THE IMPACT OF CORPORATE GOVERNANCE ON OCCUPATIONAL RISKS IN SOUTH AFRICA'S MINING INDUSTRY

by

LUKE CHARLES CHIKOSI

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SUPERVISOR: PROF AT MUTEZO

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DECLARATION OF ORIGINALITY

Name:	Luke Charles Chikosi
Student number:	45187886
Degree:	Doctor of Philosophy
Title:	***The Impact of Corporate Governance on Occupational Risks in South Africa's Mining Industry***

I affirm that the thesis submitted to the University of South Africa [UNISA] for the degree of Doctor of Commerce (Management) has not previously been submitted by me for a degree at this or any other university; that it is my original work in strategy and execution, and that all material contained herein has been duly acknowledged.

25 January 2023

L.C. CHIKOSI

DATE

DEDICATION

I dedicate this thesis to God Almighty – my creator, rock, redeemer, pillar, a fountain of inspiration, wisdom, and understanding. He has been the source of my strength throughout my life and academic journey.

I also dedicate this work to my friends and relatives, with special gratitude extended to Ema Kuona, my best friend.

My wife, Christine Misozi: thank you for the unwavering support and encouragement you accorded me throughout the program.

To my parents, Ndimupei and the late Simone Musarowana Chikosi, who played an invaluable cornerstone role in my life.

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ABSTRACT

Despite implementing various corporate governance (CG) frameworks, guidelines, and laws, mine workers continue to suffer from exposure to occupational health and safety risks. This study examines corporate governance's influence on occupational health and safety risk management performance in the South African mining sector from 2002 to 2018, with 510 firm-year observations. The study considered all the JSE-listed firms as the population. The study further purposively selected thirty JSE-listed mining firms and used content analysis to collect quantitative secondary data from 2002 to 2018 from online published integrated annual reports. The study used CG (board size, board independence, managerial ownership, audit and risk committee size, and board gender diversity) as independent variables and OHS risks (total injuries frequency rate [TIFR] and new cases of occupational diseases [NCOD]) as dependent variables. A multivariate regression model based on feasible generalised squares (FGLS) and ordinary least squares (OLS) analysis was employed to determine the influence of corporate governance variables on occupational health and safety risks. The results suggest a negative impact of CG variables on TIFR and a positive influence on NCOD. The general effect of CG on OHS risks turned out to be negative.

Moreover, the results allude to aligning corporate governance with appropriate frameworks, such as the King IV report. The results may be vital as there is an increasing trend toward attaining the “zero harm” milestone by December 2024 in the mining sector. Moreover, the results may be useful to mining firms and policymakers in tailoring OHS risk management frameworks compatible with existing internal corporate governance mechanisms. Lastly, the study recommends further studies to explore the relationship between CG-OHS risks in the South African mining sector using different research approaches.

Keywords: Corporate governance, managerial ownership, board gender diversity, board independence, audit and risk committee, total asset value, total employees, occupational health and safety risk management.

OPSOMMING

Ondanks die implementering van verskeie korporatiewebestuur (KB)-raamwerke, -riglyne en -wette, gaan mynwerkers steeds gebuk onder blootstelling aan beroepsgesondheid-en-veiligheidsrisiko's. Hierdie studie ondersoek die invloed van korporatiewe bestuur op die prestasie van beroepsgesondheid-en-veiligheidsrisikobestuur in die Suid-Afrikaanse mynwese-sektor vanaf 2002 tot 2018, met 150 firmajaarwaarnemings. Die studie het al die JSE-genoteerde firmas as die populasie gebruik. Die studie het verder doelgerig dertig JSE-genoteerde mynboufirmas geselekteer en inhoudsontleding gebruik om kwalitatiewe sekondêre data vanaf 2022 tot 2018 uit aanlyn geintegreerde jaarverslae te versamel. Die studie het KB (direksiegrootte, direksie-onafhanklikheid, bestuursbesit, oudit- en risikokomiteegrootte, en direksiegeslagsdiversiteit) as onafhanklike veranderlikes gebruik, en BVG-risiko's (totale beseringfrekwensiekoers [TIFR] en nuwe gevalle van beroepsiektes [NCOD]) as afhanklike veranderlikes. 'n Meerveranderlike regressiemodel gebaseer op uitvoerbareveralgemeendekwadrate (FGLS)- en gewonekleinstekwadrate (OLS)-ontleding is toegepas om die invloed van korporatiewebestuursveranderlikes op beroepsgesondheid-en-veiligheidsrisiko's te bepaal. Die resultate dui op 'n negatiewe impak van KB-veranderlikes op TIFS en 'n positiewe impak op NCOD. Die algemene uitwerking van KB op BVG-risiko's is as negatief identifiseer.

Daarbenewens dui die resultate op die inlynstelling van korporatiewe bestuur met toepaslike raamwerke, soos die King IV-verslag. Die resultate kan van kardinale belang wees, aangesien daar 'n toenemende tendens is om die "nulskade"-mylpaal teen Desember 2024 in die mynbousektor te bereik. Die resultate kan ook nuttig wees vir mynboufirmas en beleidsmakers om OHS-risikobestuursraamwerke te ontwerp wat met bestaande interne korporatiewebestuursmeganismes verenigbaar is. Laastens beveel die studie aan dat verdere studies gedoen word om die verband tussen KB-BVG-risiko's in die Suid-Afrikaanse mynbousektor met behulp van ander navorsingsbenaderings te verken.

Sleutelwoorde: Korporatiewe bestuur, bestuursbesit, direksiegeslagsdiversiteit, direksieonafhanlikheid, oudit-en-risikokomitee, totale batewaarde, beroepsgesondheid-en-veiligheidsrisikobestuur

OKUCASHUNIWE

Naphezu kokusebenzisa izinhlaka, imihlahlandlela, kanye nemithetho ehlukahlukene yokuphathwa kwebhizinisi (CG), abasebenzi basezimayini basaqhubeka nokubhekana nobunzima bezempilo nokuphepha emsebenzini. Lolu cwaningo luhlola umthelela wokuphathwa kwebhizinisi ekusebenzeni kokulawulwa kwezingozi zezempilo kanye nokuphepha emkhakheni wezimayini waseNingizimu Afrika kusukela ngo-2002 kuya ku-2018, ngokubhekwa kweminyaka yenkampani engama-510. Ucwaningo lubheke zonke izinkampani ezisohlwini lwe-JSE njengenani labantu. Ucwaningo luphinde lwakhetha ngamabomu izinkampani zezimayini ezisohlwini lwe-JSE ezingamashumi amathathu futhi lwasebenzisa ukuhlaziywa kokuqukethwe ukuze kuqoqwe imininingwane yesibili esebenzisa izibalo kusukela ngo-2002 kuya ku-2018 emibikweni yonyaka ehlanganisiwe eshicilelwe ku-inthanethi. Ucwaningo lusebenzise i-CG (usayizi webhodi, ukuzimela kwebhodi, ubunikazi bokuphatha, usayizi wekomiti lokucwaningwa kwamabhuku kanye nezingozi, kanye nokuhlukahluka kobulili bebhodi) njengokuhluka okuzimele kanye nobungozi be-OHS (inani eliphelele lesilinganiso sokulimala kokulimala [TIFR] kanye nezimo ezintsha zezifo zasemsebenzini [NCOD]) njengokuguquguqukayo okuncikile. Kusetshenziswe isifanekiso sendlela yezibalo esihlukahlukene esisekelwe endleleni yokulinganisela ejwayelekile (i-FGLS) kanye nokuhlaziya kwendlela yokulinganisela evamile (OLS) kwasetshenziswa ukuze kutholwe umthelela wokuhlukahluka kokubusa kwebhizinisi ezingozini zempilo nokuphepha emsebenzini. Imiphumela iphakamisa umthelela omubi wokuguquguquka kwe-CG ku-TIFR kanye nomthelela omuhle kuma-NCOD. Umthelela ojwayelekile we-CG ezingozini ze-OHS uphenduke waba mubi.

Ngaphezu kwalokho, imiphumela iqondise ekuqondiseni ukubusa kwebhizinisi nezinhlaka ezifanele, njengombiko we*King IV*. Imiphumela ingase ibaluleke njengoba kunokuthambekela okwandayo ekufinyeleleni ingqopha-mlando ‘yokungabi nangozi’ ngoZibandlela 2024 emkhakheni wezimayini. Ngaphezu kwalokho, imiphumela ingase ibe usizo ezinkampanini zezimayini nabenzi benqubomgomo ekuhleleni izinhlaka ze-OHS zokulawula ubungozi ezihambisana nezindlela ezikhona zokuphatha izinkampani zangaphakathi. Okokugcina, ucwaningo luphakamisa olunye ucwaningo lokuhlola

ubudlelwano phakathi kwezingozi ze-CG-OHS emkhakheni wezimayini eNingizimu Afrika kusetshenziswa izindlela ezahlukene zocwaningo.

Amagama asemqoka:

Corporate governance

Ukubusa kwebhizinisi

managerial ownership

ubunikazi bokuphatha

board gender diversity

ukuhlukahluka kobulili bebhodi

board independence

ukuzimela kwebhodi

audit and risk committee

ikomidi lokucwaningwa kwamabhuku kanye nezingozi

total asset value

inani eliphelele lempahla

occupational health and safety risk management

ukuphathwa kwengozi yezempilo nokuphepha emsebenzini

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ACRONYMS AND ABBREVIATIONS

AP	African Petroleum
ARC	Audit and Risk Committee
ARCTM	Accident Root Causes Tracing Model
ASSE	American Society of Safety Engineers
BBS	Behaviour-Based Models
BI	Board Independence
BoD	Board of Directors
BS	Board Size
CEO	Chief Executive Officer
CG	Corporate Governance
CGC	Corporate Governance Committee
CIM	Chief Inspector of Mines
CPI	Compensation for Permanent Injuries
CSI	Corporate Social Investment
CSR	Corporate Social Responsibility
CTF	Culture Transformation Framework
DMRE	Department of Mineral Resources and Energy
FGLS	Feasible Generalized Least Squares
FIFR	Fatal Injuries Frequency Rate
FRC	Financial Reporting Council
G20	Group of 20
GCGF	Global Corporate Governance Forum
GD	Gender Diversity
GDP	Gross Domestic Product
GFAT	Goal Freedom Theory
GHG	Greenhouse Gases
GPCGC	Guidelines-Principles of Corporate Governance in the Commonwealth
HELE	High Efficiency and Low Emission
HFM	Human Factor Model

HSA	Health and Safety Authority
HSS	Health and Safety Summit
IFE	Incident-Free Environment
IoDSA	Institute of Directors Southern Africa
IoDNZ	Institute of Directors New Zealand
ISO	International Standard Organization
JSE	Johannesburg Securities Exchange
KPI	Key Performance Indicator
LSE	London Stock Exchange
LTIFR	Lost Time Injuries Frequency Rate
MCSA	Mineral Council South Africa
MHSA	Mine Health and Safety Act
MHSC	Mine Health and Safety Council
MHSI	Mine Health and Safety Inspectorate
MO	Managerial Ownership
MOSH	Mining Industry Occupational Safety and Health
MSTAC	Modified Statistical Triangle of Accident Causation
MQA	Mining Qualifications Authority
NCOD	New Cases of Occupational Diseases
NIHL	Noise-Induced Hearing Loss
NSF	National Sanitation Foundation
OECD	Organisation of Economic Cooperation and Development
OHS	Occupational Health and Safety
OLS	Ordinary Least Squares
PCB	Polychlorinated Biphenyl
PDS	Proximity Detection System
PPE	Personal Protective Equipment
PRISMA	Preferred Reporting Items for Systematic Review and Meta-Analysis
PSE	Pakistan Stock Exchange
PwC	Price Waterhouse Coopers
ROA	Return on Assets

ROE	Return on Equity
SAMS	South African Mining Sector
SEBI	Securities Exchange of India
SME	Small and Medium Enterprise
SOE	State-Owned Enterprise
S&SD	Safety and Sustainable Development
TA	Total Asset
TAP	Tripartite Action Plan
TB	Tuberculosis
TE	Total Employees
TIFR	Total Injuries Frequency Rate
UNISA	University of South Africa
USA	United States of America
VIF	Variance Inflation Factor
WMD	World Mining Data

CHAPTER 1: INTRODUCTION TO THE STUDY

1.1 Background

In 2022, the mining industry's contribution to South African gross domestic product (GDP) grew by 4% to R494 billion in 2022 from R475 billion in 2021(World Mining Data [WMD], 2022; MCSA, 2023). Due to the importance of mining enterprises in developing and developed economies, policymakers are continuously formulating and reviewing occupational health and safety (OHS) regulatory frameworks to safeguard the lives of mine workers (Hermanus, Coulson & Pillay, 2015; Reese, 2018). The mining industry's sustainability is founded on employees' occupational well-being (Dougall & Mmola, 2015). Most importantly, health and safe working conditions play a crucial role in a sustainable mining industry that will have a positive multiplier effect on the economy as a whole. Mining is among the world's most dangerous and ancient industries (WMD, 2019). Therefore, without enforcing best corporate governance (CG) practices in the mining industry encompassing risk governance, employees remain the main vulnerable group of stakeholders.

Despite the micro and macro-economic importance of the mining industry, miners are exposed to health and safety risks that impact a firm’s sustainable operations (Department of Mineral Resources and Energy [DMRE], 2019). Numerous risks faced by firms, including health and safety risks, challenge top management to formulate and implement risk mitigation strategies such as skills development, establishing audit and risk committees, and incorporating a triple bottom line in the day-to-day operating activities (Mineral Council of South Africa [MCSA], 2018). Employees in the mining sector across the globe are faced with occupational injuries, diseases, and death due to the hazardous nature of the mining environment (DMRE, 2019). Christie and Gilder (2014) allude that health and safety risks impact the well-being of employees, society, and mining firms' financial and non-financial performance. As such, more attention should be directed to occupational risk mitigation strategies to ensure the safety of providers of human capital and sustainable mining business operations.

