomsana *et al.* (2020) highlight that the delineation the geographic location eases the process and complexity of determining environmental compliance obligations, as supported by Viljoen (2022). The identification and update of compliance obligations are outsourced to a legal service provider. It is evident that outsourcing environmental-related legal services is beneficial to the three mines, as supported by Blanchard (2016).

KPA 3 (provision for objectives setting and planning) generally scored poorly, especially when considering performance against KPI 3.2. Site-specific objectives were generally not well aligned with significant aspects and compliance obligations. The findings of Almgren and Hjelm (2021) emphasised that many organisations set and adopt environmental objectives that cannot be clearly linked to environmental aspects, impacts and compliance obligations. The alignment of significant aspects and compliance obligations with environmental objectives could not be verified for the case studies to achieve the intended outcomes of the standard. This was also a challenge identified by Mosgaard *et al.* (2022).

The provision for performance monitoring and measurement (KPA 4) performed average (3 A's, 2 B's and 1 C). The study of Housni *et al.* (2021) highlighted that monitoring and measurement of environmental factors are essential towards improved environmental performance. The document evaluation verified that individual reporting of environmental performance pertaining to environmental aspects was applied and operational controls were holistically reviewed. The gaps identified on performance monitoring and measurement resulted from the lack of implementation of the group-wide monitoring and measurement arrangements, and insufficient provision for monitoring arrangements specified in site-specific licences, permits and environmental authorisations.

KPA 5 (provision for the evaluation of compliance), generally, scored poorly. While all three mines provided for arrangements to evaluate compliance (KPI 5.1), the monitoring of compliance with regulatory requirements were poorly addressed (KPI 5.2). The results concurred with the findings of Blanchard (2016) indicating that internal evaluation of compliance against regulatory and site-specific requirements are not always frequently and adequately addressed by organisations.

The provision for internal audits (KPA 6) performed well with all three of the case studies scoring As for KPI 6.1 and KPI 6.2. EMS arrangements adequately provided for frequent management system internal auditing, and arrangements for evaluating conformity with the standard's requirements were evident. As per the study of Shandu and Saluja (2023) and Nolan (2016) the case studies recognised the importance and value of internal auditing which reflected within the internal audit reports of 2021 and 2022.

KPA 7, which provided for the arrangements for frequency of management reviews as well as the closure of action items from management reviews, fared average (2 A's, 2 B's and 2 C's). While CS2 could not provide any documented evidence of the management review process, CS1 and CS3 adequately addressed KPI7.1 by providing for regular management review processes. The mines, however, did not consistently close-out all of the necessary non-compliances and non-conformances during their management review processes. Herghiligiu *et al.* (2019) emphasised that management reviews are driven by the commitment and leadership of top management which was evident from two of the three case studies. Considering the gaps identified in addressing KPI7.2, it may be linked to a lack of documented information, rather than to a lack of leadership commitment. From a group- to an organisation-specific level, leadership commitment was demonstrated through the allocation of resources, objectives and other measures.

The provision for improvement (KPA 8) were partially addressed (scoring 2 A's, 2 B's and 2 C's). While the mines provided for new initiatives, and improvement of environmental performance, the initiatives and actions implemented could not always be clearly linked to environmental objectives, aspects and impacts, or compliance obligations. The study of Choongo *et al.* (2016) indicated that the determinisation of environmental opportunities, contribute towards strategies to enhance environmental performance.

In conclusion, the research reveals a mixed performance when considering the contribution of ISO 14001:2015 EMS performance evaluation arrangements towards enhanced environmental performance in three diamond mining case studies. KPA2 (provision for environmental compliance obligations) and KPA6 (provision for internal audits) stand out as strong performers, showcasing effective identification of compliance obligations and robust internal audit processes. In contrast, KPA3 (provision for objective setting) and KPA5 (provision for the evaluation of compliance) exhibit weaknesses, struggling with aligning site-specific objectives and monitoring regulatory compliance. Notable strengths include the successful outsourcing of environmental-related legal services (KPA2), but challenges persist in aligning objectives with environmental aspects (KPA3). Management review processes (KPA7) show average performance, with leadership commitment evident in two out of three case studies. KPA8, addressing improvement initiatives, is partially addressed, emphasising the need for clearer links to environmental

objectives. The findings offer valuable insights towards improving the contribution of ISO 14001:2015 performance evaluation towards enhanced environmental performance, highlighting areas requiring attention and improvement to optimise EMS effectiveness.

Based on the findings from the research, it was evident within the literature review and analysis that the benefits of an effective EMS outweigh the criticisms against ISO 14001:2015. Thus considering the intended outcomes of enhancing environmental performance, other diamond mines can reap the rewards from the certifiable standard.

5.3 Recommendations for improvement of performance evaluation towards enhanced environmental performance

The following recommendations are made towards improving performance evaluation, based on the results of the research from the evaluation of three diamond mines' EMS documentation:

- Environmental aspects need to be considered at an organisation/site-specific level (KPI 1.1);
- Environmental objectives need to be clearly aligned with the identified significant environmental aspects and compliance obligations (KPI 3.2);
- Monitoring and measurement arrangements should address compliance obligations, such as monitoring and measurement conditions of licences, permits and environmental authorisations (KPI 4.2 and KPI 5.2);
- Arrangements for the evaluation of compliance must be set at planned intervals, and need to include site-specific compliance obligations, such as licences, permits, authorisations and the adopted needs and expectations of interested parties (KPI 5.1 and KPI 5.2);
- Actions related to non-compliances, non-conformances and opportunities towards enhanced environmental performance need to be addressed and/or closed-out during the management review process (KPI 7.2); and
- Objectives and new innovations towards enhanced environmental performances should be clearly linked to environmental objectives, compliance obligations and the results of monitoring and measurement (KPI 8.1 and KPI 8.2).

