

Identifying the factors contributing to the high rate of fatalities in South African mines

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ABSTRACT

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The South African mining industry continues to experience an alarmingly high rate of fatalities, despite regulatory frameworks such as the Mine Health and Safety Act (MHSA). Persistent accidents raise concerns regarding the effectiveness of safety practices within the sector. This study aims to identify the underlying factors contributing to mining fatalities in South Africa and to propose actionable recommendations for improving occupational health and safety (OHS) practices. The research was conducted across various South African mines, specifically Northern Cape, targeting both operational workers and managerial personnel involved in health and safety functions. The researcher, as part of Northern Cape Mine Manager's Association (NCMMA) Safety, Health, and Environment (SHE) workstream, was tasked to investigate the cause of fatalities that happened in the mining industry from 2018 to 2022. A mixed-methods approach was employed using a sequential exploratory design. The qualitative phase consisted of semi-structured interviews to uncover in-depth perspectives on OHS challenges, followed by a quantitative survey administered to a larger sample to validate and generalize the findings. Data were analysed thematically and statistically. The findings revealed that human error, insufficient safety equipment, ineffective communication, and lack of management commitment are critical contributors to mining fatalities. Participants emphasized the need for continuous training, strong leadership, and a proactive safety culture. Quantitative data supported these views, with high agreement on the importance of resource availability and safety-oriented management. Improving mining safety requires a multifaceted strategy that addresses both human and systemic factors. The research underscores the necessity of fostering a safety-first organizational culture. The study recommends enhancing training programs, increasing investment in safety resources, promoting leadership accountability, establishing clearer communication frameworks, and conducting regular safety audits through empowered committees.

Keywords: Occupational Health and Safety (OHS); Mining industry; Workplace safety; Organizational culture; South Africa.

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1. Introduction

The South African mining industry, historically central to the country's economy, remains one of the most hazardous sectors globally. Despite numerous safety initiatives and legislative frameworks, mining operations continue to pose serious risks to worker health and well-being. Fatalities from occupational incidents - ranging from rock falls and transport accidents to toxic gas exposure and machinery-related injuries - remain alarmingly high (Gnoni & Saleh, 2017; Qian & Lin, 2018). These incidents have severe consequences, not only for individual miners and their families but also for the socio-economic stability of mining communities and the national workforce. Reports indicate a troubling increase in mining-related deaths, with fatalities rising from 51 in 2019 to 69 in 2021 (Njini, 2021), despite the presence of safety laws such as the Mine Health and Safety Act (MHSA). This disturbing trend highlights an urgent need for critical analysis and policy revision to protect vulnerable workers and ensure ethical labour practices. Thus, understanding and addressing the root causes of mining fatalities is a social imperative with widespread implications. The purpose of this article is to highlight the factors that contributed to fatalities in South African mines, with an aim of placing corrective measures to avoid recurrence.

From a scientific standpoint, while previous research has explored various safety measures and risk factors in mining, there remains a significant knowledge gap concerning the combined impact of human error,

communication failures, and managerial commitment on fatality rates (Ilbahar et al., 2018; Abdrakhmanov, 2017). Much of the existing literature focuses on isolated factors or technical interventions, with limited emphasis on the systemic and behavioural dimensions of occupational health and safety (OHS). Furthermore, there is a lack of integrated, mixed-method studies that combine empirical data with stakeholder insights to develop actionable strategies. This study contributes to the field by adopting a holistic approach that blends qualitative and quantitative data to uncover nuanced relationships between workplace culture, safety training, regulatory enforcement, and accident outcomes. In doing so, it addresses a vital gap in the literature and offers new perspectives on how to enhance compliance and safety in high-risk environments.

Conceptual Framework

This study is underpinned by a socio-technical systems framework, which recognizes that workplace safety outcomes are influenced by the interplay of human, organizational, and technical factors. Drawing from the principles of Behaviour-Based Safety (BBS) and High Reliability Organization (HRO) theory, the research investigates how leadership behaviour, organizational culture, communication, and risk perception shape safety practices. These theories suggest that fostering a culture of mindfulness, resilience, and proactive learning can significantly reduce workplace accidents

(Mensah et al., 2022b; Siabi, 2022). The conceptual framework thus integrates both behavioural science and systems theory to analyze the structural and

Aim and Objective

The primary aim of this study is to identify and analyze the factors contributing to the significant rate of fatalities in South African mines and to propose practical strategies for improving occupational health and safety practices within the sector.

2. Literature Review

The high rate of fatalities in South African mines can be attributed to a complex interplay of factors, some of which are deeply ingrained in the industry's operational culture. A significant contributor is the inadequate safety measures, which include the lack of protective gear, insufficient safety protocols, and poor employee training. These gaps in safety measures are often exacerbated by insufficient safety management systems, such as the absence of effective risk assessments, hazard identification, and safety audits (Hong, Tamakloe, & Park, 2020). Basquill (2020) highlights that despite the ongoing regulatory frameworks and improvements in safety standards, fatal accidents in the industry remain high, indicating that safety procedures are either poorly enforced or underdeveloped. As a result, workers continue to face elevated risks, and the rate of fatalities remains disturbingly high.