The need for an accident and incident-free environment (IFE) in the SAMS and beyond borders has intensified over the past two decades (Baxter, 2016). The emergence of the "zero-harm" principle has been manifested by its inclusion in regulatory, corporate governance, organisational management blueprints, and risk management frameworks (MCSA, 2018). Additionally, mining firms have since invested vast sums of money in sustainability practices such as skills development and carbon footprint reduction as strategies to curb the impact and frequency of health and safety risks (Sidler, 2015). Despite concerted efforts, mining firms still experience deaths and injuries of employees and loss of production hours due to accidents and occupational diseases. According to McNally (2017), miners are exposed to OHS hazards such as rock falls, toxic gases, dust, extreme noise levels, excessive vibrations, heat, and dangerous chemicals. Baxter (2017) asserts that OHS risk events result in production stoppages, loss of human life, deterioration of employee health, and financial loss to the mining firm. Therefore, there is a need for significant and effective governance of OHS risks in the sector.

Employees are one of the vital and crucial resources for business enterprises (Baxter, 2017; Vyas, 2015). OHS risk management practices, for instance, training and development of employees, GHG emission intensity reduction, and use of high efficiency and low emission (HELE) technology, must aim to eliminate loss of human capital through accidents, occupational diseases, and excessive vibrations. Additionally, CG structures in the mining sector need to implement robust OHS risk mitigation strategies, adding value and creating a balance between cost and reward (Baxter, 2017). Also, adopting best CG practices by mining corporations is expected to reduce the occurrence and impact of OHS risks (Boa, Johansson & Zhang, 2018). This assists mining firms towards achieving the 'zero harm' milestone by 2024.

The 'zero harm' principle implies that all mining firms in South Africa should record no OHS incidences daily. In addition, to achieve 'zero harm' in the mining environment, it is fundamental to strengthen the capacity of CG structures to effectively implement a comprehensive and sustainable set of risk governance practices in the sector (Baxter, 2017). CG structures in the mining industry are responsible for formulating, implementing,

and evaluating OHS risk-mitigating strategies such as skills development, establishing audit and risk committees, setting risk tolerance levels, GHG emission intensity reduction, use of renewable energy sources, and performance-based remuneration, among others. May, Batiz and Martinez (2019) assert that OHS risk management is at the core of good corporate governance practices in any industry. Utembe, Fausttman, Matatiele and Gulumian (2015) echo that effective and efficient OHS risk management processes in an extractive, sensitive and dangerous industry such as mining reduced accident frequency rate and impact on human fatalities. Furthermore, the occurrence of OHS risks in the mining sector due to factors such as exposure to silica dust, methane gas, pollutants, excessive noise, rock falls, flooding, vibrations, and extremely high temperatures is still high (Mabika, 2018; Abbasi, 2018; Amponsah-Tawiah & Mensah, 2016).

Previous studies on CG and OHS risk management were conducted in different countries (Klettner, Clarke & Boersma, 2013; Mabika, 2018). Klettner *et al*. (2013) conducted a qualitative content analysis on the impact of CG on firm performance in 50 listed Australian firms. Firm performance was measured in terms of financial and non-financial proxies. Financial performance was expressed as return on assets (ROA). In contrast, non-financial performance was expressed in terms of environmental performance (GHG emission), customer satisfaction, OHS risk management performance (Total Injury Frequency Rate [TIFR]), and employee satisfaction. The study found that common areas of corporate performance are linked to CG as measured by executive remuneration, OHS, employee satisfaction, customer satisfaction, and environmental performance. The study found a positive association between directors' compensation and OHS risk management performance. Mabika (2018) conducted a multiple case study on six leading mining and quarrying companies in Zimbabwe, focusing on improving workers' OHS. The study's findings support a positive and significant relationship between OHS risk management and good CG practices, such as performance-based remuneration.

This study investigated the relationship between CG and OHS hazards impacting the performance of the South African JSE-Listed mining firms. Furthermore, the study's background, main purpose, objectives, and hypotheses are presented. Likewise,

essential research notions, questions, and hypotheses are presented. Furthermore, the research's scope, limitations, methodology overview, and significance are discussed. Finally, the study suggests recommendations for reducing the impact of OHS risks to improve the sustainable and profitable performance of the SAMS.

1.2 Problem statement

Sustainable and profitable mining business worldwide has been premised on a solid cultural motive to acclimate a system of ‘zero harm’ (Dougall & Mmola, 2015). This is echoed in the existing OHS risk management performance milestones, which are not zero regardless of the implied target of ‘zero harm’. According to MCSA (2018), by 2024, the SAMS is expected to achieve the ‘zero harm’ principle, where every worker will return home uninjured, healthy, and alive.

Notwithstanding significant spending on skills development, formulation, and implementation of OHS regulations, adopting high-efficiency low emission (HELE) technology, and providing financial incentives to directors to motivate them to attain the ‘zero harm’ milestone by the year 2024, deaths, injuries and occupational diseases prevalence continue unabated (Abbas, 2018; Adhikary, Keen & Edwin, 2019; Reisenger & Ledgard, 2013; Vyas, 2015). The high OHS risk prevalence rate in the mining sector is one of the main reasons behind the over-emphasis on risk governance in the mining sector by all mining stakeholders (McNally, 2017; Vyas, 2015). While the performance of mining firms in terms of OHS risk management has improved in recent years, the sector remains the second-highest fatality rate in the world (This is Gold, 2018; Abbas, 2018). Safety, health, and environmental risks remain critical in the mining sector at the global and national levels (PricewaterhouseCoopers [PwC], 2018). PwC (2018) further alludes that safety, health, and environmental risks were ranked as the 8th most significant risk faced by mining firms nationally and globally in 2018. Despite the massive and considerable investment in risk management by mining firms, fatal accidents, injuries, new tuberculosis (TB) and silicosis infections, loss of hearing, and other occupational diseases are still prevalent in the mining sector (Utembe *et al.*, 2015 Vyas, 2015; Adhikary *et al*., 2019). Fatal accidents and occupational health incidences in the South African

mining sector also fluctuate yearly. For instance, there were 73 recorded fatalities in 2016, 90 in 2017, and 81 in 2018 (MCSA, 2019

Ruttinger and Sharma (2016) assert that mining hazards cannot be eliminated. Thus, CG structures must implement OHS risk management frameworks that reduce occupational injuries, deaths, diseases, and near misses to minimum levels. This implies that mining firms in South Africa lack adequate and comprehensive OHS risk-mitigating strategies, resulting in inadequate governance of OHS risks in SAMS.

This study will address the research question and phenomenon: *To what extent does CG influence OHS risk management in the South African mining sector (SAMS)?*

1.3 Research aim, objectives, and hypotheses

1.3.1 Research aim

The study's main aim is to determine the impact of CG on OHS risk management performance in the SAMS.

1.3.2 Research objectives

Within the context of the overall aim, the research objectives of the study are to:

- Determine the influence of board size (BS) on OHS risk management performance in the SAMS.
- Establish the impact of board independence (BI) on OHS risk management performance in the SAMS.
- Assess the impact of board gender diversity (GD) on OHS risk management performance in the SAMS.
- Determine the impact of managerial ownership (MO) on OHS risk management performance in the SAMS.
- Establish the impact of audit and risk committee size (ARC) on OHS risk management performance in the SAMS.

1.3.3 Research hypotheses

The study aims to determine the impact of CG on OHS risk management in the SAMS based on the following hypotheses:

H_1: BS has a significant and negative influence on the total injuries frequency rate (TIFR) in the SAMS.

H_2: BS has a significant and negative influence on new cases of occupational diseases (NCOD) in the SAMS.

H_3: BI has a significant and negative influence on TIFR in the SAMS.

H_4: BI has a significant and negative influence on NCOD in the SAMS.

H_5: GD has a significant and negative influence on TIFR in the SAMS.

H_6: GD has a significant and negative influence on NCOD in the SAMS.

H_7: ARC size has a significant and negative influence on TIFR in the SAMS.

H_8: ARC size has a significant and negative influence on NCOD in the SAMS.

H_9: MO has a significant and negative influence on TIFR in the SAMS.

H_{10}: MO has a significant and negative influence on NCOD in the SAMS.

1.4 Research methodology

Research methodology is a general strategy that involves determining the problem, planning process, limitations, approach, data collection, and analysis of the research inquiry (Ponto, 2015). This study investigated how mining firms' internal CG mechanisms influence OHS risk management performance in the SAMS. The study used a positivist research philosophy because this study explored the impact of CG on OHS risk management performance among JSE-listed mining firms using longitudinal quantitative secondary data (Saunders *et al*., 2019). A manifold of existing theories also formulated the tested hypotheses, allowing for further theory development (Saunders *et al.,* 2019). Moreover, this study used a deductive approach to identify relevant CG and OHS risk management theories, which offered the basis for formulating and testing hypotheses to confirm or detest the theories.

The study explored the association between CG and OHS risk management performance variables in the SAMS. Consequently, the explanatory research design was adopted to establish relationships between the predictor and response variables. Likewise, since the study utilised secondary numerical data, a quantitative methodology posited by Saunders et al. (2019) is inexpensive, reliable, and more objective. The study population consisted of all JSE-listed firms. Also, the study considered specific limitations such as data availability, time, nature of the industry, and listing status of the firm for the period spanning 2002 to 2018 in determining a sample of thirty JSE-listed mining firms purposively selected.

Using content analysis techniques, quantitative secondary data on CG and OHS risk management performance was sourced from integrated annual reports of thirty JSE-listed mining companies from 2002 to 2018. This study employed five independent, two dependent, and two control variables to determine the impact of CG on OHS risk management performance in the SAMS.

E-views and Stata were used to perform statistical analysis (descriptive and inferential) of quantitative secondary data concerning board size, board independence, board gender diversity, managerial ownership, audit and risk committee size, total asset value, number of employees, and OHS risk management indicators (TIFR and NCOD) in the SAMS. The descriptive statistical analysis produced central tendency and dispersion measures, including standard deviation, mean, mode, median, range, and trend analysis for each variable under study. Likewise, inferential statistical analysis (correlation and regression) produced bivariate and multivariate relationships between independent and dependent variables. Furthermore, multivariate regression analysis outcomes based on feasible generalised least squares (FGLS) and ordinary least squares (OLS) were used to evaluate the association between at least two predictor variables and a response variable. Diagnostic tests were performed to guarantee the robustness of the multivariate regression analysis results, including serial correlation, normality, and multicollinearity. The diagnostic tests confirmed the panel data was free from regression assumption violations.

1.5 Significance of the Study

The findings of this research inquiry offer theoretical, methodological, and practical contributions to the studies examining the impact of CG on OHS risk management in the South African mining sector. As most prior studies put much emphasis on developed economies such as the United States of America [U.S.A] (Abbas, 2018) and Australia (Panda & Leepsa, 2017), this study is an extension towards gaining insights into developing countries like South Africa. Thus adding to the existing literature on CG/OHS in hazardous industries such as the SAMS.

This study examined the impact of CG on OHS risk management performance, whilst many previous studies focused on the firm's financial performance (ROA, ROE, and Tobin's Q) (Biruk & Gurdip, 2019). The previous studies (Ajmal, Isha, Nordin, Rasheed, Mekhlafi & Naji, 2022; Thangam, Jesharin, Thangpoo, Gnanaraji & Appadurai, 2022) employed qualitative and cross-sectional approaches to explore the influence of CG on OHS risk management, whereas this study will make a meaningful contribution by using panel data and quantitative approach. In addition, given the fragmented literature on the link between CG and OHS risk management, the current study is expected to bring a difference by consolidating corporate governance and OHS risk management literature to understand the South African situation better.

According to the best of the researcher's knowledge, the study might be the first to explore the relationship between OHS risk management and corporate governance in the South African mining sector. Therefore, the findings of this study may be used as a source of reference in future studies on OHS risk management and CG. The findings are also based on the 16 years from 2002 to 2018, characterised by the evolution of the King reports on good CG (King I, II, III, and IV) and the 2007/2008 global financial crisis. In addition, during the 2002-2018 period, OHS risk management proxies fluctuated in the SAMS. Furthermore, this study proposed a conceptual CG-OHS risk management framework that may be used to mitigate occupational risks in the mining sector.

Apart from the theoretical implications, the study's findings are expected to offer practical contributions to the top management of mining companies, policymakers, and the government of South Africa to mitigate losses due to OHS risks using the proposed framework. The proposed CG-OHS risk management framework will add value to the understanding and implementing of health and safety practices in day-to-day mining activities.

1.6 Scope of the research

The research was premised on selected internal CG variables that influence OHS risks in the SAMS. It was relatively easy to access secondary data for the period (2002–2018) as listed mining firms voluntarily complied with JSE listing requirements and King IV report recommendations. Additionally, content analysis was employed to collect data from published online integrated reports.

1.7 Thesis structure

This study consists of seven chapters. Each chapter centres on a specific phase of the research inquiry development, as delineated below.

Chapter 1: Introduction

This chapter reflects on the study's overview, research problem, methodology, limitations, and significance. The chapter offers a concise context of the research problem and an orienting framework by delineating the research's aim, objectives, and hypotheses. Also, the chapter provides the readers with a good insight into the research topic conceptualisation.

Chapter 2: Corporate Governance Theoretical Perspectives

This chapter discusses the applicable CG theoretical frameworks underpinning the study and the evolution of CG practices and theories in national and international arenas. The

literature review on CG sought to determine, substantiate, and build an argument for undertaking this research.

Chapter 3: OHS Risks: Theoretical Perspectives

This chapter examined the background of the target population-mining companies and how CG impact OHS risk management. The mining companies in South Africa are the businesses on which the study was based. This chapter assisted in identifying underlying theories peculiar to the evolution of OHS risk management.

Chapter 4: Conceptual Framework

The study aims to determine the relationship between CG and OHS risk management in the SAMS. This chapter offers a discourse on the proposed integrated CG-OHS risk management framework that may be useful in attaining the ‘zero harm’ milestone by December 2024.

Chapter 5: Research Design and Methodology

This section of the study discusses the research design. Also, this chapter deliberates on how the research plan of the study was executed. Thus, this chapter's cornerstone is the information relating to the research design, population, sampling methods, research ethics, data gathering and management process, and data analysis techniques. Moreover, steps taken to ensure the reliability and validity of the data were deliberated.

Chapter 6: Results Presentation and Analysis

This section of the study presents data analysis outcomes and the interpretation thereof. This chapter is of great importance because it addresses the research question. Moreover, the hypotheses are either supported or refuted based on the results. Hence, the attainment of the research objectives.