These recommendations concur with the findings of Fura (2013), Blanchard (2016), Wairon *et al.* (2018) and Mosgaard *et al.* (2022).

5.4 Areas of future research

The limitations and conclusions of the study recommends the following areas for future research:

- Due to the limited research done on the contribution of environmental performance evaluation within the context of environmental management systems. Different case

studies can be evaluated or different scope of mining as this study focussed on underground diamond mining.

- Research on certified entities may include evaluations to determine which factors have been considered to measure continual improvement as well as verifying what measures are taken to achieve the intended outcomes as a focus point of effective implementation.
- The value of management reviews can also be investigated to determine how it has contributed to effective implementation and performance evaluation.

BIBLIOGRAPHY

- Abdeljalil, A., Nabil, S. & Rachid, M. 2022. The Environmental Aspect & Impacts for Industrial Sites: Methodological Framework and Evaluation. *International Journal of Environment, Engineering and Education*, 4(1): 5-9.
- ARM (African Rainbow Minerals). 2022. *ISO 14001 delivers on ESG*. [Online] Available at: <https://www.miningreview.com/tech-news/iso-14001-delivers-on-esg/> [Accessed 15 December 2022].
- Agboola, O., Babatunde, D.E. & Mamudu, O.A. 2020. A review on the impact of mining operation: Monitoring, assessment and management. *Results in Engineering*, 8(1): 1-19.
- Ahmed, A. 2008. *Ontological, Epistemological and Methodological Assumptions: Qualitative Versus Quantitative*, Exeter: University of Exeter.
- Akinci, M. & Kose, E. 2022. A Meta-Evaluation Research on Teacher Training Programs in Turkey. *International Journal of Progressive Education*, 18(4): 209-219.
- Albertini, E. 2016. Environmental Performance. In: E. C. Carroll, ed. *Encyclopedia of Corporate Reputation*. Paris: SAGE Publications, 275-281.
- Alberts, R. C., Retief, F. P., Cilliers, D. P., Roos, C. & Hauptfleisch, M. 2021. Environmental impact assessment (EIA) effectiveness in protected areas. *Impact Assessment and Project Appraisal*, 39(4): 290-303.
- Alberts, R.C., Retief, F.P., Roos, C., Gillars, D.P., Moolman, J., Bowers, J., MacGregor, S., Weir, F.H. & Olivier, I. 2022. Beyond legal compliance: The environmental performance of luxury safari lodges. *African Journal of Hospitality, Tourism and Leisure*, 11(2): 710-726.
- Allur, E., Boiral, O. & Testa, F. 2018. Quality and Environmental Management Linkage: A Review of the Literature. *Sustainability*, 10(4311): 1-15.
- Almgren, R. & Hjelm, O. 2021. Implementation of General Sustainability Objectives as Tools to Improve the Environmental Performance of Industry. *Sustainability*, 13(8144): 1-16.
- AMIQ (Africa Mining IQ). 2023. [Online] Available at: <https://projectsiq.co.za/mines-in-south-africa> [Accessed 21 May 2023].

- Amoatey, P. & Bani, R. 2011. Wastewater Management. In: F. Sebastián García Einschlag & G. Einschlag, eds. *Waste Water - Evaluation and Management*. Accra: InTech, 379-398.
- Anandagir, N.K., Nowo, M.D. & Syahnoedi, H.U. 2021. Opportunity and Risk Adaptation in Environmental Management System. *Earth and Environmental Science*, 940(1): 1-6.
- Angelakoglou, K. & Gaidajis, G. 2020. A Conceptual Framework to Evaluate the Environmental Sustainability Performance of Mining Industrial Facilities. *Sustainability*, 12: 1-20.
- Anglo America. 2019. Digging deeper: Mining methods explained. [Online] Available at: <https://www.angloamerican.com/futuresmart/stories/our-industry/mining-explained/digging-deeper-mining-methods-explained> [Accessed 21 May 2023].
- Anon. 2017. *European Accreditation*. [Online] Available at: <https://european-accreditation.org/wp-content/uploads/2018/10/ea-7-04-m-rev03-may-2017-2.pdf> [Accessed 03 September 2022]
- Avenant, D. 2020. *Eversheds Sutherland*. [Online] Available at: <https://www.eversheds-sutherland.com/global/en/what/articles/index.page?ArticleID=en/global/South-africa/Environmental-Legal-Compliance-Auditing-What-is-it-and-do-I-need-to-do-it> [Accessed 21 May 2022].
- Awolusi, D., Mbonigaba, J. & Tipoy, C.K. 2018. Mineral resources endowment and economic growth in Southern African countries. *International Journal Diplomacy and Economy*, 4(1): 59-75.
- Aspers, P. & Corte, U. 2019. What is Qualitative in Qualitative Research. *Qualitative Sociology*, 42(2): 139–160.
- Assan, J.K. & Muhammed, A.R. 2018. The impact of mining on farming as a livelihood strategy and its implications for poverty reduction and household well-being in Ghana. *International Journal of Development and Sustainability*, 7(1): 1-20.
- Baierl, T.M., Kaiser, F.G. & Bogner, F.X. 2021. The supportive role of environmental attitude for learning about environmental issues. *Journal of Environmental Psychology*, 81(1): 1-11.
- Benidire, L., Benidire, L. & Boularbah, A. 2020. Impacts of mining activities on soil properties: case studies from Morocco mine sites. *Soil Science Annual*, 71(4): 395-407.
- Blinova, E. S. & Ponomarenko, T.V. 2020. Assessment of the environmental aspect of. *SHS Web of Conferences*, 89(1): 1-8.