In addition to these safety gaps, human error is frequently identified as a primary cause of fatal accidents in South African mines. Research conducted by Gnoni and Saleh (2017) suggests that a significant proportion of mining accidents occur because workers fail to follow established safety norms and procedures. This non-compliance is often

linked to a failure by regulatory agencies, such as the Department of Mineral Resources and Energy (DMRE), to enforce safety regulations effectively (Qian & Lin, 2018). Further, research by Vignoli et al. (2021) emphasizes the critical role of human factors, such as fatigue, poor decision-making, and failure to communicate, in contributing to mining accidents. These human variables, particularly fatigue and stress, impair workers' cognitive abilities, which can lead to mistakes during critical operations. The interaction between human error and systemic failures in safety protocols creates a dangerous cycle that significantly impacts the safety of mining workers.

Addressing the high fatality rate requires a multifaceted approach that includes not only stricter adherence to safety protocols but also a deeper focus on the human variables that influence behavior in mining environments. As Siabi (2022) notes, the increasing reliance on automation can shift the nature of human error from simple mistakes to more complex failures in system interface and decision-making. Ergonomics, psychology, and physiology all play a role in shaping worker behavior and decision-making in high-risk situations (Mensah et al., 2022b).

Improved safety performance can be achieved by recognizing the importance of psychological well-being, reducing work-related stress, and ensuring that workers receive proper training and support (Singo et al., 2022). Moreover, changes in organizational culture that encourage cooperation among mining companies, regulatory bodies, and employees are necessary to reduce fatalities. By addressing the root causes of human error and ensuring that safety protocols are consistently followed, the mining industry can take significant strides toward reducing the incidence of fatalities and improving the overall safety of the workforce.

3. Research Design and Methodology

The Researcher applied a mixed-method approach to explore the various aspects of the subject, acknowledging the advantages of both quantitative and qualitative approaches in providing a thorough comprehension of intricate phenomena. The research technique consisted of two distinct phases. The first phase was qualitative and involved analysing underlying meanings and socio-cultural contexts (Morgan, 2018). The second phase was quantitative and intended to identify numerical trends and patterns. This approach aimed to address the limitations of using only one method by integrating qualitative and quantitative paradigms (Apuke, 2017). This methodology was deemed suitable in order to provide a comprehensive understanding of the research topic, delivering both in-depth insights and quantitative analysis of the phenomenon being studied.

Research Approach and Study Design

This study adopted a pragmatic research paradigm, which is suitable for addressing real-world problems by integrating diverse research methods. The Sequential Exploratory Design was employed, starting with a qualitative phase to gather in-depth perspectives on Occupational Health and Safety (OHS) challenges in the South African mining sector, followed by a quantitative phase to validate and generalise the findings.

Study Population and Sampling Strategy

The study population included a diverse group of stakeholders within the South African mining sector, including operational mine workers, safety officers, and managerial staff responsible for implementing and monitoring safety protocols. The inclusion criteria required participants to have at least three years of experience in the mining industry to ensure relevant insight into OHS practices. No specific exclusion criteria were applied aside from lack of consent.

In the qualitative phase, 15 participants were purposively selected based on their roles and experience with OHS systems. For the quantitative phase, a total of 150 survey respondents were targeted using stratified random sampling to ensure broad representation across job roles, experience levels, and mine types (e.g., gold, platinum, and coal). This sample size was considered sufficient for identifying statistically significant patterns while maintaining feasibility.

Data Collection

In the qualitative phase, Purposive sampling was used to select participants who held qualities or perceptions that were directly relevant to the study topic.

The following criteria was applied to choose the participants:

- i. Participants who were actively employed as OHS officials within the mining sector in South Africa were taken into consideration.
- ii. Participants who have a significant amount of experience and specific set of expertise in the field of OHS.
- iii. Participants who were willing to take part in the study and accessible to do so. By focusing on these specific participants, the research attempted to collect nuanced views and perceptions pertaining to OHS in the mining industry. These are essential for comprehending the intricate dynamics that exist within this sector. The recruitment process for selecting participants involved an initial discussion of the study's objectives and needs to identify potential candidates. Participants were then selected through outreach via professional networks, industry groups, and direct contact with mining companies. Individuals who met the criteria and consented to participate were included, ensuring a knowledgeable and relevant sample for the study.

The study included a sample of 13 participants who are OHS officials working in the South African

mining industry. The selection of these individuals as key informants was based on their valuable insights and opinions that are relevant to the research aims. In the pilot study, a total of two individuals were selected to evaluate and improve the research equipment and processes. The results of the pilot study were utilised to enhance the main study, although they were not included in the final sample size.

In the quantitative phase, a structured questionnaire was designed based on themes emerging from the qualitative analysis. The questionnaire consisted of Likert-scale items measuring perceptions of human error, safety resources, management commitment, and communication. Validity was ensured through expert review and pilot testing with a small subsample of mining professionals ($n = 10$). Surveys were distributed both electronically and in paper form depending on site access and participant preference. There were no significant barriers to data collection, though some participants required translations into local languages, which was facilitated by bilingual fieldworkers.