Chapter 7: Research Summary, Contributions, Limitations and Directions for Future Research

Since the overall objective is to suggest practical, theoretical, and methodological recommendations to academia, policymakers, and mining firms, this chapter outlines necessary measures to manage the impact of OHS risks among JSE-listed mining firms. The recommendations are mainly based on the scholarly opinions in the literature review compared to the study outcomes.

1.8 Summary

The rationale for this research is engrained in the argument that CG significantly correlates to SAMS OHS risks. Mitigating the frequency and impact of OHS risks in the SAMS lies with the effectiveness of the internal CG mechanisms.

The study uses secondary data sources such as integrated annual and supplementary reports, case study reviews, journals, published articles, textbooks, and newspapers to capture recent trends in CG mechanisms and OHS risk management in the mining sector.

The mining industry was selected for this study due to its invaluable importance in the economy as well as its high rate of fatalities (Dougall & Mmola, 2015). To achieve the goal of this study, the research methodology was formalised, encompassing the overview of the design, universe, data collection and analysis, results, and recommendations for future research.

CHAPTER 2: CORPORATE GOVERNANCE THEORETICAL PERSPECTIVES

2.1 Introduction

The previous chapter presented the background in which the study is grounded. This chapter provides a theoretical basis for CG evolution in South Africa and globally. This chapter is intended to reveal the contests faced by governing bodies of mining firms to achieve the 'zero harm' milestone in the SAMS. Moreover, this chapter reviews the literature on CG frameworks, theories, and empirical studies. Firstly, the definition and components of CG are discussed in detail. Also, CG evolution from the 1700s to date is reviewed. Furthermore, different CG theories and frameworks are highlighted. Lastly, empirical studies on CG and firm performance, including OHS risk management issues, are deliberated.

2.2 Definition of corporate governance

CG is defined differently by various proponents grounded on their theoretical viewpoints. Alharbi and Alharbi (2021) define CG as the set of control mechanisms to promote and protect the interests of multiple stakeholders. Additionally, the Institute of Directors Southern Africa (IoDSA, 2016:11) states that *CG "is the exercise of ethical and effective leadership by the governing body towards the achievement of governance outcomes such as ethical culture, good performance, effective control, and legitimacy".* Cadbury (2018) echoes that CG is the measure taken to attain equilibrium between the social and economic objectives of stakeholders and the company by the governing body.

CG can be narrowly or broadly defined. In addition, CG has been defined according to different codes of best practice such as the Organisation of Economic Co-operation and Development (OECD, 2019), Common Wealth Association of Corporate Governance, Guidelines-Principles of Corporate Governance in the Commonwealth [GPCGC] (1999), Belgian Code of Corporate Governance of 2020 (Corporate Governance Committee [CGC], 2020), and Securities and Exchange Board of India Committee on Corporate

Governance [SEBI], (2004). The narrow definition states that CG covers controlling and governance issues within the company itself (Global Corporate Governance Forum [GCCF], 2005). In its narrowest sense, CG emphasises the behaviour of companies, non-financial and financial performance, growth, efficiency, and treatment of stakeholders. Under the broader definition, CG entails the relationship between internal and external stakeholders and corporations. Stakeholders of corporations include but are not limited to creditors, shareholders, financial markets, government, customers, customers, and employees. As such, business entities, for instance, mining firms, must balance their economic interest and that of their stakeholders. According to Cadbury (2018), CG, in its broad context, focuses on maintaining the equilibrium concerning profit and people goals and among corporations and societal goals. Intrinsically, employees are critical stakeholders that must be taken care of through implementing sound OHS risk management strategies. The responsibility of balancing the corporation's economic interests and employees' well-being is solely the duty of the corporate governance body. Broadly, CG also incorporates social responsibility offerings to charities and environmental protection projects.

Different codes of best practices define CG in various ways. GPCGC (1999) states CG is fundamentally about leadership adeptness, justice, accountability, and responsibility. CG also involves a set of affairs among the firm's leadership, investors, and other key stakeholders (OECD, 2019). On the same front, CGC (2020) asserts that CG is a collection of principles, policies, and guidelines bestowing which corporations are overseen and controlled. However, SEBI (2004) contends that CG is concerned with recognising undisputable constitutional rights of stockholders as actual owners of the firm and directors as agents who act on behalf of stockholders.

Cadbury (2018) emphasised that the CG matrix exists to boost efficiency and effectiveness in utilising resources and to guarantee that somebody is held to account for how the company's economic resources are used. CG refers to the private and public institutes comprising laws, principles, regulations, policies, and conventional business codes of practice that govern the association between business managers and financiers

on the one hand and shareholders on the other (OECD, 2019). The primary goal for CG is to arrange in a line as closely as possible the interests of all stakeholders and companies (IoDSA, 2016; OECD, 2019).

It has been argued that there is no single best model of CG, and it cannot be generally applied in standard form but is somewhat accustomed to the economic, legal, and political circumstances experienced by firms and countries (Alharbi & Alharbi, 2021; OECD, 2019). This diversity echoes discrete societal values, various forms of ownership structures, industry conditions, and competitive conditions strength in addition to the enforceability of contracts.

The above-mentioned definitions and arguments infer that CG is strongly linked to the social, political, economic, and regulatory environment in which corporations operate. The effectiveness of CG is premised on the political positions of shareholders and debt holders and the implementation of the legal system (Buallay, Hamdan & Zureigat, 2017). Thus, CG is critical in every institute's better financial and non-financial performance. As CG adds to enhanced performance, every entity is anticipated to implement strategies to attain a predefined goal, for instance, the ‘zero harm’ milestone, by December 2024 in the mining sector. However, the IoDSA (2016) definition of CG was adopted in this study.

2.3 Importance of corporate governance

The need to embrace the best corporate governance practices worldwide has been necessitated by the dynamic socio-economic, political, and regulatory environment coupled with corporate scandals (Yilmaz, 2018; Wachira, 2019; Ali & Khan, 2022). Recently, CG has become a prominent topic in boardroom discussions because of its critical role in firms' sustainable and profitable growth and development (OECD, 2019).

Best corporate governance practices have become infused into daily business operations due to factors such as technological developments, financial markets liberalization and deregulations, increase in competition, technological improvements, increasing capital mobilisation, international financial integration, and the rise of the private market-based investment process (Ali & Khan, 2022; Global Corporate Governance Forum [GCGF], 2005).

Technological advancement has steered to the opening of financial markets, free trade, and the apportionment of capital for competing purposes within and across different nations has become multifaceted, as has the monitoring of how capital is being utilised (GCGF, 2005). The dynamics brought about by technological improvements made best practices of corporate governance more challenging to offer investors flawless and comprehensive financial statements (GCGF, 2005). The impact of technological advances in CG structures has been evidenced by establishing information technology committees as recommended by King IV's report on CG (IoDSA, 2016).

2.4 Evolution of corporate governance

The evolution of CG started centuries ago in response to corporate failures, global financial crises, frauds, company collapses, legislation, and regulatory changes (Tshipa, Bummer, Wolmarans & Du Toit, 2018). Regulatory bodies and stock exchanges such as the Johannesburg Securities Exchange (JSE) and London Stock Exchange (LSE) issued directives regarding the adoption of corporate governance mechanisms and disclosure by listed companies to minimise corporate failures (Yilmaz, 2018).

2.4.1 Global context

CG revolution started first in the developed world and then spread to developing countries (Yilmaz, 2018). The earliest chronicled CG failure was the South Sea Bubble in the 1700s, which triggered the corporate regulations and code revolution in England (Chouaibi, Chouaibi & Rossi, 2021; Conlen, 2015). At the same time, CG was formalised by introducing securities law to respond to the 1929 stock market crisis (Chouaibi *et al*., 2021).

Additionally, in Europe and the USA, the spread of capitalism was directly linked to the rise of democratic political systems (Robinson, 2020). As capitalism spread uncontrollably during the fourth industrial revolution, few individuals became richer and richer whilst most people became poorer (Callaghy, 2019). The widening inequality gap led to intervention by political systems to regulate and control business activities, as there was unlimited abuse of market power (Siddiqui, 2018). Despite the intervention of governments, capitalism prevailed.

Siddiqui (2018) further asserts that the success of capitalism gave rise to the significant expansion of large businesses. Most investors explored the opportunity by funding extensive developments and big business entities by tying their capital together. The capitalists became shareholders in corporations that invested vast sums of funds (Robinson, 2020). As a result, established large corporations could not be managed and controlled effectively by proprietors and their management for definite reasons. In the twentieth century, publicly owned enterprises became a reliable legal form of business ownership (Siddiqui, 2018). As such, public companies were regarded as attractive to investors as they possess features such as limited liability, separate business entities, and going concern entities.

In Africa, the need for good CG practices was triggered by corporate incidences, for instance, fraudulent reporting, as in the case of African Petroleum (AP) in Nigeria's corporate scandals (Imade, 2019). The major causes of such CG malpractices were overtrading, creative accounting, fraud, high gearing ratios, and poor liquidity management. Consequently, CG failures in Africa led shareholders and key stakeholders to demand effective governance practices. Since CG was placed under the radar over the last two decades, many codes and laws were promulgated to protect the interests of the companies and key stakeholders.

2.4.2 Evolution of corporate governance in South Africa

South African CG evolution is best explained by introducing soft codes such as King I to King IV (IoDSA, 2016) and promulgating the Companies Act 71 of 2008. King I to IV

(IoDSA, 2016) reports on good CG were instituted and evolved from 1994 to 2016 in South Africa. Additionally, the hazardous nature, labour and capital intensiveness of the SAMS gave rise to the emergence of CG (Moroe & Khoza-Shangase, 2018). The governing bodies of the mining sector need to act in a way that protects and promotes the interest of workers by ensuring healthy and safe working environments (Lu, Taksa & Jia, 2020; Moroe & Khoza-Shangase, 2018). Moreover, the CG mechanisms of mines need to protect and promote the health and social welfare of the communities around them (Lu *et al*., 2020; Gul & Ak, 2018). Furthermore, mining companies also need to formulate and implement strategies that eliminate the destruction of the natural environment. To this end, the high demand to protect the economic, social, and environmental interests of mining firms has given rise to changes in laws as well as corporate governance frameworks that guide the top management practices in South Africa and the world at large (Jiskani *et al*., 2019; Sealetsa, 2021; Tetzlaf *et al.,* 2021).

2.5 Corporate Governance: theoretical perspectives

Literature on CG has raised many questions regarding the readiness of mining companies to effectively work towards the attainment of ‘zero harm’ (MCSA, 2020), and this study justifies the need to comprehend the CG variables and their impact on OHS risk management. According to Damschroder (2020) and Van Patten, Williams, Gregory, Keating, and Wulf (2020), theories form the basis of literature review in any research inquiry. As such, a manifold of corporate governance theories is explored to determine the impact of CG on OHS risk management. Moreover, it is suggested that applying a mixture of CG theories offers a comprehensive insight into the strength of CG practices rather than relying on one theory (Remenyi, 2020; Tjano, 2022). However, CG theories form the basis of BS, BI, GD, MO, and top management duties instead of corporate regulatory structures. CG is deeply founded in many theories, such as the agency (Jensen and Meckling, 1976), shareholder (Friedman, 1970), stakeholder (Freeman, 1984), stewardship (Donaldson & Davis, 1989), and legitimacy theory (Dowling & Pfeffer, 1975). This study reviewed six CG theories: legitimacy theory, shareholder theory, enlightened shareholder theory, stakeholder theory, stewardship theory, and agency theory.

2.5.1 Agency Theory

As promulgated by Jensen and Meckling (1976), agency theory affirms a conflict of interests between stockholders and the board of directors due to separation of ownership and control, different risk tolerances and appetite, moral hazards, and information asymmetry. Agency problems can be traced back to when humankind started to venture into entrepreneurship and focused on maximising their interest (Panda & Leepsa, 2017). Panda and Leepsa (2017) further conjecture that agency problem exists in firms because principals (shareholders) appoint agents (managers) to manage their economic interests whilst managers are risk averse and are concerned about their benefits. In this study, the agency theory provides the basis for the investigation of the impact of CG on OHS risk management in the SAMS. In this light, directors of companies are appointed by shareholders to meet key performance targets, such as the achievement of the ‘zero harm’ milestone by December 2024.

2.5.2 Shareholder theory

The shareholder theory is grounded on the relationship between firm shareholders and directors (Friedman, 1970). According to shareholder theory, the market controls the company's board of directors' quality and level of commitment. Most importantly, competitive markets control the quality of CG by decreasing the demand for shares in underachieving firms and, consequential, lower share values. A significant decrease in share prices and values may increase the probability of hostile takeovers and mergers, putting the jobs of management at risk. The board of directors will always seek to steer the company towards success and maximise shareholder returns to protect their jobs and reputation. Deegan (2019) postulates that the board of directors needs to perform exceptionally well in critical areas such as OHS risk management, CG, corporate social investment (CSI), production, sales, carbon footprint reduction, and innovation research. The shareholder theory is significant as managers of mining companies need to work towards achieving the company’s objectives, such as health and safety milestones, increasing the shareholder value for which they are paid.

2.5.3 Stakeholder theory

Stakeholder theory was founded by Freeman (1984) as a management instrument and advanced into a well-founded theory based on a tremendous explanatory perspective. According to stakeholder theory, the balance of stakeholder interest is the major determinant of a business entity's policy. Pedrini and Ferri (2018) indicate that the stakeholders of a company are classified into consubstantial, contractual, and contextual. Pedrini and Ferri (2018) further propose that the most important class of stakeholders is substantial since they are critical to the firm's sustainable growth, including shareholders, strategic partners, and employees. In addition, contractual stakeholders refer to stakeholders with official contracts with entities such as suppliers and financial institutes. Also, contextual stakeholders are agents of the societal and natural systems in which the firm operates. They play a crucial role in getting firm trustworthiness and, subsequently, the acceptance of their operations (Pedrini & Ferri, 2018).