- Briggs , L.K. 2017. ISO 14001:2015 Environmental management systems. *A practical guide for SMEs*. https://www.iso.org/files/live/sites/isoorg/files/store/en/iso_14001_guide_preview.
- Biswas, P. 2019. *ISO 14001:2015 Clause 7.5 Documented Information*, s.l.: Pretesh Biswas.
- Blanchard, A. 2016. How can outsourcing environmental services benefit your business?. [Online] Available at: <https://emsen.com/2016/09/26/reasons-outsource-environmental-services/> [Accessed 12 October 2023].
- Boiral, O. & Henri, J.F. 2012. Modelling the impact of ISO 14001 on environmental performance: A comparative approach. *Journal of Environmental Management*, 99(1): 84-97.
- Borsky, S. & Leither, S. M. 2022. International trade in rough diamonds and the Kimberley Process Certification Scheme. *World Development*, 152.
- Bowen, G. A. 2009. Document Analysis as a Qualitative Research Method. *Qualitative Research Journal*, 9(2): 27-40.
- Bravi, L. & Santos, G. 2020. Environmental management system according to ISO 14001:2015 as a driver to sustainable development. *Corporate Social Responsibility and Environmental Management*, 27(6): 2599-2614.
- Brunnhuber, K., Caliska, D. & Juhl, C. 2020. What Evidence-Based Research is and why is it important?. *Journal of Clinical Epidemiology*, 129(3): 10-16.
- Cacciattolo, M. 2015. Ethical Considerations in Research. In: *The Praxis of English Language Teaching and Learning*. s.l.:Sense Publishers, 55-73.
- Cain, J., Medina, M. & Romanelli, F. 2022. Deficiencies of Traditional Grading Systems and Recommendations for the Future. *American Journal of Pharmaceutical Education*, 86(7): 908-915.
- Camilleri, M.A. 2022. The rationale for ISO 14001 certification: A systematic review and a cost-benefit analysis. *Corporate Social Responsibility and Environmental Management* , 29(4): 1067-1083.
- Campos, L.M., de Melo Heinzen, D.A. & Verdinelli, M.A. 2015. Environmental performance indicators: a study on ISO 14001 certified companies. *Journal of Cleaner Production*, 99(1): 286-296.

- Cardno, C. 2018. Policy Document Analysis: A Practical Educational Leadership Tool and a Qualitative Research Method. *Educational Administration: Theory and Practice*, 24(4): 623-640.
- Carrillo-Labela, R., Fort, F. & Parras-Rosa, M. 2020. Motives, Barriers, and Expected Benefits of ISO 14001. *Sustainability*, 12(5): 1-17.
- Casey, J.P. 2019. *Mining Technology*. [Online] Available at: <https://www.mining-technology.com/analysis/history-of-mining-in-south-africa/> [Accessed 16 May 2022]
- Choongo, P., Van Burg, E. & Masurel, E. 2016. Factors Influencing the Identification of Sustainable Opportunities by SMEs: Empirical Evidence from Zambia. *Sustainability*, 8(81): 2-24.
- Claassens, C.E., Cilliers, D.P., Retief, F.P., Roos, C. & Alberts, R.C. 2022. The consideration of waste management in environmental impact assessment (EIA) for developments in protected areas. *Impact Assessment and Project Appraisal*, 40(4): 320-330.
- Creswell, J. & Clark, V. 2017. *Designing and conducting mixed methods research*. 2nd ed. Nebraska: SAGE Publications.
- Da Fonseca, L.M.C.M. 2015. ISO 14001:2015: An Improved Tool for Sustainability. *Journal of Industrial Engineering and Management*, 8(1): 37-50
- Daniel, E. 2016. The Usefulness of Qualitative and Quantitative Approaches and Methods in Researching Problem-Solving Ability in Science Education Curriculum. *Journal of Education and Practice*, 7(15): 91-100.
- Danthurebandara, M., Van Acker, K. & Van Passel, S. 2012. Environmental and socio-economic impacts of landfills. In: *International conference on natural sciences and environmental technologies for waste and wastewater treatment remediation emissions related to climate environmental and economic effects*. Kalmar, Sweden: Linnaeus University, 40-52.
- Davids, A.F. 2020. Compliance and enforcement: The Legal Suitability of the Utilisation of Criminal Sanctions in South African Environmental Law. *Masters degree in Public Law and Jurisprudence at University of the Western Cape*, 9-72.
- DEA (Department of Environmental Affairs). 1998. National Environmental Management Act 107 of 1998. Republic of South Africa. Pretoria.