Data Analysis

Qualitative data were transcribed verbatim and analysed using thematic analysis, following Braun and Clarke's (2019) six-step method. Coding was conducted manually and verified through peer debriefing to ensure reliability. Emerging themes were used to build a conceptual framework and guide the design of the quantitative survey.

Quantitative data were captured using Microsoft Excel and exported to SPSS version 25 for analysis. Descriptive statistics such as means and standard deviations were calculated to summarise participant responses. Inferential statistics, including Pearson's correlation and multiple regression analysis, were applied to examine relationships among variables such as human error, safety equipment availability, management support, and communication effectiveness. Data cleaning and validation processes included range and consistency checks.

Ethical Considerations

Ethical clearance for the study was obtained from the RBS Research Ethics Committee under reference number [RBSREC2024/228]. All participants provided informed consent, and anonymity and confidentiality were maintained throughout the research process. Participation was entirely voluntary, and participants were informed of their right to withdraw from the study at any stage without penalty. All data were securely stored and used solely for research purposes.

4. Research Findings and Discussion

4.1 Results

Demographic Profile of Respondents

The quantitative study drew on responses from 150 participants. Most respondents (72%) were male, with a dominant age group of 41 years and older, suggesting a mature and experienced workforce. Work experience distribution showed that the largest group (34%) had 11–15 years of experience, followed

by 6–10 years (28%), indicating deep familiarity with mining operations and occupational health and safety (OHS) practices.

Quantitative Results

Understanding the perceptions related to causes of fatalities in South African mines is vital for enhancing safety protocols and reducing accidents. To this end, a descriptive analysis was conducted using a Likert scale where respondents rated their level of agreement from 1 (strongly disagree) to 5 (strongly agree) on a set of statements.

Fatalities in South African mines are primarily due to human error.

Table 1: Fatalities in South African mines are primarily due to human error.

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Strongly Disagree	9	6.0	6.0	6.0
Disagree	9	6.0	6.0	12.0
Neutral	33	22.0	22.0	34.0
Agree	69	46.0	46.0	80.0
Strongly Agree	30	20.0	20.0	100.0
Total	150	100.0	100.0	

The presented figures in table 1 illuminate workers' perceptions on the impact of human error on mortality in South African mines. The responses are classified into five categories, spanning from "Strongly Disagree" to "Strongly Agree." 46.0% of the respondents belong to the "Agree" group, while 20.0% fall into the "Strongly Agree" category. A lesser proportion of individuals either express a "Disagree" (6.0%) or "Strongly Disagree" (6.0%)

stance towards the idea that human error is a key factor contributing to deaths. Meanwhile, 22.0% maintain a "Neutral" position. The findings suggest that a considerable number of workers (66%) hold the view that human error is a major factor in the occurrence of deaths in South African mines. To comprehensively grasp the significance of these findings, it is imperative to juxtapose and analyse the survey data alongside the existing body of research concerning the factors contributing to fatalities in the mining industry (Morgan, 2018:270). Existing literature often underscores the multifaceted nature of mining accidents, wherein both human and systemic elements play crucial roles (Hofmann, 2018; Nell, 2017). The notable prevalence of "Agree" and "Strongly Agree" responses echoes prior research, which emphasises the substantial impact of human factors on safety outcomes in mining operations.

However, the presence of participants expressing "Neutral," "Disagree," and "Strongly Disagree" opinions suggests a diversity of perspectives or understandings regarding the primary factors contributing to fatalities (Basquill, 2020). Further investigation is warranted to comprehend the underlying reasons for these reactions, including potential reservations about attributing blame solely to individuals without considering institutional factors (Basquill, 2020). The favourable responses may also indicate a recognition among personnel that addressing human error is paramount for enhancing safety in mines (Gnoni and Saleh, 2017). This alignment with the literature underscores the

importance of implementing solutions that combine efforts to reduce human error with systemic improvements to foster a safer working environment (Hudson et al., 2019). In summary, the survey findings suggest a nuanced understanding among respondents regarding the factors contributing to fatalities in the mining industry. While human error is acknowledged as a significant contributor to accidents, there may be varying perspectives on the extent to which systemic factors also play a role (Papas and Morris, 2019). By analysing these findings alongside existing research, it becomes apparent that addressing safety challenges in mining requires a holistic approach that considers both individual behaviors and broader organisational dynamics (Abdrakhmanov, 2017). This comprehensive understanding is essential for developing effective strategies to mitigate risks and enhance safety outcomes in mining operations.

Insufficient safety equipment and resources contribute to fatalities.