Freeman (1984) alludes that the most contributing to risk management is the addition of implicit contracts such as employment and sales. Freeman (1984) further asserts that corporate risk management practice increases the firm value and reduces financial costs and chances of bankruptcy. Thus, stakeholder theory provides new insight into possible drivers for risk management. One of the elements of risk management is operational, which embeds OHS risk management performance. Thus, the literature of this study was based on the premises of stakeholder theory, bearing the fact that employees are one of the key stakeholders interested in the firm's performance (Vyas, 2015; Dougall & Mmola, 2015). As such, if the management of mining firms inadequately balances the interest of employees, especially OHS, and firm performance, the management risks steering the firm into a loss-making entity.

2.5.4 Enlightened stakeholder theory

Enlightened shareholder theory is deeply rooted in the complex and robust interdependence between the company and certain groups, such as employees, customers, investors, creditors, and suppliers, based on the work by Jensen (2001).

Additionally, enlightened stakeholder theory states that firms cannot maximize their long-term values if they do not consider the interests of their stakeholders (Lund, 2020). One of the practical consequences of the enlightened stakeholder theory is that board members must be carefully chosen. The board members must be well versed in accountancy and company law and know perfectly about the company's organisation, processes and procedures, and industry. They also need to be well-equipped with risk assessment skills and expertise faced by the firm and its stakeholders (Keay & Igbal, 2019).

2.5.5 Legitimacy theory

Legitimacy theory is rooted in the generalised discernment that business operations are appropriate, suitable, or inapt with some socially developed norms and values (Deegan, 2019; Dzingai & Fakoya, 2017). Legitimacy theory has been used as a basis for previous studies by various researchers on corporate social responsibility reporting in the South African mining sector (Cronje & Sturdy, 2017; Shuro & Stainbank, 2014). Deegan (2019) posits that the theory is premised on the notion that profit is not a complete benchmark of the organisation's legitimacy. Dzingai and Fakoya (2017) point out that the organisation's legitimacy is grounded in its compliance with societal expectations, and failure to comply will result in exclusions being put in place in the form of restrictions on the business activities, right to use natural resources and demand for its products. The firm's legitimacy is also impacted by corporate crimes and scandals, environmental disasters, industrial infrastructure failure, health and safety incidences, and product failure (Pedrini & Ferri, 2018).

Kyere and Ausloos (2022) further stated that a business might act to remain legitimate by voluntarily reporting social and environmental aspects in the corporate integrated annual reports and/or sustainability development reports. Social and environmental factors include non-financial metrics such as GHG emission intensity, employee fatalities, occupational health incidences, corporate social responsibility, and skills development (Deegan, 2019).

Legitimation may take one or more of the following forms: educating stakeholders about the business' intentions, seeking to change stakeholder perceptions of issues, and seeking to alter external expectations about the company's performance (Pedrini & Ferri, 2018; Deegan, 2019). In this study, legitimacy theory offered the grounds for investigating the relationship between CG and OHS risk management in the SAMS since reporting OHS risk management is a vital, legitimate issue that guarantees a social license to operate.

2.5.6 Stewardship theory

Stewardship theory is premised on the assumption that managers are good stewards who execute their duties to pursue and promote the interests of shareholders (Donaldson & Davis, 1991). The stewards are expected to act in a manner that balances firm performance and governance by satisfying the requirements of the integrated parties (Kyere & Ausloos, 2022). Mukwarami *et al.* (2022) point out a positive correlation between shareholder value and management utilities. Under the banner of stewardship theory, management is an agent whose interests align with those of shareholders (Tshipa *et al*., 2018). Tshipa *et al.* (2018) also propound that managers as stewards are inspired to make decisions that equal those of owners that would boost firm performance.

Stewardship theory is based on the premise that managers execute their duties carefully to enhance shareholder returns by being noble overseers of company assets (Mukwarami *et al*., 2022). The positive link between shareholder value and CG under stewardship theory is embedded in the structure and hierarchy of organisations. As such, CG ought to deliver enabling and empowering systems and processes to managers, allowing managers to provide the best returns to shareholders (Tshipa *et al.,* 2018). Thus, managers meeting key stakeholder groups' interests and expectations will increase firm performance, including production, OHS, sales, profitability, CG, and climate risk management (Dougall & Mmola, 2015). Henceforth, the stewardship theory is relevant in addressing the CG/OHS risk management performance debate in the mining sector of South Africa.

The stewardship role implies that CG mechanisms of mining firms are charged with the responsibility of ensuring that no worker must go home dead, sick, or injured. As stewards, mining firms' board of directors (BoD) formulate and implement policies, frameworks, and relevant legislation to protect and promote the OHS of employees.

The aforementioned theories are vital to the study as they posit the sustainable performance of firms, promote good CG practices, and ensure a strong relationship between the board of directors and other firm stakeholders to steer the company toward achieving its key performance targets. To this end, the relationship between management and other key company stakeholders should be well-matched to mitigate the impact and frequency of OHS risks in the mining sector. As such, CG practices need to be attuned to OHS risk mitigation strategies.

2.6 Mechanisms of corporate governance

De Beer (2020) asserts that CG comprises internal and external mechanisms. Internal CG mechanisms are concerned with promoting and protecting shareholders and functions on the governing body to monitor and control top management. Internal CG mechanisms are broadly divided into the board of directors and ownership structure. BoD components comprise board size and composition, Chief Executive officer (CEO) duality, and audit committee. At the same time, the ownership structure includes internal ownership, external ownership, institutional investors, and family-controlled businesses (de Beer, 2020). However, external CG mechanisms are broadly divided into the takeover market and the legal system. The market takeover is further split into the domestic and international markets and the legal system into civil, criminal, and corporate laws (Dzingai & Fakoya, 2017). Conversely, external CG monitors and controls the manager’s actions through regulation involving various stakeholders such as creditors, debtors, lawyers, and suppliers**.** The current study employed BS, BI, GD, MO, and ARC to explore the impact of CG on OHS risk management in the SAMS as in previous studies (Mukwarami *et al.*, 2022; Tshipa *et al*., 2018; Tjano, 2022).

2.6.1 Board of Directors

Corporate governance distinguishes the function, structure, and role of a board of directors (BoD), recognising the approaches in which companies are organised (Naciti, 2019). The BoD, which is the primary vehicle for corporate governance, is liable for safeguarding the interests of the stakeholders of a firm by controlling its operation and backing its decision-making (Chams & Garcia-Blandon, 2019). The BoD is one of the internal CG mechanisms proxies that comprises BS, board composition (women on board, age of board members, race, experience, and qualifications), BI, and board committees (Imade, 2019; Gennari, 2018; Wachira, 2019). According to IoDSA (2016), corporate governing boards execute critical roles and are considered the core business management mechanism. In addition, Ntim, Opong, and Danbolt (2015) point out that corporate boards perform two distinct roles: agency and resource dependency. Besides, the roles of corporate boards may vary by country. The BS and firm performance may vary by firm-level attributes and country-specific characteristics (Ntim *et al.,* 2015). Broadly, directors are categorised into executive and non-executive directors. Executive directors are involved in the company's management, including developing strategies for growth, long-term goals and decision-making. Yet, non-executive directors are not part of management but assist executive directors in decision and policy making (Imade, 2019). For this study, BoD characteristics entailing BS, BI, GD, MO and ARC were utilised to examine the impact of CG on OHS risks in the SAMS.

2.6.2 Board size

BS refers to the number of members that constitute BoD, including executive and non-executive independent directors of a firm (Mahmood, Kouser, Ali, Ahmad & Salman, 2018; Zabri, Ahmad & Wah, 2016). Effectively structuring the board is critical to how the company is governed (Zabri *et al*., 2016; Endrikat, Devilliers, Guenther & Guenther, 2021). Various empirical studies have found that board size differs from nation to nation due to different cultures (Mahrool, Naza & Azee, 2020; Addo, 2019).

Additionally, Zabri *et al.* (2016) studied the impact of CG practices on the financial performance of the top 100 listed Malaysian firms. They found an average board size of nine members and a negative relationship between financial performance and board size from 2008 to 2012. In the same way, the size of BoD in JSE-listed companies is not prescribed by law or CG frameworks but rather by a flexible approach. The size of corporate boards in South Africa is determined by the size and nature of the company (Ntim *et al*., 2015). Previous studies were conducted on the effect of board size on firm performance (market, operational and financial) with different findings and results. A study by Akram, Omair, Ameen, Jaskani, and Babar (2014) on the impact of CG on the financial performance of listed Pakistan banks using the survey method found no significant relationship between BS and financial performance. Buallay *et al*. (2017) investigated the impact of CG on operational, financial, and market performance in Saudi Arabia-listed firms. The study found a negative and insignificant relationship between the BS and financial performance, BS and operational performance, and BS and market performance using pooled data collected from the Saudi Arabia stock exchange. Ntim *et al*. (2015) studied the impact of CG on firm value in JSE-listed firms and found a positive relationship between BS and firm value. Limited research on the impact of BS on OHS risk management in the SAMS has been undertaken. In this study, BS was used as one of the CG variables in examining its impact on OHS risk management.

Risk management is one of the key performance areas of BoD in every entity (IoDSA, 2016; FRC, 2015), and as such, OHS risk management is embedded in the daily duties of the board of directors. IoDNZ (2013) further predicates that board members who fail to show leadership in OHS risk management are incompetent in executing their daily duties and responsibilities as directors and their moral duty, damaging the entity's image.

The extant literature, therefore, presents proof that board size as a CG proxy substantially impacts firm performance in terms of occupational risk management of the organisation, which is measured through TIFR and NCOD. Therefore, this study proposes a hypothesis to prove if CG variables as measured by BS might have significant impacts on OHS risk management, and the hypotheses are stated as follows:

H_1: BS has a significant and negative influence on the total injuries frequency rate (TIFR) in the SAMS.

H_2: BS has a significant and negative influence on the new cases of occupational diseases (NCOD) in the SAMS.

2.6.3 **Board independence**

Zabri *et al.* (2016) define board independence (BI) as the ratio of the aggregate number of independent to the aggregate number of directors expressed as a percentage. Cadbury Report (2018) asserts that corporate boards must consist mostly of independent non-executive directors. IoDSA (2016) indicates that members of the corporate governing body may be classified as non-executive independent only if it determines that there is no interest, position, or relationship, which, when adjudicated from the viewpoint of a rational and knowledgeable third party, is probably to sway improperly or lead to bias in decision-making in the finest interests of the entity.

Various researchers examined the impact of BI on the performance of firms with inconsistent findings (Zabri *et al.,* 2016; Fuzi, Halim & Julizaerma, 2016; Uribe-Bohorquez, Martnez- Ferroro & Garcia-Sanchez, 2016). A study by Zabri *et al.* (2016) on the impact of CG practices on firm performance in Malaysia's top 100 listed companies found that 46% of the BoD comprised independent directors. The study also found a weak positive relationship between board independence and firm performance among the top 100 listed Malaysian firms.

The extant literature suggests that BI significantly impacts firm performance, including OHS risk management (Bisset, 2020; Setia-Atmaja & Hidayat, 2021; Karim, Ranjan & Khan, 2020). However, the current study builds on the previous studies by striving to establish if BI impacts OHS risk management in the SAMS.
Therefore, the proposed hypotheses are stated as follows:

H_3: BI has a significant and negative influence on the TIFR in the SAMS.

H_4: BI has a significant and negative influence on the NCOD in the SAMS.

2.6.4 Women on board

The inclusion of women in BoD has recently been given remarkable attention (Wachira, 2019; Nguyen, Locke & Reddy, 2015; Ggyapang, Monem & Hu, 2015). The number of women on the board is one of the common proxies of board gender diversity (GD) and balance (Gennari, 2018; Perryman, Fernando & Tripathy, 2016). Gennari (2018) asserts that many firms' increased presence of women in the BoD is a clear commitment toward the 2030 corporate sustainability agenda goal five (5): women on boards. Proponents of board GD argue that the inclusion of women in board composition influences firm performance in a positive way (Marinova, Plantenga & Remery, 2020; Brahma, Nwafor & Boateng, 2020). Also, the 'tokenism' theory by Kanter (1977) posits that women's representation in corporate boards should be at least three to improve firm performance. The lines of literature on board GD focus on diverse areas. Some areas of literature cover the association between GD and the financial performance of firms (Adnan, Sabli & Abdullah, 2013), GD and corporate sustainability (Ibrahim, Saleh & Hassan, 2020), and GD and risk management (Bufarwa, Elamer, Ntim & AL hares, 2020; Agyamany-Mintah & Schadewitz, 2017).

According to Arora (2022), GD increased board effectiveness in key performance areas such as OHS, production, sustainability, and profitability and recommended embracing women's presence in BoD. On the one hand, Addo (2019) found no link between GD and firm risk management among listed firms in Ghana. On the other hand, Garcia-Izquiedo (2018) asserts that the inclusion of women in corporate boards has long been considered an organisation's good corporate governance practice. Monteiro, Garcia-Sanchez, and Aibar-Guzman (2022) carried out a study in 1243 international firms on the impact of women managers on labour and human rights performance and found a positive relationship. The findings by Monteiro et al. (2022) confirmed that the presence of women in management teams is a major driving force for improved social responsibility performance among international firms. Poletti-Hughes and Briano-Turrent (2019) examined the relationship between gender diversity on BoD and corporate risk-taking and

found a positive association. Henceforth, mining firms in South Africa must embrace board GD to improve good corporate governance, which will cascade into reducing operational risks such as OHS.

GD is one of the corporate governance variables that impact firm risks, such as OHS risks, as given in the literature, and it is fundamentally vital to view that gender diversity and OHS risk management are significantly correlated. In the case of the SAMS, GD, as represented by the percentage of women in the BoD, require further investigation. Therefore, the hypotheses to be tested are provided as follows:
H_5: GD has a significant and negative influence on the TIFR in the SAMS.
H_6: GD has a significant and negative influence on the NCOD in the SAMS.

2.6.5 Audit and risk committee

"The governing board should ensure that its arrangements for delegation within its structures promote independent judgement and assist with balance of power and the effective discharge of its duties" (IoDSA 2016:54). According to the eighth principle of King Report on Corporate Governance for South Africa (King IV) and corporate governance (IoDSA, 2016) a governing body should constitute different board committees possessing adequate skills, experience, and capacity to execute delegated duties. IoDSA (2016) points out that King IV's report on CG does not prescribe board committees that should be established. Nevertheless, the governing board may use discretion to establish appropriate board committees for the organisation. As postulated by King IV (IoDSA, 2016) governing body, board committees might delegate responsibilities and duties, including audit, remuneration, nominations, risk governance, and social and ethics committees. In this study, audit and risk committee (ARC) size was used as proxies for board committees to measure the impact of CG on OHS risk management in the SAMS.