- DEA (Department of Environmental Affairs). 2004. National Environmental Management: Air Quality Act 39 of 2004. Republic of South Africa. Pretoria.
- DEA (Department of Environmental Affairs). 2004. National Environmental Management: Biodiversity Act 10 of 2004. Republic of South Africa. Pretoria.
- DEA (Department of Environmental Affairs). 2008. National Environmental Management: Waste Act 59 of 2008. Republic of South Africa. Pretoria.
- DEA (Department of Environmental Affairs). 2013. National Environmental Management: Air Quality Act 39 of 2004. *GNR 827 National Dust Control Regulations*. Republic of South Africa. Pretoria.
- DEA (Department of Environmental Affairs). 2017. National Environmental Management Act 107 of 1998. *GNR 326 Amendments to the Environmental Impact Assessment Regulation, 2014*. Republic of South Africa. Pretoria.
- DEA (Department of Environmental Affairs). 2019. Carbon Tax Act 15 of 2019. Republic of South Africa. Pretoria.
- DEA (Department of Environmental Affairs). 2020. National Environmental Management: Biodiversity Act 10 of 2004. *GNR 1020 Alien and Invasive Species Regulations*. Republic of South Africa. Pretoria.
- DEFF (Department of Environment, Forestry and Fisheries). 2020. *National Waste Management Strategy 2020*. Cape Town, South Africa.
- DMRE (Department of Mineral Resources and Energy). 2002. Minerals and Petroleum Resources Development Act 28 of 2002. Republic of South Africa. Pretoria.
- Dupendant, J. 2016. The Case of the International Organization for Standardization (ISO). *International Regulatory Co-operation and International*. https://www.oecd.org/gov/regulatory-policy/ISO_Full-Report.
- Donnenfeld, Z., Crookes, C. & Hedden, S. 2018. A delicate balance: Water scarcity in South Africa. *Southern Africa Report*, 13(1): 1-19.
- Doorasamy, M. 2015. Benchmarking: business strategy to improve environmental performance. *Investment Management and Financial Innovations*, 12(2): 214-229.

- Dorcak, P., Markovic, P. & Svetozarovova, N. 2017. Key Performance Indicators in the Process of Performance Evaluation Selected Approaches. *International Journal of System Modeling and Simulation*, 2(4): 17-20.
- Dougall, A.W. & Mmola, T.M. 2015. Identification of key performance areas in the southern African surface mining delivery environment. *The Journal of Southern African Institute of Mining and Metallurgy*, 115: 1001-1006.
- Doyle, L., Brady, A. & Byrne, G. 2009. An overview of mixed methods research. *Journal of Research in Nursing*, 14(1): 175-185.
- DWS (Department of Water and Sanitation). 1998. National Water Act 36 of 1998. Republic of South Africa. Pretoria: Department of Water and Sanitation.
- Dzomonda, O. & Fatoki, O. 2020. Environmental Sustainability Commitment and Financial Performance of Firms Listed on Johannesburg Stock Exchange (JSE). *International Journal of Environmental Research and Public Health*, 17(1): 1-21.
- Edwards, E. 2016. *The Edwards Deming Institute*. [Online] Available at: <https://deming.org/explore/pdsa/> [Accessed 16 December 2022].
- Emmanuel, A.Y., Jerry, C.S. & Dzigbodi, D.A. 2018. Review of environmental and health impacts of mining in Ghana. *Journal of Health and Pollution*, 8(17): 43.
- Erhabor, N.I. & Don, J.U. 2016. Impact of Environmental Education On the Knowledge and Attitude of Students Towards the Environment. *International Journal of Environmental and Science Education*, 11(12): 5367-5375.
- Fahlén, J. & Langell, A. 2014. Internal Quality Audits as an Improvement Tool. *Master Thesis LIU-IEI-TEL-A—14/01983—SE at Linköping University*, 45-56.
- Faure, M. 2022. Economic approaches to environmental governance: a principled analysis.. In: D. Fisher, ed. *Fundamental Concepts of Environmental Law*. Queensland, Australia: Edward Elgar Publishing, 94-122.
- Fitzmaurice, M. 2018. Environmental Compliance Control. *Wroclaw Review of Law Administration & Economics*, 8(2): 373-392.
- Flemström, K. 2003. Definition of relevant. *Demomstrate and Assess New Tools for Environmental Sustainability*, 1(1): 5-20.

- Fonseca, L.M. & Domingues, J.P. 2018. Exploratory Research of ISO 14001:2015 Transition among Portuguese Organizations. *Sustainability*, 10(781): 1-16.
- Fura, B. 2013. Improving ISO 14001 Environmental Management Systems. *Polish Journal of Environmental Studies*, 22(6): 1711-1721.
- Garrido, E., González, C. & Orcos, R. 2019. ISO 14001 and CO2 emissions: An analysis of the contingent role of country features. *Business Strategy and the Environment*, 29(2): 698-710.
- Gilsbach, L., Schütte, P. & Franken, G. 2019. Applying water risk assessment methods in mining: Current challenges and opportunities. *Water Resources and Industry*, 22(1): 100-118.
- Gutterman, A.S. 2023. *Compliance Audits*. [Online] Available at: <https://dx.doi.org/10.2139/ssrn.4522678> [Accessed 09 November 2023].
- Haggard, E.L., Sheridan, C.M. & Harding, K.G. 2015. Quantification of water usage at a South African platinum processing plant. *Water SA*, 41(2): 279-286.
- Hakim, W. & Yunus, A. 2017. Environmental audit as instrument for environmental protection and management. *The Business and Management Review*, 9(2): 228-232.
- Hamann, R., Hönke, J. & O'Riordan, T. 2018. Environmental and Natural Resources. In: A. Draude, T. A. Börzel & T. Risse, eds. *The Oxford Handbook of Governance and Limited Statehood*. Oxford: Oxford University Press, 498-519.
- Hammer, M. 2014. *Advisera*. [Online] Available at: <https://advisera.com/14001academy/knowledgebase/how-to-use-good-environmental-objectives/> [Accessed 30 August 2023].
- Hammer, M. 2016. How to achieve continual improvement of your EMS according to ISO 14001:2015. *ISO 14001 Blog*, 22 February.
- Hammerl, M. & Hörmann, S. 2016. EMAS & Biodiversity: How to address biodiversity protection through environmental management systems. Germany, Lake Constance Foundation (LCF) and Global Nature Fund (GNF).
- Haradhan, M. 2018. Qualitative Research Methodology in Social Sciences and Related Subjects. *Journal of Economic Development, Environment and People*, 7(1): 23-48.
- Harling, K. 2012. An Overview of Case Study. *SSRN Electronic Journal*, 1(1): 1-7.