Table 2: Insufficient safety equipment and resources contribute to fatalities.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	3	2.0	2.0	2.0
	Neutral	3	2.0	2.0	4.0
	Agree	81	54.0	54.0	58.0
	Strongly Agree	63	42.0	42.0	100.0
	Total	150	100.0	100.0	

The information provided in table 2 provide insights into workers' perceptions on the correlation between inadequate safety equipment and resources and the occurrence of deaths in South African mines. Responses are classified into four tiers, spanning from "Disagree" to "Strongly Agree." 54.0% of the responses belong to the "Agree" group, while 42.0% fall into the "Strongly Agree" category. A lesser proportion of individuals either express "Disagreement" (2.0%) or remain "Neutral" (2.0%) with the idea that inadequate safety equipment and resources are factors contributing to deaths. The results suggest that most personnel in South African mines believe that deficiencies in safety equipment and resources are a key contributing factor to deaths. To ensure a comprehensive understanding of the survey findings, it is essential to analyse them in conjunction with existing research on the relationship between safety equipment, resources, and fatalities in the mining industry (Anger, 2015). Previous studies underscore the critical importance of well-maintained and appropriate safety equipment, along with adequate resources, in effectively reducing accidents and fatalities (Hecker et al., 2019; Leclercq et al., 2018). The significant proportion of respondents indicating "Agree" and "Strongly Agree" aligns with prior research, which highlights the detrimental impact of insufficient safety equipment and resources on safety outcomes. However, the presence of participants in the "Disagree" and "Neutral" categories suggests a consensus among employees regarding the crucial role inadequate safety equipment and resources may play in causing

fatalities (Basquill, 2020). Nonetheless, a more in-depth examination is necessary to understand the specific concerns or reservations held by those who disagree or remain neutral, to identify potential areas for improvement (Gnoni and Saleh, 2017). The favourable responses may indicate that workers recognise the necessity of allocating resources and ensuring the maintenance of adequate safety equipment to prevent accidents and foster a safer work environment (Qian and Lin, 2018). This alignment with existing literature underscores the ongoing need for improvement in safety protocols and resource allocation within the mining sector (Qian and Lin, 2018). In summary, the survey findings reflect a widespread acknowledgment among respondents of the critical importance of sufficient safety equipment and resources in mitigating accidents and fatalities in the mining industry (Rahman, 2017). By analysing these findings alongside existing research, it becomes apparent that addressing deficiencies in safety equipment and resource allocation is essential for enhancing safety outcomes (Abdrakhmanov, 2017). This comprehensive understanding underscores the imperative of ongoing improvement efforts to ensure the well-being of workers in mining operations.

Poor communication within mining operations.

Table 3: Poor communication within mining operations

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	3	2.0	2.0	2.0
	Neutral	12	8.0	8.0	10.0
	Agree	78	52.0	52.0	62.0
	Strongly Agree	57	38.0	38.0	100.0
	Total	150	100.0	100.0	

The offered data in Table 3 provide insights into workers' perceptions on the correlation between inadequate communication and mortality in South African mines. Responses are classified into four categories, spanning from "Disagree" to "Strongly Agree." 52.0% of the responses belong to the "Agree" group, while 38.0% fall into the "Strongly Agree" category. A lesser proportion of individuals either "Disagree" (2.0%) or express a "Neutral" (8.0%) stance on the idea that inadequate communication contributes to mortality. The findings indicate that most personnel hold the opinion that inadequate communication within mining operations is a key contributing factor to deaths.

To provide a comprehensive understanding of the survey findings, it is imperative to analyse them in conjunction with existing research on the correlation between communication failures and fatalities in the mining industry. Numerous studies consistently underscore the critical importance of effective communication in mitigating accidents and deaths in mining operations (Carayon, 2021; Miao et al., 2020). The significant proportion of respondents indicating "Agree" and "Strongly Agree" aligns with prior research, which emphasises the detrimental impact of

inadequate communication on safety outcomes. However, the presence of participants in the "Disagree" and "Neutral" categories suggests potential variations in understanding or explanations regarding the impact of communication failures on fatalities (Ilbahar, et al., 2018). Further investigation is warranted to comprehend the underlying reasons for these reactions, which may include concerns about solely attributing deaths to communication problems without considering other factors (Abdrakhmanov, 2017). The favourable responses may also indicate a recognition among personnel of the need to address communication challenges to enhance safety in mines (Basquill, 2020). This alignment with existing literature underscores the importance of fostering a culture that encourages open communication, delivering effective training, and leveraging technology to enhance communication in mining operations (Papas and Morris, 2019). In summary, the survey findings reflect a widespread acknowledgment among respondents of the critical importance of effective communication in preventing accidents and fatalities in the mining industry (Papas and Morris, 2019). By analysing these findings alongside existing research, it becomes apparent that addressing communication failures is essential for improving safety outcomes. This comprehensive understanding underscores the imperative of promoting a culture of open communication and implementing strategies to enhance communication effectiveness in mining operations (Basquill, 2020).