Establishing sub-committees such as the ARC is a legal requirement for organisations that publish audited integrated annual reports (IoDSA, 2016). IoDSA (2016) asserts that one of the roles of ARC is to oversee the governance of financial and non-financial risks that influence the integrity of published integrated annual reports of an organisation.

Various studies have found that corporate governance variables such as the size of ARC influence OHS risk management practices (Perez-Cornejo & de Quevedo-Puente, 2019; Biruk & Gurdip, 2019). According to IoDNZ (2013), OHS risk management is an integral success factor for BoD. IoDNZ (2013) points out that OHS risk management is a CG issue, and the board should integrate health and safety risks in the governing structures, such as sub-committees, remuneration, and ARC.

In a study conducted in Sweden, Nordlof, Wiitavaara, Hogberg, and Westerling (2017) investigated the influence of economic factors and CG on OHS risk management in 197 Swedish manufacturing firms. According to the study results, ROA, ROE, firm size, and the presence of ARC were found to have a significant and positive effect on OHS risk management practices. Additionally, other studies reported a significant and positive relationship between ARC and firm performance (Perez-Cornejo & De Quevedo-Puente, 2019; Biruk & Gurdip, 2019).

Given the literature, it has become apparent that ARC influences OHS risk management practices. Therefore, this study focuses on establishing a relationship between CG as represented by the size of ARC and OHS risk management in the SAMS. Thus, the relationship was confirmed through testing of the hypotheses stated as follows:

H_7: ARC size has a significant and negative influence on TIFR in the SAMS.
H_8: ARC size has a significant and negative influence on NCOD in the SAMS.

2.6.6 Ownership structure

The approach concerning integrated reporting and CG is strongly influenced by the ownership structure of firms (Wachira, 2019; Nugraha, 2021). Ownership structure plays a crucial part in firms' CG and OHS risk management. The company’s ownership structure is categorized into internal (managerial) and external (shareholder) ownership structures. Internal ownership is well-defined as the proportion of equity held by top management, whereas external ownership refers to the proportion of total equity held by outsiders (Din, Javid & Imran, 2017). Numerous studies were done in various countries on the impact of

ownership structure on the performance of firms with inconsistent findings (Addo, 2019; Rehanan, Ramizan, Haq, Hwang & Kim, 2021; Berk-Berga, Dovbekova & Abual, 2017).

The extant literature suggests that directors' shareholding (managerial ownership) as a proxy for ownership structure significantly impacts firm performance, including OHS risk management. However, this study was premised on previous empirical studies to determine the impact of managerial ownership (MO), measured as directors' equity ratio and the total number of shareholders' equity on OHS risk management in the SAMS. Therefore, the proposed hypotheses are stated as follows:

H_9: MO has a significant and negative influence on TIFR in the SAMS.
H_{10}: MO has a significant and negative influence on NCOD in the SAMS.

2.7 Corporate governance frameworks

In the last three decades, various CG frameworks and guidelines were promulgated necessitated by corporate scandals, mining accidents, and financial crises in the last decade (de Beer, 2020). For instance, in 2011, the DMR was implicated in the corrupt issuance of mining Rights to Imperial Crown Trading. Also, on the 8th of May 2022, four mine workers lost their lives at the Kusasalethu mine due to an infrastructure-related incident (MCSA, 2022). Additionally, South Africa lost more than 11000 mine workers to OHS-related incidences between 1984 and 2005. Consequently, in labour-intensive and dangerous industries such as the mining sector, CG practices resurgence is linked to the financial crisis, corporate scandals, and OHS risk management. For this study, CG frameworks that were utilised are the King IV Report on CG (IoDSA, 2016), OECD principles of CG (OECD, 2019), and the Cadbury Report (FRC, 2018).

2.7.1 Cadbury Report

The Cadbury Report was promulgated in 1992 by the Financial Reporting Council (FRC), the London Stock Exchange (LSE), and the accountancy profession as a ground-breaking effort to try and recommend guidelines, principles, and foundations of a set of CG codes to avert and minimise corporate scandals and failures in the future. In the United Kingdom, contemporary CG started with the promulgation of the Cadbury report in 1992 (FRC,

2015). The promulgation of the Cadbury Report was driven by an increasing lack of investor confidence, board accountability, and several high-profile company financial collapses (Ilonga, 2014).

Ilonga (2014) conjectures that the Cadbury Report brought about more than a few significant benefits in how firms are managed and controlled. Increased accountability, fairness, transparency and independence, protection of weak and widely distributed stockholders against the self-engrossed board of directors and managers, and prevention of company collapses such as Enron, Parmalat, and the Maxwell Companies are some of the main benefits of applying Cadbury Report best codes of corporate governance (Ilonga, 2014). Intrinsically, firms in the SAMS are not an exception in using the Cadbury Report recommendations to mitigate inherent risks such as OHS risks.

2.7.2 OECD Principles of corporate governance

OECD principles on CG were promulgated in 1999 and reviewed in 2015 from 8 to 9 June in Fukuoka, Japan. Initially, the principles were meant to assist firms operating in Group of 20 (G20) member countries. Instead, it was adopted by firms domiciled in non-G20 countries. The framework was later called the G20/OECD principles of CG. The G20/OECD principles of CG aid policymakers and regulators to enhance regulation, legal, and institutional framework for CG, supporting economic efficiency, sustainable growth, and financial stability in member countries. Guidelines for OECD advocate for a flexible CG framework that suits the firm's regulatory and political environment context. The OECD principles on CG comprise six sections: guaranteeing the premises for CG framework efficacy, the rights and impartial treatment of stakeholders and principal ownership functions, institutional investors, securities exchange boards and the intermediaries, disclosure and transparency, and the obligation of the BoD.

In the SAMS, the OCED (2019) principles of CG are relevant since South Africa is one of the member countries and can be applied flexibly as long as the firm is not violating the laws of the land. Principle (IV) encourages firms to embrace the role of stakeholders, including employees in CG (OECD, 2015). Firms need to uphold and promote the rights

established by law or through mutual agreements of their stakeholders. Mining firms need to apply this principle by protecting employees' right to a healthy and safe environment by improving one of the aspects of non-financial performance.

The OECD principle (IV) further encourages stakeholders, including employees, to report unethical business practices by firms to regulators, such as the unsafe working environment. Furthermore, principle (V) of the OECD corporate governance encourages firms to disclose both financial and non-financial performance of firms fully. Accordingly, in the SAMS, firms must fully report on their financial performance (income statement, Balance sheet, and cash flow statements) and non-financial performance (for instance, OHS risks). Furthermore, the OECD guidelines encourage firms to disclose human resources policy fully. Hence, employees are regarded as invaluable assets. As such, mining firms must disclose their policies on OHS and how they intend to mitigate risks associated with a poor health working environment.

2.7.3 King IV Report

King IV's Report on CG was promulgated by IoDSA (2016) as a replacement for King III's report on CG in its entirety, and it came into effect in 2016. King I, II, and III reports on CG were based on different principles. King I and III reports were both based on the “explain” principle, implying that BoD had a choice of not implementing the codes of CG as outlined in the report if they had a justified explanation. The “apply or explain” principle formed the core of the King III report (IoDSA, 2009). The BoD is expected to execute their duties in good faith, is recommended to apply certain codes as enshrined in King III's report and would apply certain principles not recommended by the code for the advantage of the enterprise. The BoD is mandated to explain the practice and the reasons for applying such principles. According to IoDSA (2009), the overriding reason for applying an approach not recommended by King III's report must be in the company's best interests. The evolution of the King reports on good CG from 1994 to 2016 and maybe into the future was necessitated by significant changes in laws governing the operations of companies, corporate failures, and the 2008 global financial crisis. For instance, the amendment of Companies Act 71 of 2008 necessitated the need to change from King II

to King III in 2009. IoDSA (2009) asserts that CG frameworks need to be aligned with the country's laws to enhance companies' good corporate citizenship status.

2.8 Corporate Governance: empirical perspectives

Various studies were carried out on the impact of CG on the performance of firms with inconsistent results. However, limited attention was given to the impact of CG on OHS risk management in the SAMS. Most studies were done to determine the relationship between CG variables and the financial performance of firms, with inconsistent findings in different economic sectors globally.

Adaku, Ankrah, and Nekugri (2021) investigated the factors that influence OHS culture in the mining industry in twelve countries: Brazil, China, India, Turkey, Sweden, Kenya, Mongolia, Russia, Ghana, Taiwan, and South Africa, using the Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) approach. The study found that commitment from the BoD and top management is the key determinant of OHS risk management performance in the mining sector in developed and developing countries. The findings of the study are supported by Waring (2019). Waring (2019) studied the five pillars of OHS risk management performance in an authoritarian socio-economic context and found CG as the cornerstone.

Tang, Yang, and Yang (2020) carried out a study to examine the impact of CG on corporate social responsibility (CSR) among Chinese state-owned enterprises (SOEs) from the period 2008 to 2016 using qualitative comparative analysis. The empirical results showed that concentrated ownership as one of CG proxies positively influenced OHS risk management performance through enhanced CSR.

Mahmood, Kouser, Ali, Ahmad, and Salaman (2018) examined the association between CG and sustainability performance of 100 listed Pakistan firms using a quantitative design method from 2012 to 2015. CG proxies were board GD, BS, and BI, whereas sustainability performance proxies were environmental, social, and economic. However,

OHS risk management is one of the key social performance indicators (Mahmood *et al*., 2018).

The Ordinary Least Squares (O.L.S.) estimation technique GD and BS confirmed an insignificant and positive relationship with social sustainability performance among Pakistan-listed companies. However, BI significantly and positively affected social sustainability performance, including OHS risk management of companies listed on the Pakistan Stock Exchange (PSE). Moreover, Zaman, Jain, Samara, and Jamali (2022) examined the relationship between CG and OHS risk management performance over 27 years using a systematic review of 218 published journal articles and found a positive and significant relationship.

One of the studies done by Gennari (2018) examines the impact of board gender diversity on CSR and a company's strategy towards sustainability in selected large European companies. The study employed a descriptive analysis of secondary quantitative data and a qualitative content analysis with a directed approach. The empirical results showed that women on board positively influence the company's involvement in CSR activities and shift the corporate culture towards sustainability by developing and implementing OHS risk management strategies. In addition, the role of women on board can lead to a more sustainable corporate world (Gennari, 2018; Tjahjad, Soewarno & Mustikaningtiyas, 2021).

The assessment by Ganson (2014) on the efficacy of OHS risk management practices at AngloGold Ashanti Company in Obuasi, Ghana, using the survey method, found that CG mechanisms impact OHS risk management performance. Quantitative data was collected using interviews and questionnaires from employees and management selected using a stratified and simple random sampling technique. The study found that more than 50% of respondents strongly agree that a lack of top management commitment caused most occupational injuries and health incidents, employees' negation to account for minor injuries in addition to near misses, and the expenditure incurred in health and safety training of employees.

Hove-Sibanda, Sibanda, and Pooe (2017) investigated the impact of CG on firm competitiveness and performance of one hundred and fifty-two small and medium enterprises (SMEs) in South Africa, Gauteng area. The study was based on a cross-sectional survey, which employed quantitative research methods. The study confirmed that adopting CG practices positively impacts OHS risk management and the competitiveness of SMEs.

As evidenced by the extant literature, the relationship between CG and OHS risk management in the SAMS context is a novel study. Prior studies did not explicitly investigate the CG/OHS risk management relationship among mining firms in South Africa. Henceforth, the current study explored the CG-OHS risk management relationship to offer a foundation for future studies.

2.9 Summary

In this chapter, different CG definitions were examined, and it was found that there is no universal definition of CG. CG can be defined using either narrow or broad definitions by different proponents of CG. The study, therefore, adopts the broad definition of CG in South Africa as proposed by IoDSA (2016).

In addition, the chapter discusses the importance of CG and its evolution. CG best practices worldwide have been necessitated by the dynamic nature of the political, socio-economic, technological, and regulatory environment. The dynamic nature of the business environments also facilitated the evolution of CG for the past decades.

The chapter discusses CG mechanisms such as board size, board independence, women on the board, ownership structure, and board committees and their impact on the performance of firms. The BoD, through its mechanisms, has the responsibility of steering the company into a sustainable and profitable entity. The last sections of the chapter examined theories underpinning CG and firm performance, empirical perspectives, and

CG frameworks. For this study, agency theory, stakeholder theory, enlightened stakeholder theory, legitimacy theory, stewardship theory, and shareholder theory were reviewed. The next chapter reviews the literature on OHS risks in the SAMS literature.

CHAPTER 3: OHS RISKS: THEORETICAL PERSPECTIVES

3.1 Introduction

The previous chapter deliberated on CG definition, evolution, frameworks, and theories from the South African perspective. The definition and frameworks of CG vary from country to country. Also, the frameworks were crafted in different parts of the world for reasons such as a change in laws, political systems, economic conditions, and corporate failures (IoDNZ, 2013). The vast literature indicates that CG frameworks were formulated and implemented in different countries due to the rise of stakeholder activism, corporate scandals, legislation and policy changes, OHS risk management issues, and economic downturns (Cadbury, 2018; Institute of Directors Southern Africa [IoDSA], 2016).

This chapter deliberates on the OHS definition, theories, and empirical studies. Additionally, this chapter reviewed the emergence of OHS risk management centuries ago. This chapter examines the OHS risk management performance in the SAMS. Numerous theories on OHS risk have been developed to explain the causes of OHS incidences in hazardous sectors such as mining, manufacturing, and construction. These theoretical perspectives include, among others, the domino theory of safety (Frank, 1969), Frank's bird theory (Frank, 1966), and Heinrich's theory (1931). Many studies were done in various countries and economic sectors on the effect of CG on the financial performance of listed companies, with different outcomes depending on CG variables employed.