- Hasan, M.T. & Huq, M.M. 2010. Quantification of Qualitative Parameters for Performance Appraisal: A Case Study. *ASA University Review*, 4(2): 39-48.
- Hayter, R. & Patchell, K. 2017. Resources and Development. *The International Encyclopedia of Geography*, 1-13. DOI: 10.1002/9781118786352.wbieg0959
- Herghiligi, I.V., Pislariu, M. & Vilcu, A. 2019. Sustainable Environmental Management System Integration and Business Performance: A Balance Assessment Approach Using Fuzzy Logic. *Sustainability*, 11(1): 1-20.
- Hiwase, P. D. & Hajare, H. V. 2018. Review of Environmental Assessment Methods. *International Journal Research in Engineering, Science and Technologies*, 3(4): 7-10.
- Ho, L.L. & Law, P.L. 2015. Impact of Implementation of ISO 14001 Environmental Management Systems on Environmental Performance: A Case Study. *International Journal of Engineering Research and Science & Technology*, 4(1): 1
- Hodge, R. A., Ericsson, M. & Löf, O. 2022. The global mining industry: corporate profile, complexity, and change. *Mineral Economics*, 35(1): 587–606.
- Housni, F., Maurady, A. & Boumane, A. 2021. Indicators for monitoring and assessment of environmental management systems in ports. *EDP Sciences*, 234(55): 1-4.
- IAF (International Accreditation Forum). 2018. IAF Mandatory Document for the Audit and Certification of a Management System Operated by a Multi-Site Organization. *IAF MD 1:2018, Issue 2*.
- IAF (International Accreditation Forum). 2021. *Accredited Certification and the Supply Chain*. [Online] Available at: <https://stage.iaf.nu/en/news/accredited-certification-and-the-supply-chain/> [Accessed 7 August 2023].
- Ibrahim, M. 2015. The art of Data Analysis. *Journal of Allied Health Sciences*, 1(1): 98-104.
- ISO. International Organization for Standardization. 2021. *ISO Online Browsing Platform*. [Online] Available at: <https://www.iso.org/obp/ui/#iso:std:iso:14031:ed-3:v1:en> [Accessed 7 July 2022].
- ISO. International Organization for Standardization. 2015. Environmental management systems - Requirements with guidance for use. *Copyright protected: D. du Toit for South African Certification and Auditing Services (SACAS)*. ISBN 978-0-626-32761-3.

- ISO. International Organization for Standardization. 2018. Guidelines for auditing management systems. <https://synergia.org/wp-content/uploads/2021/02/ISO-19011-2018-Pedomannya-Audit-Sistem-Manajemen-EN.pdf>
- Johnstone, L. 2020. The construction of environmental performance in ISO 14001- certified SMEs. *Journal of Cleaner Production*, 263(1): 1-11.
- Johnstone, L. & Hallberg, P. 2020. ISO 14001 adoption and environmental performance in small to medium sized enterprises. *Journal of Environmental Management*, 266(1): 1-11.
- Joseph, M.S., Yann, L. & Michael, S. 2021. Understanding and monitoring environmental performance of infrastructure design projects. *International Conference of Engineering Design*, 1(1): 3269-3277.
- Kalyar, M.N., Shoukat, A. & Shafique, I. 2019. Enhancing firms' environmental performance and financial performance through green supply chain management practices and institutional pressures. *Sustainability Accounting, Management and Policy Journal*, 10(1108): 1-13.
- Kameswaran, S., Gunavathi, Y. & Gopi Krishna, P. 2019. Dust pollution and its influence on vegetation - a critical analysis. *Research Journal of Life Sciences, Bioinformatics, Pharmaceutical and Chemical Sciences*, 5(1): 341-363.
- Kapuka, A. & Hlasny, T. 2021. Climate change impacts on ecosystems and adaptation options in nine countries in southern Africa: What do we know?. *Socio-Ecological Systems*, 12(12): 1-20.
- King, N.D., Strydom, H.A. & Retief, F.P. 2018. The concept 'environmental management'. In: N.D. King, H.A. Strydom & F.P. Retief, eds. *Environmental Management in South Africa*. Cape Town: JUTA, 12-31
- Kirschke, S. & Newig, J. 2017. Addressing Complexity in Environmental Management and Governance. *Sustainability*, 9(6): 983.
- Kowalska, I. J. 2014. Risk management in the hard coal mining industry: Social and environmental aspects of collieries' liquidation. *Resources Policy*, 41(1): 124-134.
- Labudin, B., Skripnichenko, V. & Titova, . 2019. Financial and legal mechanisms of newly industrialized mining: Case study of diamond mining sector. *Advances in Social Science, Education and Humanities Research*, 240(2): 188-190.