Management Commitment to Safety

Table 4: Management commitment to safety plays a crucial role in reducing fatalities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	6	4.0	4.0	4.0
	Disagree	3	2.0	2.0	6.0
	Neutral	27	18.0	18.0	24.0
	Agree	45	30.0	30.0	54.0
	Strongly Agree	69	46.0	46.0	100.0
	Total	150	100.0	100.0	

The supplied data in table 4 provide insights into workers' perceptions of the impact of managerial commitment on fatalities in South African mines. The responses are classified into five categories, spanning from "Strongly Disagree" to "Strongly Agree." A total of 46.0% of the respondents strongly agree, while 30.0% agree. A minority of individuals, namely 2.0% who "Disagree" and 4.0% who "Strongly Disagree," hold the belief that managerial commitment is essential in minimising deaths. Meanwhile, 18.0% of respondents remain "Neutral" on this matter. The findings indicate that most workers hold the opinion that management commitment significantly contributes to the reduction of deaths. To gain a comprehensive understanding of the survey findings, it is imperative to juxtapose them with existing research on the correlation between managerial commitment and safety outcomes in the mining industry (Anger, 2015). Consistent studies underscore the pivotal role of leadership and management dedication in establishing and upholding a robust safety culture (Hudson et al., 2019;

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Salminen et al., 2019). The notable prevalence of "Agree" and "Strongly Agree" responses aligns with prior research, emphasising the positive influence of managerial commitment on safety in mining activities. However, the presence of respondents in the "Disagree" and "Strongly Disagree" categories suggests varying perspectives or concerns regarding the impact of managerial commitment on fatalities (Basquill, 2020). Further investigation is warranted to understand the underlying reasons for these reactions, which may include doubts about the efficacy of managerial measures or the perceived need for additional safety initiatives. The favourable responses may also indicate that workers recognise the necessity of firm leadership commitment in fostering a safety-oriented environment and implementing effective safety protocols (Abdrakhmanov, 2017). This connection with existing literature underscores the significance of leadership engagement in safety efforts, consistent communication from management, and the adoption of explicit safety regulations. In summary, the research underscores that the mining sector is significantly affected by human error, inadequate safety equipment, ineffective communication, and the crucial role of management in determining the frequency of fatalities (Basquill, 2020). When comparing these perspectives with existing literature, it becomes evident that safety in the mining industry is a multifaceted issue with several dimensions, and numerous factors contribute to accidents and deaths (Basquill, 2020). This comprehensive understanding highlights the complex interplay between various

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elements in shaping safety outcomes in mining operations (Abdrakhmanov, 2017). By recognising the importance of managerial commitment and addressing other contributing factors such as human error and communication failures, mining companies can strive towards fostering safer working environments and reducing the incidence of fatalities in the industry (Basquill, 2020).

Thematic analysis yielded four overarching themes with multiple subthemes, highlighting systemic and behavioural contributors to mining fatalities.

Qualitative Results

Table 5: Themes and Subthemes

Theme	Subtheme
Leadership, Culture, and Workforce Engagement	The Role of Leadership and its Commitment to OHS versus Production Priorities
	Influence of Company OHS Culture and its Impact on Compliance
	The Effectiveness of Communication, Training, and Learning Frameworks
	Worker Involvement, Behaviour-Based Safety (BBS), and Safety Culture Promotion

Subtheme 5.1: The Role of Leadership and its Commitment to OHS versus. Production Priorities

The multifaceted nature of OHS has been widely acknowledged, with its many aspects influenced by a range of circumstances, including rules and human behaviors. According to Abdrakhmanov (2017), leadership, organisational culture, and worker engagement are of utmost importance in terms of their effect. The interplay between these functions

provides a perspective through which one may assess the efficacy and achievement of OHS systems within an organisation. The impact of leadership and organisational culture on OHS is significant and farreaching. The presence of laws, regulations, and procedures is important, but their effectiveness depends heavily on the ethical values and organisational culture fostered by leadership.

Leadership, regardless of the specific circumstances, establishes the prevailing atmosphere or attitude. Within the domain of OHS, the driving principle at play is the decision-making process that determines if safety takes precedence over productivity or whether the well-being of the workforce is jeopardized in favour of short-term advantages. Participant 3 offers an insightful peek into their organisation's ethos, revealing:

"Our leaders often say, 'Production is crucial, but not at the cost of safety.' It's a challenging balance but one we strive for."

Participant 10 went on to highlight that: *"Leadership in OHS sets the standard for safety concerns. Compliance with safety protocols is influenced by the culture of the organisation. It is an ongoing effort to strike a balance between production and safety."*

Participant 2 shared a similar perspective and said that: *"Whether safety or productivity is given more weight in OHS is a matter of leadership. Whether or whether employees follow safety protocols is affected by the culture of the company. It takes constant work to maintain this equilibrium."*

The perspectives shared by Participants 3, 10, and 2 emphasise the crucial influence of leadership and organisational culture on the establishment of OHS priorities within organisations. Participant 3's response highlights the significance of leadership in establishing the atmosphere for safety, emphasising the organisational philosophy that places safety above production. Participant 10 and Participant 2 both underscore the impact of leadership on safety

priorities. Participant 10 acknowledges the difficult task organisations face in balancing productivity and safety, while Participant 2 emphasises the ongoing effort needed to sustain this equilibrium.