Most of the previous studies explored the impact of CG on financial performance, not considering non-financial performance variables such as OHS risks. Publicly listed firms must disclose information in their integrated annual and sustainability reports grounded on the triple bottom line principle (IoDSA, 2016). Inversely, most studies done during the last two decades gave little attention to the impact of CG on OHS risk management due to the limited availability of standardised reported information.

According to King I and II reports on CG, publicly listed entities were not mandated to report on their non-financial matrices, as the application of frameworks was based on the

“explain “principle. As such, applying recommended practices by King I and II reports on CG was voluntary as long as the governing body could explain the reason for not using certain principles (IoDSA, 2016).

3.2 Overview of the South African mining sector

The mining sector is regarded as the mainstay industry in South Africa due to its invaluable direct and indirect contribution to the South African economy (MCSA, 2018). In 2019, the mining industry had a market capitalisation of R1.28 trillion, employed 454 861 individuals, and contributed R360.9 billion and R24.3billion to Gross Domestic Product (GDP) and tax revenue, respectively, in South Africa (MCSA, 2020; PwC, 2020).

The mining sector produces all the metal and mineral needs for the African continent, including diamonds, cobalt, copper, and uranium. In the 2022 financial year, the mining industry in South Africa:

- The direct contribution to GDP grew by 4% to R494 billion (2021: R475 billion).
- The percentage contribution of mining to the economy was 7.53% (2021: 7.56%).
- Employed 475,561 people (2021: 458,954).
- Paid employees R175 billion (2021: R166 billion).
- Contributed R27 billion (2021: R26 billion) to PAYE on behalf of employees.
- Paid corporate income tax of R74 billion (2021: R81 billion).
- Paid R29 billion in value-added taxes (2021: R35 billion).
- Royalties of R14 billion (2021: R12 billion).
- Exported R878 billion worth of minerals (2021: R856 billion) (MCSA, 2023).

Mining in South Africa started before white settlers settled in South Africa (MCSA, 2018). The discovery of diamonds in the Orange River led to mining operations in South Africa in 1867. Immediately after, gold was found in Pilgrim’s Rest beside Barberton. The constant hunt for precious minerals led to more extensive gold deposit discovery at rocky

hills in Gauteng, where approximately 40% of the aggregate gold was found worldwide (Sidler, 2015). South Africa is rich in precious metals and minerals such as platinum, chrome, vanadium, manganese, vermiculite, zirconium, ilmenite, rutile, and palladium, among others (MCSA, 2020). Furthermore, South Africa is the 3rd prime coal exporting country globally (MCSA, 2020). The mining sector comprises major companies with subsidiaries in South Africa and beyond. These include Anglo American Plc., Kumba Resources, Anglo Platinum, De Beers, Exxaro, Goldfields, Harmony Gold, JFPI corporation, Impala Platinum, Wesizwe Platinum, Anglo Coal, and BHP Billiton (MCSA, 2020: PwC, 2020).

The capacity to maintain a sustainable and profitable mining industry in South Africa has been premised on a solid cultural motive to acclimate a system of ‘zero harm’ (Dougall & Mmola, 2015). The quest to attain the ‘zero harm’ milestone by December 2024 is echoed in existing OHS risk management performance milestones, regardless of the inferred objective of ‘zero harm’, which is statistically not zero. According to MCSA (2018), by 2024, all mining companies in South Africa were expected to achieve the ‘zero harm’ principle where every worker would return home uninjured, healthy, and alive. The attainment of the ‘zero harm’ principle infers that all mining firms in South Africa should record no health and safety incidents daily. However, workers in the mining industry are still getting injured, killed, or ill due to exposure to mining safety and health hazards.

In addition, to achieve the ‘zero harm’ milestone by December 2024 in the mining environment, it is important to strengthen the capacity of CG structures for the effective implementation of a comprehensive and sustainable set of CG practices in the SAMS (Baxter, 2017; MCSA, 2020). CG structures in the mining industry are responsible for formulating, implementing, and evaluating OHS risk-mitigating strategies such as skills development, GHG emission intensity reduction, use of renewable energy sources, and performance-based remuneration, among others (Baxter, 2017).
Notwithstanding significant spending on skills development, formulation and application of health and safety regulations, use of high-efficiency low emission (HELE) technology and providing financial incentives to directors to motivate them to attain the “zero harm”

milestone by the year 2024, deaths, injuries and occupational diseases prevalence continue unabated (Abbas, 2018; Reisenger & Ledgard, 2013; Vyas, 2015). The mining sector's high-risk prevalence rate is among the primary reasons behind overemphasising best CG practices in the mining sector for all stakeholders (McNally, 2017; Vyas, 2015). While mines' performance in OHS risk management has improved recently, the mining sector remains the second-highest fatality rate globally (This is Gold, 2018; Abbas, 2018). Safety, health, and environmental risks remain critical in the mining sector globally and nationally (PricewaterhouseCoopers [PwC], 2018). PwC (2018) further alludes that safety, health, and environmental risks were ranked as the 8th most significant risks faced by mining firms nationally and globally in 2018. Despite massive and considerable investment in sustainability by mining firms, fatal accidents, injuries, new tuberculosis (TB) and silicosis infections, loss of hearing, and other occupational diseases are still prevalent in the mining sector (Utembe, Fausttman, Matatiele & Gulumian, 2015; Vyas, 2015).

Though fatal accidents and incidences have decreased for years, OHS incidences in the SAMS remain fluctuating yearly. For instance, there were 73 recorded fatalities in 2016, 90 in 2017, 81 in 2018, 49 in 2019, and 52 in 2020 (MCSA, 2020). Additionally, the occurrence of OHS risks in the mining sector due to factors such as exposure to silica dust, methane gas, pollutants, excessive noise, rock falls, flooding, vibrations, and extremely high temperatures is still high (Mabika, 2018; Abbasi, 2018; Amponsah-Tawiah & Mensah, 2016).

Adhikary *et al*. (2019) assert that OHS risk management is one of the critical corporate governance practices in any industry. Utembe *et al.* (2015) echo that effective and efficient occupational risk management processes in an extractive, sensitive and dangerous industry such as mining reduce accident frequency rate and impact and human fatalities.

Conversely, Ruttinger and Sharma (2016) assert that mining hazards cannot be eliminated. Accordingly, there is a need for corporate governance structures to develop and apply occupational health and safety risk management frameworks that lessen

occupational risks to the lowest level. The high OHS risk frequency rate suggests that mining firms in South Africa lack adequate and comprehensive occupational health and safety risk mitigating strategies. This study proposed an occupational risk management framework employed by CG structures in the mining sector to achieve the ‘zero harm’ milestone.

3.3 OHS risks definition.

Different academics, researchers, and institutions have defined the concept of OHS risks differently (Alli, 2015; Friend & Kohn, 2023; International Standards Organisation [ISO] 45001:2018). Alli (2015) defines OHS as the discipline of the expectancy, acknowledgement, assessment, and control of risks emanating from a workplace that could harm workers' physical and psychological well-being, considering the potential influence on immediate societies and the overall surroundings. Friend and Kohn (2023) referred to OHS management as part of the broader management system of an organization, and it is used to develop and implement its policy and manage its OHS-related risks. According to ISO 45001: 2018, OHS is a set of activities to prevent injuries and health problems to workers and to provide safe and healthy workplaces.

3.4 Emergence of health and safety risk management

The emergence and evolution of OHS risk management can be traced back to 3000 BC when Egyptians developed the first aid manual for employees exposed to toxic gold and silver fumes (Reese, 2018; Pelders, 2019). The awareness and the need for safeguarding and improving human resources' health and safety spread worldwide as many regulations, acts, and policies were promulgated to ensure employee well-being. Attention to OHS risks in SAMS started as early as 1911, although the mining industry started in the Stone Age (Sidler, 2015; Williams & Herbert, 2019). Table 3.1 summarises the evolution of OHS risk management globally, including the SAMS, as a regulatory requirement.

Table 3.1: Journey to zero harm

Year	Health and Safety Act or Concession
3000BC	Workplace first aid manual by Egyptians
2000BC	Compensation for Permanent Injuries (CPI) was introduced in Greece
1500BC	Workplace Compensation for Quarry Workers by Greeks
400BC	Discovery of respiratory problems among quarry workers by Greeks
100BC	Romans' goddess of safety
500AD–1500AD (Middle Ages)	Occupational injuries and diseases were documented
1700	Ramazzini published his treatise on occupational diseases.
1806	Unions' right to strike curtailed by "conspiracy" decision.
1842	Right to strike upheld by Massachusetts Supreme Court.
1867	Massachusetts instituted the first factory inspection.
1869	The railroad air brake was invented.
1877	Massachusetts passed a law requiring guarding dangerous machinery and authority for factory inspection enforcement.
1878	First recorded call by labour for federal occupational safety and health law.
1881	Passed the first U.S. workers' compensation law; it was declared unconstitutional in 1904
1906	Pittsburgh survey conducted by Russell Sage Foundation.
1907	In Monongah, West Virginia, 362 miners died in a mine disaster.
1908	Congress passed a workers' compensation law covering government employees.
1909	The Bureau of Labour study on the Phossy jaw was released.
1910	U.S. Bureau of Mines created
1910	First National Conference on Industrial Diseases was called by the American Association for Labour Legislation.
1911	Mines and Works Act, No. 12 of 1911
1912	U.S. Public Health Service expanded to include a division of occupational health. Children's Bureau was created by the U.S. Congress to investigate dangerous occupations, accidents, and employment.

Year	Health and Safety Act or Concession
1913	The U.S. Department of Labour was established.
1916	U.S. Supreme Court declared workers' compensation laws to be constitutional.
1918	American Standards Association was founded; it sponsored many safety standards (It is now called the American National Standards Institute).
1921	The International Labour Organization (founded in 1919 in Geneva, Switzerland) set up a safety service.
1930-1934	Up to 2,000 workers died while constructing a tunnel at Gauley Bridge, West Virginia.1934 – The U.S. Bureau of Labour Standards was created
1936	Frances Perkins, Secretary of Labour, called for a federal occupational safety and health law. Walsh–Healey (Public Contracts) Act passed
1937	The Congress of Industrial Organisations (CIO) founded
1943	Publication of Alice Hamilton's Exploring the Dangerous Trades
1952	The Coal Mine Safety Act passed
1956	The Mines and Works Act, No.27 of 1956
1991	Minerals Act No. 50 of 1991
1996	The Mine Health and Safety Act, No. 29 of 1996
2009	Establishment of the Mining Industry Occupational Safety and Health Learning Hub
2010	Inclusion of Health and Safety in the Revised Mining Charter.
2011	Tripartite stakeholder principals approve of the culture of the Transformation framework.
2012	Establishment of the Chief Executive Officer (CEO) Zero Harm Task Team
2014	Tripartite stakeholders agree on 2014 milestones for health and safety. Centre of Excellence launched.
2016	Tripartite stakeholders sign a declaration of action as a step change to improve industry occupational health and safety performance, harness 2024 milestones, and accelerate the industry's Journey to Zero Harm.
2017	Mining Industry OHS Fall of Ground Task Team established

Source: Researcher's compilation

3.5 Current trends impacting health and safety issues.

More than a few spot checks have determined the necessity for OHS risk management. This includes an upsurge in financial disclosures, stricter reporting and control prerequisites, and a safety culture (May *et al*., 2019; Pelders, 2109).

3.5.1 Financial disclosures with stricter reporting and control requirements

The firm's financial performance is often linked to OHS risk management modifications in the workplace. The underlying supposition is that if employees work in a pleasant atmosphere that is not dangerous, healthy, economically sound, and creative, these benefits will be manifested in the organisation's financial results (Sidler, 2015; Lornudd *et al*., 2021).

3.5.2 Safety culture

Safety beliefs are usually employed to demonstrate collective practices in organisations that assist or inhibit certain behaviours or consequences of OHS (Nordlof *et al*., 2017; Alshemeli, Davidson & Khalid, 2022). There are common beliefs and norms among the organisation's employees that are acquired through social interaction at the place of work that concerns OHS risks and hazards, which is henceforth termed safety culture (Alshemeli *et al*., 2022; Sidler, 2015). The most common cultural crucial aspects of progressive or adverse safety culture include, among others, board of directors' commitment, employee participation, risk-taking, and productivity pressure. Secondary and primary OHS culture drivers entail the following:

- Security and technology issues.
- Labour unions pressure.
- Business continuity besides catastrophe readiness in a 9/11 aftermath world.
- Rating agencies' emphasis.
- Regulatory adherence.
- Globalisation in a constantly competitive business atmosphere (Salguero-Caparros, Pardo-Ferreira, Martinez-Rojas & Rubio-Romero, 2020; Sidler, 2015).

3.6 Concept of health and safety risks in the mining sector

The Health and Safety Authority [HSA] (2018) defines health and safety risk as the probability that an employee may be injured, killed, or suffer adverse health effects if subjected to occupational hazards. Occupational health and safety hazards faced by mineworkers are, among others, accidents, rock falls, gas explosions, structure failures, hazardous chemical and gas exposure, malfunctioning equipment, excessive noise levels, whole-body vibrations, musculoskeletal disorders, thermal stress, and exposure to silica (Minerals Council South Africa [MCSA], 2018; Bao, Johansson & Zhang, 2018; Sidler, 2015).

Approximately 2.2 million employees worldwide die yearly because of occupational accidents and diseases, and 270 million suffer grave injuries (WMD, 2019). Additionally, 160 million fall ill for a short or long time from work-related reasons (WMD, 2019). Furthermore, occupational diseases such as Tuberculosis (TB) and Silicosis also take a toll on the mineworkers in the SAMS. In 2017, 387,355 mineworkers were screened for TB, and 2367 were diagnosed with TB (MCSA, 2018). On the same note, fatalities recorded in 2017 in the South African mining sector were 86 (MCSA, 2018). The TB prevalence rate in the mining sector is significantly increased by inhaling silica dioxide in crystalline forms such as quartz, cristobalite, or tridymite (MCSA, 2018; Sidler, 2015).

Bao *et al.* (2018) state that there is a need for mining companies to invest in skills development and sustainable environmental, social, and economic practices to mitigate exposure to OHS risks. SAMS invested over R6 billion in skills development (MCSA, 2018). Likewise, the Mining Charter requires all South African mining firms to invest 5% of annual leviable payroll into skills development. Thus, for the past five years, the South African mining firms contributed over R5 billion towards Mining Charter skills development (MCSA, 2018).