- Lee, N. & Colley, R. 1991. *Reviewing the Quality of Environmental Statements* , Manchester: University of Manchester.
- Lee, K. H., Park, P. J. & Yook, K. H. 2017. The Value Relevance of Environmental Audits: Evidence from Japan. *Business Strategy and the Environment*, 26(5): 609-625.
- Lellis, C. 2017. ISO 14001:2015 Revision: What You Should Know to Stay Competitive. *Corporate Sustainability, ISO 14001*, 20 July.
- Leonard, L. 2018. Mining Corporations, Democratic Meddling, and Environmental Justice in South Africa. *Social Sciences*, 7(259): 1-17.
- Lira, J.M., Salgado, E.G. & Beijo, L.A. 2021. Shedding light on the diffusion of ISO 14001 across Africa, Asia and Oceania. *Journal of Cleaner Production*, 289(1): 1-17.
- Lo-lacono-Ferreira, V.G., Capuz-Rizo, S.F. & Torregrosa-López, J.I. 2018. Key Performance Indicators to optimize the environmental performance of Higher Education Institutions with environmental management system – A case study of Universitat Politècnica de València. *Journal of Cleaner Production*, 178(1): 846-865.
- Lowry, J.B., Narayan, M. & Evan, K.G. 2019. Understanding post-mining landforms: Utilising pre-mine geomorphology to improve rehabilitation outcomes. *Geomorphology*, 328(1): 93-107.
- Mahdawi, S.M., Ayedh, A.M. & Khairi, K.F. 2018. Effectiveness of Internal Audit. *International Journal of Science and Research*, 7(1): 1797-1802.
- Maliwatu, E. 2018. ISO 14001:2015 - Understanding context with related risks and opportunities – A South African construction industry perspective. *Mini-dissertation submitted in partial fulfilment of the requirements for the degree Masters in Environmental Management at the North-West University*. 47-64.
- Martins, F. & Fonseca, L. 2018. Comparison between eco-management and audit scheme and ISO 14001:2015. *Energy Procedia*, 153(1): 450-454.
- Mathew, C. 2014. Introducing Key Performance Indicators: Perspective of Higher Education Performance Monitoring and Evaluation in Nigeria. *Journal of Education and Practice*, 5(29): 130-136.
- Martlhare, W. 2020. A review of the ISO 14001:2015 in the South African mining sector. *Project: Environmental Management Systems ISO 14001*, 1(1): 7-8

- McKechnie, W.F. 2019. Diamond exploration and mining in Southern Africa: some thoughts on past, current, and possible future trends. *The Journal of Southern African Institute of Mining and Metallurgy*, 19(1): 123-131.
- Miles, D.A. and Scott, L. 2017. Workshop: Confessions of a Dissertation Chair Part 1: The Six Mistakes Doctoral Students Make With the Dissertation. *Presented at the 5th Annual 2017 Black Doctoral Network Conference in Atlanta, GA on October 26-29 2017.*
- Miles, M.B., Huberman, A. M. & Saldaña, J. 2020. Qualitative Data Analysis . In: *Designing Matrix and Network Displays*. Washington DC: SAGE, 107-119.
- Mngoma, W., Pillay, P. & Reddy, P.S. 2011. Environmental Governance at the Local Government Sphere in South Africa. *African Journal of Public Affairs*, 4(2): 105-117.
- Mohajan, H.K. 2020. Quantitative Research: A Successful Investigation in Natural and Social Sciences. *Journal of Economic Development, Environment and People*, 9(4): 50-79.
- Mosgaard, M.A., Bundgaard, A.M. & Kristensen, H.S. 2022. ISO 14001 practices – A study of environmental objectives in Danish organizations. *Journal of Cleaner Production*, 331: 1-14.
- Mungai, E.M., Ndiritu, S.W. & Rajwani, T. 2020. Do voluntary environmental management systems improve environmental performance? Evidence from waste management by Kenyan firms. *Journal of Cleaner Production*, 265(1): 1-11.
- Natalia, L., Lomba, L. & Giner, B. 2019. Green Chemistry and Environmental Management Systems: Relationships, Synergies, Advantages and Barriers of Joint Implementation at Universities. *Environmental Management*, 64(2): 1-11.
- Nawrocka, D., Brorson, T. & Lindqvist, T. 2009. ISO 14001 in environmental supply chain practices. *Journal of Cleaner Production*, 17(16): 1435-1443.
- Nichols, E.S. & Natsoulis, T. 2016. The Importance of Non-Disclosure Agreements in Real Estate Transactions. *The Real Estate Finance Journal*, 1(1): 65-70.
- Ningbo, Z., Changyou, L. & Mengsong, P. 2015. Effects of caving–mining ratio on the coal and waste rocks gangue flows and the amount of cyclically caved coal in fully mechanized mining of super-thick coal seams. *International Journal of Mining Science and Technology*, 25(1): 145-150.