These results are consistent with the current body of research on OHS management, which highlights the crucial importance of leadership and organisational culture in fostering a secure working environment. Hilson and Maconachie (2020) examine the influence of leadership on safety practices in mining operations, emphasising the significance of leaders' dedication to safety as a catalyst for fostering an organisational safety culture. Furthermore, Loosemore and Malouf (2019) highlight the significance of organisational culture in influencing compliance with safety protocols and cultivating a secure working environment. In addition, the emphasis placed by Participant 10 and Participant 2 on the ongoing effort needed to maintain a harmonious equilibrium between productivity and safety aligns with the conclusions drawn by studies like Su et al. (2021), which propose that organisations must consistently endeavour to achieve a balance between productivity objectives and safety precautions. Although leadership and organisational culture play a crucial role in determining safety results, some researchers warn that if there is a mismatch between the values of the organisation and its safety goals, it may negatively impact safety performance (Chen and Zorigt, 2013). Thus, it is crucial for organisations to give top priority to cultivating a culture that emphasises safety and ensuring that the values of

leadership are in line with safety goals to successfully handle OHS concerns.

Sub-theme .2: Influence of Company OHS Culture and its Impact on Compliance

The ubiquitous organisational culture is an extension of the leadership's ethos. Culture is not only a theoretical term but rather a tangible representation of the values, beliefs, and practices that are actively present and shared inside an organisation. The phenomenon known as the "invisible hand" exerts influence on human behavior, shapes individuals' perceptions, and establishes the standard for determining social acceptability.

Participant 2 offers a succinct encapsulation of this, noting: *"A company that values safety instils that into its culture. And when safety becomes culture, compliance is a natural outcome."*

Participant 5 mentioned that: *"Leadership ideals are reflected in organisational culture. A culture of safety naturally encourages conformity. Adherence is natural when safety is deeply embedded in a culture."*

Participant 11 with a similar emphasis highlighted that: *"Leadership influences the culture of an organisation, which in turn affects how people feel about safety. Compliance is innate in an organisation with a robust safety culture. The principles of safety are ingrained in the very fabric of the company."*

The contributions made by Participants 2, 5, and 11 emphasise the interdependent connection between leadership principles and organisational culture in influencing safety outcomes inside organisations.

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Participant 2's remark emphasises the profound impact of a safety-oriented culture, in which safety ideals are deeply embedded in the organisational ethos, resulting in automatic adherence to safety protocols. Participants 5 and 11 highlight the significance of leadership in shaping organisational culture, especially in promoting a robust safety culture characterised by a natural commitment to safety procedures.

These results are consistent with the current body of research on safety culture and its influence on the safety performance of organisations. Loosemore and Malouf (2019) examine the impact of leadership on safety culture in construction organisations, emphasising the significance of leadership principles in promoting a culture that prioritises safety. Hilson et al. (2022) highlight the importance of a robust safety culture in fostering adherence to safety protocols and reducing workplace risks.

In addition, the emphasis placed by Participant 5 and Participant 11 on the inherent obedience that stems from a well-established safety culture aligns with the conclusions drawn by studies like Singh et al. (2022), which propose that organisations with a strong safety culture are more inclined to attain substantial levels of adherence to safety regulations. Nevertheless, it is important to note that while safety culture is crucial in encouraging adherence to regulations, several researchers warn that if there is a mismatch between the values of leadership and the emphasis placed on safety, it might hinder the establishment of a favourable safety culture (Danielsen and Hinton, 2020).

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Hence, it is essential for organisations to give utmost importance to cultivating a culture that prioritises safety, aligns with the values of leadership, and encourages effortless adherence to safety protocols.

Sub-theme 5.3: The Effectiveness of Communication, Training, and Learning Frameworks

The workforce is an essential element of any OHS policy. Employees are essential contributors to OHS systems, as they actively participate in implementing safety regulations rather than just passively following them. However, individuals play an important role as active participants who can significantly influence the efficiency of these systems through their involvement, understanding, and involvement. Continuous education and a sense of ownership are two essential elements that underpin this dynamic. The need of continuous education in the domain of OHS cannot be emphasised enough. Aside from the usual initial training or orientation, it is crucial to continuously gather information and improve abilities to maintain a skilled workforce that can effectively handle new challenges and adjust to changing situations.

Participant 1's observation offers a testament to this importance, stating:

“Continuous training sessions and clear communication channels have drastically minimised our on-ground errors.”

Participant 7 highlighted that: *“It is critical for OHS systems to have employee buy-in. An efficient staff is the result of a culture that values ownership and encourages ongoing education. Errors are decreased and safety is enhanced via training and clear communication.”*

Participant 9 emphasised that: *“Workers have an important role as OHS stakeholders. It is crucial to prioritise ownership and ongoing education. Errors are reduced and safety results are improved via regular training and efficient communication.”*

The perspectives shared by Participants 1, 7, and 9 emphasise the crucial influence of the workforce in determining OHS outcomes within organisations. The observation made by Participant 1 emphasises the significant positive effect of ongoing training and effective communication channels in reducing mistakes and improving safety on the ground. Participants 7 and 9 also highlight the significance of employee involvement, ongoing education, and ownership in promoting a skilled workforce and enhancing safety results.