According to a report published by AngloGold Ashanti in 2016, mining companies in South Africa face a broad spectrum of risks, namely, OHS, employee relations, political, social license, resource nationalisation, metal prices and currency instability, high costs, long-term planning, and expertise scarcity.

Incidents in the SAMS include the two most publicised cases in 2007 and 2012 (MCSA, 2018). Baxter (2016) states that in 2007, 3200 miners were trapped underground, and all were rescued alive. In 2007, a countrywide strike involving 240,000 miners and 60 mining companies suspended their operations. The primary reason for the industrial action was hazardous working conditions. Furthermore, in 2012, fierce clashes at the Lonmin mine resulted in the death of 34 individuals, and 78 more suffered grave injuries (MICSA, 2018). Health and Safety risks faced by mining companies started to be recorded in the 1950s. By 1960, 36,000 men had died from accidents in the gold mines since the century's onset (Mining Health and Safety [MHSC] Council, 2018). The yearly death toll in the SAMS fluctuates around 800 (MHSC, 2018; WMD, 2019). Mining companies are also facing operational risks through human error and deficiencies in management.

In the face of the information mentioned above on OHS risk management in the SAMS, it can be concluded that there is a need for further research regarding the topic. At this point, the research investigated the impact of CG on OHS risk management in the SAMS. The study determined areas of improvement within CG mechanisms to minimise or eliminate the impact of mining companies' health and safety risks in South Africa.

3.7 Causes of health and safety risks in the mining sector

According to the literature on OHS risk management, employees in the mining industry are exposed to occupational hazards that constantly threaten their safety and health (Ganson, 2014). These causes are peculiar to the mining industry and were identified by MCSA (2019). Miners are exposed to occupational hazards daily, such as safety, physical, chemical, biological, ergonomic, and physiological hazards (Yu, Zhou, Hu, Wang & Jin, 2019; MHSC, 2018).

3.7.1 Safety hazards

These are the most prevalent in most workplaces. MHSC (2018) states that safety hazards entail risky working situations that may lead to injury, occupational diseases, and human life loss. These hazards include spills, moving machinery parts, electrical hazards, and confined spaces (MCSA, 2020).

3.7.2 Biological hazards

Yu *et al.* (2019) posit that biological hazards include bacteria, viruses, insects, plants, birds, animals, and humans. Ganson (2014) points out that snakebites, injuries, bacteria, fungi, and viruses are the most common biological hazards. Biological sources may cause different health issues, ranging from skin irritations to HIV/AIDS (Yu *et al.*, 2019; Guner & Ekmekci, 2019). Mines in remote locations in tropical climates usually experience the challenge of increased diseases such as malaria and dengue fever (Elgstrand *et al.,* 2017). Diseases such as leptospirosis and ankylostomiasis, primarily transmitted by rats and worsened by poor sanitation in mining communities, were eradicated in the developed countries whereas, in developing countries such as South Africa, remain a challenge (Elgstrand *et al.,* 2017). As such, mining companies in South Africa are still challenged in crafting risk management strategies to eradicate diseases caused by poor sanitation in the mining communities.

3.7.3 Chemical hazards

Chemical hazards are present when an employee is exposed to the preparation of chemicals or exhaust fumes from machinery in the workplace (MHSC, 2018; Elgstrand *et al.,* 2017). Miners are usually exposed to harmful chemicals such as cyanide and mercury, which harm miners' health (MCSA, 2020). MCSA (2020) presuppose that employees are exposed to toxic chemicals in mining when the ore is excavated, crushed, and extracted. For example, when gold ore is mined and crushed, toxic substances such as arsenic and lead are released into the immediate surroundings, contaminating air, water, and soil. For instance, coal mining environments are characterised by high exposure to polymeric chemicals.

Mabika (2018) posits that chemical hazards include exposure to solvents, exhaust fumes from machinery, explosives, carbon monoxide, helium, silicon dust, and propane. Exposure to mining chemicals results in OHS risks such as skin irritations, respiratory diseases, poisoning, and even death (MCSA, 2018; Immink, Louw & Brat, 2018).

When miners are exposed to toxic substances such as mercury, lead, or cyanide, they may suffer sub-ante intoxications (Mabika, 2018). Additionally, symptoms of sub-ante intoxications include fine tremors, increased salivation and swelling of the gums, extreme behavioural and temperament swings, memory loss, and sleeplessness (MHSC, 2018). Also, when miners are chronically exposed to toxic substances such as mercury and lead, a permanent neurological impairment may occur associated with reduced motor skills and moderate cognitive impairment (Ganson, 2014). Likewise, contact with toxic chemicals may damage the lungs, resulting in severe erosive bronchitis (MCSA, 2019).

However, each chemical possesses unique hazards and must be handled aptly to guarantee worker safety (Hermanus, Coulson & Pillay, 2015). As such, top management in the mining sector should conduct risk assessments to establish best practices to mitigate health risks associated with chemical hazards.

The board of directors needs to establish a customised operating process that guides the use of appropriate personal protective equipment (PPE), safe handling, and proper disposal of chemicals. In addition, mining companies need to improve ventilation, cleanliness, and housekeeping to minimise chemical exposure to employees. Moreover, regular training and drilling should be conducted regarding the company's chemical spill response and hygiene plan.

3.7.4 Physical hazards

Physical hazards refer to aspects inside the working environment that cause harm to the human body without necessarily coming into physical contact (MHSC, 2018). These factors include radiation, extreme exposure to sunbeams, extreme temperatures, hot and cold, continuous loud noise, deprived lighting, poor ventilation, dust, and defective

electrical wiring (MCSA, 2020). The mines' physical environment matches the typical working environment, which creates a cradle of risks for miners. Moscicka-Teske, Sadlowska-Wrzesinska, Najder, and Butlewski (2019) indicate that the most common physical hazards in the mining sector are:

- Inadequate light.
- Cramped work pace.
- Poor air quality consisting of high moisture concentration, particle contamination, diminished oxygen levels, and mine gas pollution.
- Continuous airflow (in surface excavations up to 5m/s, drift mining up to 8m/s and during transport up to 12m/s).
- Higher atmospheric pressure due to depth.
- Variations in rock mass structure.
- Leakages or condensation from the roof.
- Noise and vibration of mining machinery and transport during extraction and transportation of mineral ore.
- Natural hazards (rock bursts, fire, methane, coal dust explosions, an outburst of gases, rocks, etc.

Exposure to tremors during mining processes arises when employees use vibrating hand tools or vehicles such as excavators (MHSC, 2019; Williams & Hebert, 2019). Elgstrand *et al.* (2017) allude that physical hazards such as vibrations can primarily affect peripheral blood circulation and the nervous and musculoskeletal systems. MHSC (2018) echoes that continuous use of vibrating tools and vehicles leads to health problems such as severe neck, lower back, and shoulder pain, numbness, tingling in hands, joint or bone pain, and hand-arm vibration syndrome.

Coulson and Christofides (2020) postulate that exposure to excessive and continuous noise during mining operations without proper personal protective equipment may lead to noise-induced hearing loss (NIHL) among miners.

Asumeng *et al.* (2015) indicate that NIHL is a common problem in mining sectors in the developing world. Elgstrand *et al.* (2017) state that *e*xcessive noise levels are experienced during mining operations such as crushing, blasting, drilling, and screening. Additionally, toxic chemicals used during mining operations negatively impact the human auditory system (MCSA, 2019). Toxic chemicals that can harm the auditory system include solvents, fuels, metals, asphyxiants, and polychlorinated biphenyls (PCBs). Furthermore, Moscicka-Teske *et al.* (2019) suggest that miners' prolonged exposure to excessive noise levels also poses health risks, such as increased cortisol levels and heart pulse rate.

Baxter (2017) asserts that extreme hot or cold temperatures are critical physical hazards that may cause considerable occupational health and safety risk occurrence and severity in hazardous industries such as mining. Moscicka-Teske *et al*. (2019) postulate that miners are unprotected from extremely high temperatures in open-cast mines in warm climates due to their closeness to heat-emitting machinery and processes in deeper underground shaft mines. Miners are also exposed to extreme cold stress in open-cast mines in cold climates (Hermanus *et al.,* 2015). As such, exposure to extreme temperatures by miners results in thermal stress. Negative effects of thermal stress entail anxiety, reduced performance and efficiency, thermal injuries, and even loss of human life.

Moreover, Elgstrand *et al.* (2017) propound that thermal stress increases the probability of accidents. Furthermore, thermal stress leads to excessive sweating, skin irritations, and other heat illnesses. Heatstroke is one of the fatal consequences of heat stress, leading to death (Baxter, 2017).

On the contrary, Asumeng *et al.* (2015) indicate that cold stress is caused by working in open-cast mines in cold climates and is worsened by insufficient thermal insulation and inactivity. Like heat stress, cold stress results in decreased performance and productivity, discomfort, cold injuries, and adverse health effects. Elgstrand *et al.* (2017) state that cold injuries include, among others, frostbite, chilblain, hypothermia, and musculoskeletal disorders.

According to Coulson and Christofides (2020), mining activities generate dust, especially during blasting, drilling, and soil removal. These dust particles may harm human safety, health, and the environment (Mining Qualifications Authority [MQA], 2015). Silica and coal dust are the most abundant dust particles released into the atmosphere during mining. Generally, dust and pebbles may physically harm the miner's body. Hermanus *et al.* (2015) posit that dust particles may enter the miner's eyes, nose, and ears if the personal protective equipment is not used effectively. When dust particles disturb employees' vision, they may lead to fatal accidents during mining operations (Coulson & Christofides, 2020; Hermanus *et al.,* 2015). In addition, employees may inhale dust particles, leading to respiratory diseases such as silicosis, increased risk of occupational tuberculosis, brain damage, lung cancer, and central nervous system damage (Coulson & Christofides, 2020; MCSA, 2020).

3.7.5 Ergonomic hazards

Schutte (2005) defines ergonomics as the technical know-how and practice of developing systems apt for people in the workplace. The proper application of ergonomics in the development and valuation of equipment, workplaces, and work settings is essential so that responsibilities are required of people within their confines, and the paramount use is made of their competencies (Hermanus *et al.,* 2015).

Ergonomic hazards arise when the nature of the job, body posture, and working conditions significantly strain the employee's body (MQA, 2015). MQA (2015) further predicates that ergonomic hazards are the most challenging to identify since it is impossible to spot the human body's strain immediately. These hazards include improperly adjusted workstations, poor posture, recurrent lifting, vibration, the need to apply excessive force repeatedly, and uncomfortable positions (Coulson *et al.*, 2020). In the mining industry, ergonomic hazards usually contribute to noise-induced hearing loss, musculoskeletal disorders, operator fatigue, and heat stress (Baxter, 2016).

3.7.6 Psychological hazards

The government of Alberta (2011) defines psychological hazard as any threat that influences an employee's emotional well-being by overwhelming individual managing mechanisms. In addition, psychological hazards affect the employee's capability to execute their duties healthily and safely. Asumeng *et al.* (2015) postulate that psychological hazards at the workplace include technological changes, depression, anxiety, work-life conflict, fatigue, and long working hours.

In the mining sector, the risks in the workplace that affect psychological well-being are linked to high productivity demands and monetary incentives that may impact mining entities' OHS practices (Hermanus *et al.,*2015). Elgstrand *et al.* (2017) further point out that financial stress and incentivised remunerations to reach production goals are an undesirable combination constantly associated with a philosophy of risk-taking and failure to adhere to health and safety policies in an already highly risky work environment.

Other psychological hazards in the mining sector are violence, bullying, and discrimination in other mining entities (Coulson & Christofides, 2020). For instance, the deteriorating labour relations at Marikana in 2012 resulted in the death of 34 miners (Baxter, 2016). There is a culture of blaming and intimidating employees in African mines, leading to depression (Hermanus *et al.,* 2015), as depressed employees lack concentration when executing their duties, increasing the chances of occupational health and safety risk incidences. Furthermore, Asumeng *et al.* (2015) propound that depressed employees are most likely to disregard health and safety protocols as their minds will not be in a good state to work, increasing the likelihood of fatal mining accidents.

Elgstrand *et al.* (2017) conceive that the effect of depression among miners is substance abuse, especially alcohol and illicit drugs. High rates of alcohol and illegal drug usage have been found among underground miners and those with a heavy workload. Moscicka-Teske *et al.* (2019) echo that high alcohol dependency increases absenteeism, health service utilisation, and fatal accidents.

Intoxicated miners are likely to defy health and safety rules, leading to unsafe acts and, consequently, accidents. Over and above, fatal and traumatic injuries in the mining industry continue unabated and usually have a permanent psychological effect on the miners. As such, witnesses, supervisors, managers, and colleagues experience post-traumatic disorders. Often, line managers feel personally liable even in the nonexistence of negligence, and they need to face top management and government inquiries.

3.8 OHS theories.

OHS risk management practices in hazardous industries such as mining and construction are based on the human error model, Heinrich's Domino theory, accident root causes tracing model, and management-based models (Hosseinian & Torghabeh, 2012) as discussed in the succeeding sub-sections.

3.8.1 Heinrich's domino theory of accident causation

The domino theory of safety posits that workplace accidents are caused by a sequence of events (Heinrich, 1931; Collins, 2011). The Domino theory refers to human and machinery association, frequency of repetition and level of impact relation, risky actions cause, management role in accident avoidance, accident-related costs, and safety on efficiency (Hosseinian & Torghabeh, 2012). Hosseinian and Torghabeh (2012) further conjecture that the domino principle is founded on five successive factors such as the following:

i. Ancestry and social surroundings: Ancestry and social environment are referred to as the progression of attaining an understanding of behaviours and abilities in the workplace. Inadequate expertise, understanding of executing tasks, and unsuitable social and environmental circumstances result in fatal mistakes.
ii. Carelessness: Human errors or lack of due diligence are undesirable attributes of human nature, even though undesirable characteristics might be learned. Thus, carelessness will result in unsafe acts/conditions.
iii. Unsafe act and mechanical or physical condition: Unsafe acts/conditions entail inaccuracies and technical let-downs resulting in the accident.

iv. Accident: Accidents are outcomes of unsafe acts/conditions that result in injuries or deaths.
v. Injury: Accidents will ultimately result in injuries and, in some cases, deaths.