- Nel, J.G. & Kotze, L.J. 2009. Environmental Management: An Introduction. In: *Environmental Management in South Africa*. 1-33
- Nolan, J., 2016. Advisera. [Online] Available at: <https://advisera.com/14001academy/blog/2016/07/04/what-competences-should-an-iso-14001-internal-auditor-have/> [Accessed 12 November 2023].
- NWU (North-West University), 2023. *North West University*. [Online] Available at: <https://services.nwu.ac.za/research-support/research-ethics> [Accessed 25 September 2022].
- Okarma, K., Lech, P. & Andriukaitis, D., 2022. A Visual Feedback for Water-Flow Monitoring in Recirculating Aquaculture Systems. *Applied Science*, 12(1): 1-14.
- Okello, N.O., Camminga, S. & Zunckel, M. 2018. Spatial and Temporal Trends of PM₁₀ and SO₂ in the Richards Bay Area. *Clean Air Journal*, 8(2): 1-10.
- Oluleye, G. 2021. Environmental Impacts of Mined Diamonds. *London, Centre for Environmental Policy*, Imperial College London.
- Paluchamy, B., Mishra, D.P. & Panigrahi, D C. 2021. Airborne respirable dust in fully mechanised underground metalliferous mines – Generation, health impacts and control measures for cleaner production. *Journal of Cleaner Production*, 3(5) 1-19.
- Piek, B. 2019. Evaluating the effectiveness of non-conformance reporting systems of ISO 14001 certification auditing in South Africa: A certification body's perspective. *Mini-dissertation submitted in partial fulfilment of the requirements for the degree Master of Environmental Management at the North-West University*. 13-19.
- PMG (Parliamentary Monitoring Group). 2018. *Parliamentary Monitoring Group*. [Online] Available at: <https://pmg.org.za/committee-meeting/27487/> [Accessed 20 February 2023].
- Pokorná, P., Hovorka, J. & Brejcha, J. 2016. Impact of Mining Activities on the Air Quality in The Village Nearby a Coal Strip Mine. *Earth and Environmental Science*, 44(1): 1-4.
- Pretty, M.M. & Odeku, K.O. 2017. Harmful mining activities, environmental impacts and effects in the mining communities in South Africa: a critical perspective. *Environmental Economic*, 8(4): 14-21.
- Rahmat, R.F., Satria, I.S. & Siregar, B. 2017. Water Pipeline Monitoring and Leak Detection using Flow Liquid Meter Sensor. *Materials Science and Engineering*, 190(1): 1-6.

- Realyvásquez-Vargas, A., Arrendondo-Soto, K.C. & Ravelo, G. 2018. Applying the Plan-Do-Check-Act (PDCA) Cycle to Reduce the Defects in the Manufacturing Industry. A Case Study. *Applied Sciences*, 8(11): 2181.
- Rohov, H., Prykhodko, S. & Kolodiziev, O. 2021. Factors of national environmental performance in sustainability management aspect. *Problems and Perspectives in Management*, 19(3): 70-84.
- Roudgarmi, P. 2011. Qualitative research for environmental sciences: A review. *Journal of Food, Agriculture & Environment*, 9(4): 871-879.
- RSA (Republic of South Africa). 1996. The Constitution of South Africa. *The Bill of Rights*. Republic of South Africa. Pretoria.
- Salca Rotaru, C.M. 2019. The environmental management system between freedom of will and legal imperative. *Law Review*, 10(2): 192-201.
- Sandham, L.A., Huysamen, C., Retief, F.P., Morrison-Saunders, A., Bond, A.J. & Pope, J. 2020. Evaluating Environmental Impact Assessment report quality in South African national parks. *KOEDOE - African Protected Area Conservation and Science*, 62(1): 1-9.
- Sandham, L. A. & Pretorius, H. M. 2008. A review of EIA report quality in the North West province of South Africa. *Environmental Impact Assessment Review*, 28(5): 229-240.
- Sayre, D. 2018. Why mining companies should obtain ISO 14001 certification. [Online] Available at: <https://advisera.com/14001academy/blog/2018/04/17/why-mining-companies-should-obtain-iso-14001-certification/> [Accessed 17 April 2023].
- Seeger, M.W., Islam, K. & Seeger, H.S. 2021. Emergency Preparedness, Response, and Strategic Communication for Natural Disasters. In: C. H. Botan, ed. *The Handbook of Strategic Communication*. Purdue: John Wiley & Sons, Inc.: 206-220.
- Seloa, P.I. & Ngole-Jeme, V.M. 2022. Community Perceptions on Environmental and Social Impacts of Mining in Limpopo South Africa and the Implications on Corporate Social Responsibility. *Journl of Integratve Environmental Sciences*, 19(1): 189–207.
- Shamaileh, A.Y. 2015. An evaluation of the effectiveness of environmental policy of Jordan. *Journal of Governance and Regulation*, 4(3): 138-159.
- Shandu, N. & Saluja, S. 2023. Fraud Triangle as an Audit Tool. *Management and Labour Studies*, 48(3): 418-443.

- Sibanda, L.K. & Broadhurst, J.L. 2018. Exploring an alternative approach to mine waste management in the South African gold sector of the article. *MWD Conference – “Risk to Opportunity”*, 1(1): 1130-1134.
- Sileyew, K.J. 2019. Research Design and Methodology. *Text Mining - Analysis, Programming and Application*, 7(1): 1-12.
- Smit, N.P. 2020. Environmental legal compliance through self-regulation in the petrochemical industry in South Africa. *Mini-dissertation accepted in partial fulfilment of the requirements for the degree Master of Laws in Environmental Law and Governance at the North-West University*. 51-57.
- Sordello, R., De Lachapelle, F.F. & Livoreil, B. 2019. Evidence of the environmental impact of noise pollution on biodiversity: a systematic map protocol. *Environmental Evidence*, 8(8): 1-7.
- Sorooshian, S. & Yee, L.S. 2019. Demotivating factors affecting the implementation of ISO 14001:2015 in Malaysia. *Environmental Quality Management*, 1-11. DOI: 10.1002/tqem.21664
- Stojanovic, S. 2015. *Advisera*. [Online] Available at: <https://advisera.com/14001academy/blog/2015/07/06/environmental-performance-evaluation/> [Accessed 21 March 2023].
- Stojanovic, S. 2016. *ISO 14001 Blog*. [Online] Available at: <https://advisera.com/14001academy/blog/2016/11/07/7-steps-in-handling-waste-according-to-iso-14001/> [Accessed 22 03 2022].
- Sungur, A., Vural, A. & Gundogdu, A. 2020. Effect of antimonite mineralization area on heavy metal contents and geochemical fractions of agricultural soils in Gümüşhane Province, Turkey. *Catena*, 184(1): 2-10.
- Svartson, H. 2017. An investigation of what the changes in ISO 14001:2015 mean from an organisational perspective. Uppsala: Uppsala University.
- Swain, J. & King, B. 2022. Using Informal Conversations in Qualitative Research. *International Journal of Qualitative Methods*, 21(1): 1-10.