These results are consistent with the current body of research on the significance of staff engagement and ongoing education in advancing OHS inside organisations. Ayhan et al. (2020) highlight the significance of employee participation and ongoing training in improving safety performance in construction projects. They emphasise the crucial role of committed and knowledgeable personnel in minimising accidents and injuries.

In addition, Vignoli et al. (2021) emphasise the need of continuous education and improving skills to prepare the workforce to successfully tackle new safety concerns and adjust to evolving working circumstances. Furthermore, the importance attributed by Participant 7 and Participant 9 to employee participation and ownership in OHS systems corresponds with the conclusions of studies such as Ji et al. (2023), which suggest that actively involving workers in safety initiatives leads to enhanced safety outcomes. However, researchers caution that inadequate support and resources from management can hinder workers' ability to fully engage in safety activities, despite the importance of ongoing education and employee involvement in efficient OHS systems (Donkor et al., 2023). Therefore, it is crucial for organisations to prioritise providing extensive training and adequate resources to empower people to actively participate in OHS efforts and cultivate a safety-focused atmosphere

Sub-theme 5.4: Worker Involvement, Behaviour-Based Safety (BBS), and Safety Culture Promotion

Continuous education provides workers with information, while the notion of ownership fosters a feeling of accountability among them. The establishment of ownership occurs when workers are seen not just as implementers of safety standards but rather as active participants in the advancement of these policies.

As Participant 3 insightfully points out: *"Involving workers in decision-making and promoting BBS has*

given everyone a sense of ownership. Safety isn't just a management concern anymore."

Participant 4 in support further stated: *"Workers are more likely to take pride in safety when they are involved in making decisions that affect them. Adopting BBS encourages responsibility. Ensuring everyone's safety is our shared duty."*

Participant 8 acknowledged that: *"Worker involvement in decision-making fosters ownership in safety. BBS promotes accountability among workers. Safety is no longer solely a management concern but a shared responsibility."*

The findings from Participants 3, 4, and 8 highlight the significant influence of worker participation and ownership on OHS outcomes in organisations. The insight from Participant 3 emphasises the transition towards a culture in which safety is not only the responsibility of management, but also a collective obligation among all workers. Participants 4 and 8 also highlight the significance of empowering workers by including them in decision-making and BBS) as techniques to encourage ownership and responsibility in safety.

These results are corroborated by the current body of research on participatory methods for OHS management. Siabi et al. (2022) examine the advantages of engaging workers in decision-making processes and fostering ownership in safety. They emphasise the beneficial influence on safety and organisational culture. In their study, Ofosu et al. (2022) highlights the significance of BBS

in enhancing worker responsibility and cultivating a safety-oriented culture, whereby people proactively recognise and resolve safety issues. In addition, the focus placed by Participant 4 and Participant 8 on the communal responsibility for safety aligns with the conclusions drawn by Arthur-Holmes and Abrefa-Busia (2022) in their investigations. These studies propose that when all workers share a commitment to safety, it results in improved safety outcomes. Although worker engagement and ownership are essential aspects of good OHS systems, some researchers warn that a lack of management support and resources might impede workers' capacity to fully participate in safety activities (Hong et al., 2020). Hence, it is essential for organisations to give utmost importance to establishing a conducive atmosphere that fosters employee empowerment, encouraging them to actively engage in decision-making processes and assume responsibility for safety measures.

4.2 Discussion

Key Findings

The research identified four primary contributors to mining fatalities: (1) human error, (2) inadequate safety equipment, (3) ineffective communication, and (4) limited management commitment to OHS. Both qualitative and quantitative findings aligned closely, reinforcing the interconnectedness of systemic shortcomings and individual behaviour in occupational risk.

Interpretation of Key Findings

These findings are consistent with previous studies highlighting the multifaceted nature of mine safety failures. For instance, Gnoni and Saleh (2022) emphasised the role of non-compliance due to poor safety training, while Qian and Lin (2019) discussed the limitations of regulatory enforcement. This study extends existing knowledge by showing that the perception of safety culture, rather than the mere existence of policies, strongly influences safety behaviour and compliance. Moreover, the results support Ilbahar et al.'s (2021) argument that technical safety measures must be supported by strong leadership and cultural reinforcement. The high ratings for management commitment and communication in this study underscore the importance of organizational leadership as a catalyst for OHS compliance.

Delineations and Limitations

The use of a sequential exploratory mixed-methods design enhanced the validity and depth of the findings by combining rich qualitative insight with measurable patterns. The demographic diversity of participants also ensured a broad spectrum of experiences. However, several limitations must be noted. First, self-reported data may be subject to bias, particularly social desirability bias in the survey responses. Second, the sample was geographically limited to certain mining regions, which may affect generalisability to the entire sector. Third, language barriers during some interviews may have limited the precision of responses despite the use of interpreters.

Future research could incorporate longitudinal designs to evaluate the impact of specific interventions over time and should explore the role of emerging technologies (e.g., predictive analytics, real-time monitoring) in enhancing mine safety.

5. Recommendations and Conclusions

Recommendations

Based on the study's findings, the following recommendations are proposed to enhance occupational health and safety (OHS) practices within the South African mining sector:

- **Continuous Improvement in Safety Management: A Strategic Imperative**

The notion of continual improvement is crucial for ensuring successful OHS in mining enterprises, given the intrinsic nature of safety management. To put this strategic need into action, it is highly advised for mining businesses to regularly evaluate their current OHS regimes (Anger, 2015).

- **Inclusive Training and Education Initiatives: Nurturing a Culture of Lifelong Learning**

Education serves as the foundation on which a strong safety culture is established in the mining sector. To cater to the varied requirements and opinions of the workforce, it is highly recommended for mining businesses to create and execute comprehensive training programs that promote inclusivity (Anger, 2015). These programs should go beyond just a simple task of checking boxes to comply with regulations;

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they should be intended to foster a culture of ongoing learning and improvement. Inclusive training encompasses more than just ensuring accessibility; it also involves acknowledging the many roles and responsibilities present in the mining industry.

- **Addressing Dissenting Views and Concerns: Fostering Inclusive Dialogue**

To get a thorough comprehension of worker views, it is crucial to acknowledge and tackle opposing opinions inside the firm. The opposing comments, which often represent a range of perspectives and concerns, provide vital insights that may greatly enhance the improvement of OHS measures (Papas and Morris, 2019). To successfully deal with opposing opinions, mining companies are advised to build transparent communication channels and use focused talks or workshops.

- **Balancing Safety and Production Priorities: Nurturing a Symbiotic Approach**

To attain this state of balance, leadership training plays a crucial role in highlighting the need of cultivating a culture that equally prioritises both safety and productivity. Leadership training programs should cultivate a profound understanding of the interdependent connection between safety and productivity. Leaders at all levels of the firm should possess the aptitude and expertise required to effectively negotiate the intricacies of this relationship.

It is important to recognise that a secure working environment is not an obstacle to productivity, but rather a necessary condition for long-term success (Abdrakhmanov, 2017).

- **Embracing Modern Technologies and Innovations: Pioneering Safety Enhancement**

The incorporation of contemporary technology and innovations is crucial for improving safety measures in the ever-changing mining industry. It is advisable for organisations to aggressively adopt technology breakthroughs, using technologies like Artificial Intelligence (AI) for the purpose of safety monitoring and risk management (Abdrakhmanov, 2017). Adopting AI solutions such as Cosmo Eye may significantly transform safety processes by providing sophisticated monitoring capabilities. The Cosmo Eye platform exemplifies AI technology by offering mining businesses a full solution for safety monitoring. The capacity to evaluate extensive information in real-time facilitates the prompt identification of possible dangers, allowing timely action to avert accidents. Organisations may greatly improve their risk management skills and strengthen safety standards by using AI technologies (Anger, 2015).

- **Flexibility and Adaptability: Navigating the Dynamic Terrain**

Considering the intrinsically volatile nature of work environments in the mining industry, businesses must give priority to incorporating flexibility and adaptation into their safety standards. The suggestion

is to foster a culture that promptly addresses unforeseen alterations, adapts safety protocols appropriately, and continually pursues avenues for improvement (Abdrakhmanov, 2017).

- **Promoting Worker Involvement and Safety Culture: A Collective Commitment**

Organisations must acknowledge the crucial importance of worker participation in decision-making processes to establish a safety-focused culture. Mining businesses are advised to actively include workers in safety-related decision-making processes, promoting a collective sense of accountability (Rahman, 2017). Leadership techniques that promote and exhibit safety ideals are essential in developing the organisation's culture and greatly contribute to establishing a good safety ethos.

- **Enhanced Incident Investigation Protocols Proactive Prevention for a Safer Future**

Enhancing incident investigation processes is crucial for conducting a thorough examination of events, with a major emphasis on avoiding future occurrences. It is advised to implement a proactive strategy for preventing incidents, which involves more than just analysing incidents after they occur (Fischer and Boone, 2015). This entails conducting periodic evaluations and revisions of procedures, integrating insights gained from accidents, and aggressively soliciting input from the workforce (Gnoni and Saleh, 2017).

Mining businesses exhibit a dedication to the safety of their workers and a proactive approach to reducing mishaps by giving priority to improved incident investigation methods.

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Conclusions

This study provides a comprehensive exploration of the factors contributing to fatalities in South African

mines. The findings reveal that human error, insufficient safety resources, inadequate communication, and weak management commitment are among the primary contributors to fatal incidents. Addressing these systemic and behavioural shortcomings is vital for reducing accident rates and improving overall safety outcomes. The research underscores the importance of continuous employee training, the provision of adequate safety equipment, and the development of a robust safety culture. Effective leadership, when combined with transparent communication and worker involvement, plays a pivotal role in ensuring that OHS protocols are respected and consistently applied. Moreover, regular safety audits and committee-led evaluations can help adapt strategies to changing workplace dynamics and regulatory expectations. By aligning safety practices with operational realities and fostering a proactive and collaborative safety culture, the mining sector can significantly reduce fatalities. Such improvements not only ensure compliance with legal and ethical standards but also contribute to the long-term sustainability and social responsibility of mining operations in South Africa.

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