- Switzer, J., Ehrenfeld, J. & Milledge, M. 2021. ISO 14001 and Environmental Performance: The Management Goal Link. *Final Draft for Technology, Business and Environment Program at the University of Massachusetts-Boston*, 1-9.
- Szoke, J. I. 2021. ISO 14001 EMS in the renewable energy sector: Practices and perceptions in South Africa. *Dissertation accepted in partial fulfilment of the requirements for the degree Master of Environmental Management at the North West University*, 12-20.
- Taherdoost, H. 2022. What are Different Research Approaches? Comprehensive Review of Qualitative, Quantitative, and Mixed Method Research, Their Applications, Types, and Limitations. *Journal of Management Science & Engineering Research*, 5(1): 53-63.
- Taza-Asaba, J. 2013. Environmental Monitoring and Compliance Methodology: Developed through Lessons Learnt from Oil & Gas Companies in Cameroon. Alberta, Canada, *International Association for Impact Assessment*.
- Terblanche, K., Mander, N.D. & Douwes, E. 2013. *General Invasive Alien Plant Control: Insight into Best Practice, Removal Methods, Training & Equipment*. 1 ed. Durban: EThekweni Municipality.
- Tomsana, A., Itoba-Tombo, E. F. & Human, I. S. 2020. An analysis of environmental obligations and liabilities of an electricity distribution company to improve sustainable development. *SN Applied Sciences*, 2(1648): 1-18.
- Tomšič, N., Bojnec, S. & Simčič, B. 2015. Corporate sustainability and economic performance in small and medium sized enterprises. *Journal of Cleaner Production*, 108(10): 603-612.
- Tsoku, L.M. 2022. Biodiversity offsets: Investigating the perceived benefits for conservation in South Africa. *Dissertation accepted in partial fulfilment of the requirements for the degree Master of Environmental Management at the North-West University*. 29-57.
- UNEP (United Nations Environment Programme). 2016. Regional Assessment for Africa. *GEO-6: Global Environment Outlook*, Nairobi, Kenya. 215p.
- Usmani, F., 2022. *PM Study Circle*. [Online] Available at: <https://pmstudycircle.com/key-performance-area-kpa/> [Accessed 25 September 2023].
- Van Schalkwyk, E. 2012. How can the quality of South African Environmental Management Programmes be determined? *Mini-dissertation submitted in partial fulfilment of the*

requirements for the degree Masters in Environmental Management at the Potchefstroom Campus of the North-West University. 10-40.

- Velimirović, D., Velimirović, M. & Stanković, R. 2011. Role and importance of key performance indicators measurement. *Serbian Journal of Management*, 6(1): 63-72.
- Venter, P. 2019. *ISO 14001:2015 Simplified. (Clause 9.0 Performance evaluation)*. [Online] Available at: <https://www.isoqar.co.za/post/iso-14001-2015-simplified-clause-9-0-performance-evaluation> [Accessed 2 April 2023].
- Viljoen, M. 2022. Opinion: Environmental law in South Africa – a complex and evolving set of requirements. *Inlexso*, 7 June, 1-3.
- Vílchez, F.V. 2017. The dark side of ISO 14001: The symbolic environmental behavior. *European Research on Management and Business Economics*, 23(1): 33-39.
- Virah-Sawmy, M., Ebeling, E. & Taplin, R. 2014. Mining and biodiversity offsets: A transparent and science-based approach to measure “no-net-loss”. *Journal of Environmental Management*, 143(1): 61-70.
- Wairon, E. Purwanggono, B. & Handayani, N.U. 2018. Analysis of ISO 14001 implementation and program performance assessment ratings company (PROPER) environmental management in Power Plants with gap analysis tools. *SHS Web of Conferences*, 49(1): 1-9.
- Waxin, M., Knuteson, S.L. & Bartholomew, A. 2019. Outcomes and Key Factors of Success for ISO 14001 Certification: Evidence from an Emerging Arab Gulf Country. *Sustainability*, 12(258): 2-17.
- Wilson, M.J. 2019. The importance of parent material in soil classification: A review in a historical context. *Catena*, 182(1): 104-131.
- Winter, E.M. 2012. Calibration and verification of instruments. *Journal of Sports Sciences*, 30(12): 1197–1198.
- Woollatt, G. 2015. Quality Assurance of Continuous Emission Monitoring Systems: A practitioner’s guide/technical report. *The Clean Air Journal*, 25(2): 36-41.

- Xu, D., Li, W. & Dong, L. 2020. A composite life cycle sustainability index for sustainability prioritization of industrial systems. In: J. Ren & S. Toniolo, eds. *Life Cycle Sustainability Assessment for Decision-Making*. s.l.:Elsevier, 225-252.
- Yusuf, M. 2021. Mining and its Effects on Climate Change. *Aspects in Mining and Mineral Science*, 7(3): 817-818.
- Zarzycka, E. & Krasodomska, J. 2021. Environmental key performance indicators: the role of regulations and stakeholder influence. *Environment Systems and Decisions*, 41(1): 651–666.
- Zhang, C., Liu, D. & Rong, P. 2017. Selection of Greenhouse gases Monitoring Instrument channels for CO₂ in near infrared band. *Optik*, 144(1): 597-602.