Social environment and ancestry are the processes of attaining understanding and expertise in the workplace (Heinrich, 1931). In the context of mine accidents, it refers to gaining OHS risk management expertise and skills (MQA, 2019). As such, a lack of appropriate health and safety skills and sufficient knowledge in executing mining duties and responsibilities will likely result in faults in an employee and, subsequently, fatal accidents.

The fault of a person refers to an employee's detrimental characteristics and may lead to an unsafe act or condition (Heinrich, 1931). These unwanted characteristics may be attained at the workplace or undesirable traits inborn to a specific person (Nascimento, Majummdar & Ochieng, 2013; Hosseinian & Torghabeh, 2012). Carelessness in the mining industry may include failure to observe OHS guidelines and deliberately not maintaining mining equipment and machinery, resulting in fatal mining accidents and health incidences (Williams & Herbert, 2019). On the part of mining governing bodies, carelessness is manifested in failure to have an effective risk management oversight that must be cascaded down to employees. In addition, the negligence of top management may be exhibited by failure to monitor and evaluate OHS risk management measures in the SAMS (Heinrich, 1931; Bird & Germain, 1985).

Moreover, unsafe acts and/or mechanical or physical condition involves faults and technical malfunctioning that lead to accidents (Heinrich, 1931; Bird & Germain, 1985). For instance, poor lightning, drainage, ventilation, and poorly maintained and outdated machinery (Baxter, 2016). Per se, mining accidents result from unsafe acts that lead to injuries and deaths and occupational diseases such as Silicosis.

Heinrich’s domino theory encompasses five dominos that happen chronologically if the first domino falls. However, the accident can be prevented when the succession series is

upset (Toft, Dell, Klockner & Hutton, 2012). For instance, unsafe acts/conditions can be eradicated to avert accidents and related injuries. Heinrich's domino theory was criticised for simplifying human behaviour in controlling accident processes.

Furthermore, Toft *et al.* (2012) postulate that Heinrich's domino theory became the foundation of numerous studies on the accident causation model, focusing on the management role in accident prevention; these studies are called the Management Model or Domino's Updated Models. Management models propound that the management system is liable for accidents. These models encompass but are not limited to the multiple causation model (Petersen, 1971), Weaver updated Dominos (Weaver, 1971), and the updated Domino sequence (Bird, 1974).

3.8.2 Management based-based models.

Scholars criticised Heinrich's model assumptions for overgeneralising human behaviour control in accident causation (Toft *et al.,* 2012; Nascimento *et al*., 2013). However, Heinrich's accident causation is the groundwork for numerous causation models. Successively, Heinrich's Domino Theory has been modernised and improved over past decades, resulting in the emergence of management-based models, for example, the multiple causation model (Petersen, 1971), Weaver updated model (Weaver, 1971) and Updated domino sequence (Bird, 1974). These theories are discussed below.

3.8.2.1 Multiple causation model

Accidents are triggered by a blend of unsafe acts and conditions (Petersen, 1971). Nevertheless, at least two unsafe acts/conditions must exist for a disastrous accident (Hosseinian & Torghabeh, 2012). Contrary to the Domino theory, an accident is a consequence of mutual sub-causes and causes (Toft *et al.,* 2012). Management must identify sub-causes to prevent an unsafe act or unsafe condition. Figure 3.1 illustrates how accidents befall, as proposed by the multiple causation model (Peterson, 1971).

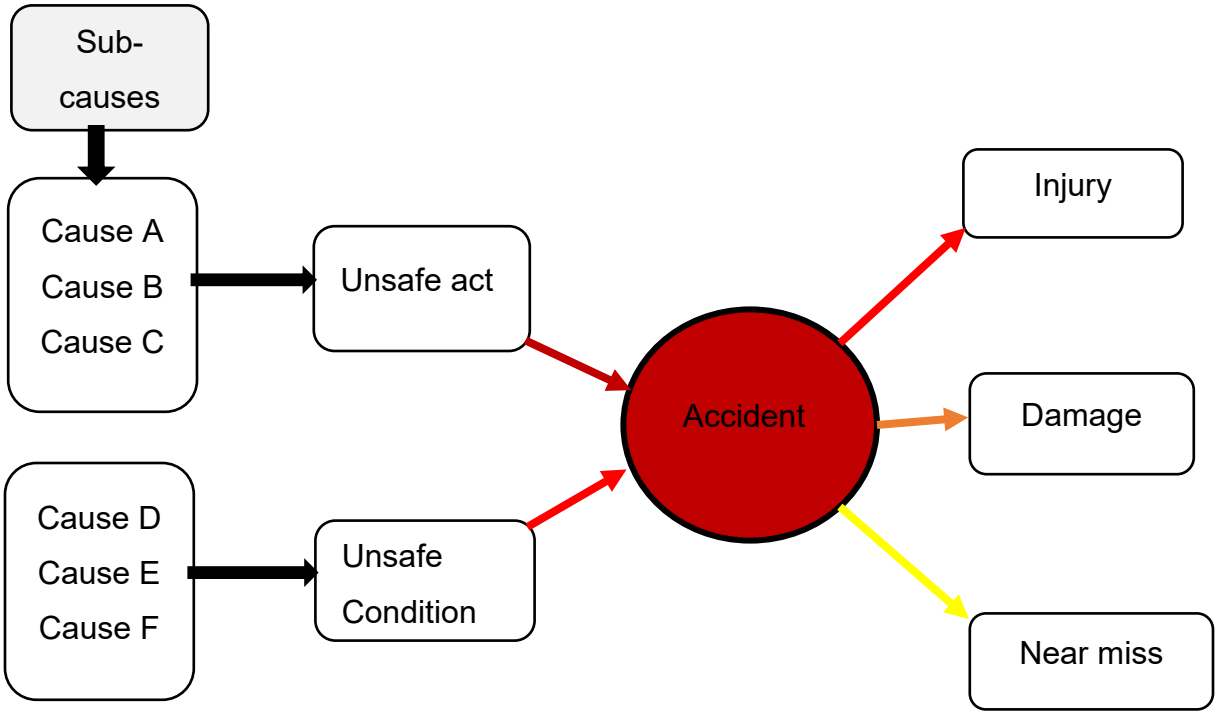

Figure 3.1: Multiple causation model

Source: Hosseinian & Torghabeh (2012:55)

In the context of this study, the multiple causation model is significant because different conditions, including unsafe acts by employees and management, cause accidents in the SAMS. Nonetheless, mining accidents occur because of human and environmental conditions that can be swayed by constraints such as economic and political. Therefore, the multiple causation model is one of the theories underpinning this research on corporate governance's impact on OHS risks in the SAMS.

3.8.2.2 Weaver updated model.

Weaver (1971) improved Heinrich's Domino theory by stressing the management system's role in inhibiting workplace accidents. The Weaver updated model deliberated on domino three (Unsafe act/or mechanical condition), four (accident), and five (injury) of Heinrich's Domino model accident causation as faults arise from operating activities. Moreover, Weaver (1971) exposed the role of operational errors and omissions by describing the root cause of the accident.

Weaver (1971) posits that the prevalence of unrestricted unsafe environments lies in management's safety awareness and expertise to avert the accident from befalling. Intrinsically, Weaver's updated model delivers footing for this study on the impact of corporate governance on OHS risks in the SAMS because it integrates the operational errors (human behaviour) and unsafe conditions, which are poor ventilation and drainage, poorly maintained mining equipment, and failure to implement health and safety regulations and guidelines. The governing bodies of mining companies are responsible for holistically mitigating all the mining companies' risks. The inability to reduce health and safety risks by the BoD in the SAMS infers the frequency and severity of health and safety risks primarily caused by human behaviour.

3.8.2.3 Updated domino sequence

Loftus and Bird (1971) modified Heinrich's Domino theory of accident causation by focusing on the management system's role in the accident causation series. The updated sequence is outlined as follows:

i. Inadequate control/Management: This involves a scanty program, the standard program, and compliance with the standard.
ii. Elementary causes or ancestries: These can be categorised into individual and job factors.
iii. Immediate causes: Immediate causes refer to sub-standard acts and circumstances.
iv. Incident: Refers to interaction with matter and energy.
v. Loss: Refers to the loss of property, such as a vehicle, injury to people, or deaths due to accidents.

Figure 3.2 illustrates the updated sequence model.

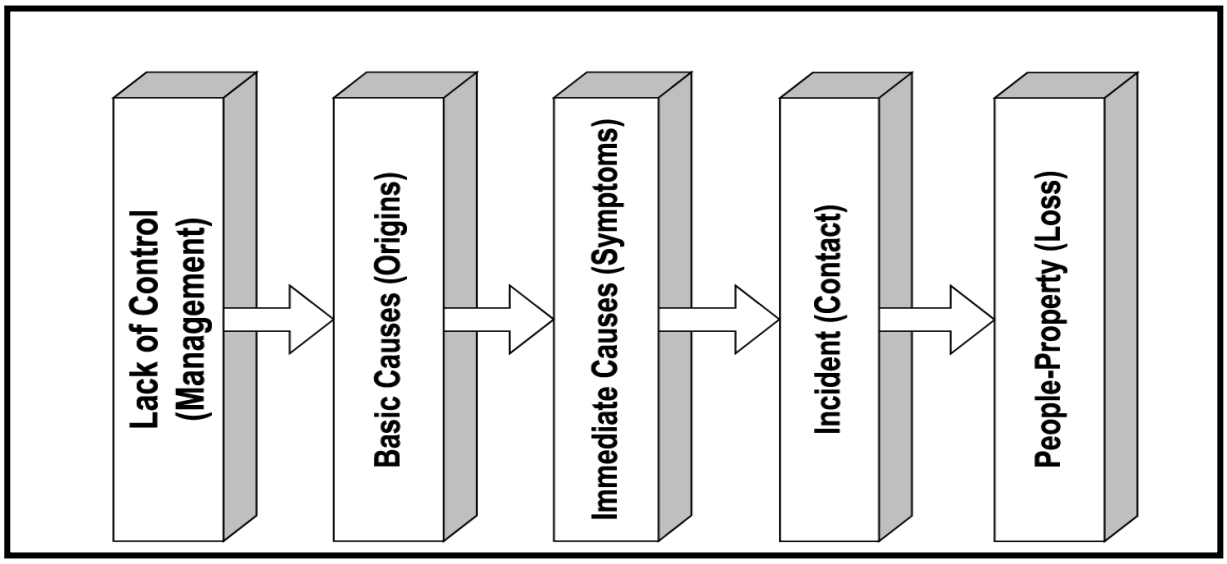

Figure 3.2: Updated domino sequence of accident causation theory
Source: Hosseinian & Torghabeh (2012:56)

Hosseinian and Torghabeh (2012) posit that the updated Domino sequence of accident causation theory can be applied to accident and loss management control types. As such, the updated domino sequence of accident causation theory is relevant in exploring the impact of CG on OHS in the SAMS.

3.8.3 Accident Root Causes Tracing Model (ARCTM)

ARCTM was derived from the Heinrich Domino model (1959), updated Domino sequence (Loftus and Bird, 1974), Weaver updated model (1971), and multiple causation model (Petersen, 1971). The main aim of ARCTM was to provide occupational accident investigators with a simplified framework pinpointing fundamental causes of occupational accidents, such as mining accidents associated with other accident investigation models. ARCTM proclaims that accidents are a consequence of a single or amalgamation of factors. The most significant of these factors are outlined in the following sections.

3.8.3.1 Unsafe condition

According to Hosseinian and Torghabeh (2012), unsafe conditions refer to workplace conditions and hazardous environments as per health and safety standards. In mining health and safety, dangerous conditions may include malfunctioning equipment, poor ventilation, poor drainage, inadequate personal equipment, and inadequate health and safety training (Baxter, 2016). Unsafe conditions may be an outcome of factors such as management acts/omissions; management and leadership of the mining company may, for instance, inadequately invest in OHS equipment, thereby exposing workers to health and safety hazards such as toxic gases and rock falls (Toft *et al.,* 2012; Coulson & Christofides, 2020). A typical example of unsafe worker acts is when miners decide not to comply with OHS regulations and guidelines, leading to catastrophic accidents in South African mines. Likewise, events unrelated to human factors, such as floods or seismic activity, may result in fatal mining accidents (Hosseinian & Torghabeh, 2012).

3.8.3.2 Reaction of a worker to unsafe conditions

Hosseinian and Torghabeh (2012) observe that the reaction to unsafe conditions, such as poor drainage and ventilation, depends on whether the employee pinpointed the unsafe condition. If the miner fails to identify the hazardous conditions intrinsically, there is no risk and hazard concern by the employee. Still, there are some primary unsafe factors, such as earthquakes, that mine employees and health and safety representatives should consider during mining operations (Coulson & Christofides, 2020).

Human factors violation may lead to trauma, injuries, and death. Stranks (2012) also emphasised that if the mining employee recognises unsafe conditions, the reaction is to suspend operations until conditions are safe. For example, if the mine shafts are flooding, the response is to suspend mining activities until the flooding stops (Hosseinian & Torghabeh, 2012). If the mining employee detects unsafe mining situations and continues working, the management must investigate the accident.

3.8.3.3 Performing unsafe acts without consideration of the workplace's environmental condition.

In this case, a worker (miner) continues to perform mining duties, ignoring unsafe conditions in the mine (Toft *et al.,* 2012; Hosseinian & Torghabeh, 2012). For instance, the employee might work in a mine with inadequate or no personal protective equipment.

ARCTM applies to this study as it can be applied by mine accident investigators as a primary investigation and reporting instrument (Hosseinian & Torghabeh, 2012). The ARCTM affirms that accidents result from risky conditions, response to unsafe conditions, and employee or management's hazardous actions (Toft *et al.,* 2012). Therefore, accidents imply that unsafe and unhealthy mine conditions are linked to corporate governance; hence, this study's need.

3.8.4 Human error models

Human error models are broadly grouped into human behaviour and human factor models.

3.8.4.1 Goal Freedom Alertness Theory (GFAT)

GFAT of accidents posits that a psychosomatically satisfying and desirable work atmosphere results in the safe execution of duties (Hosseinian & Torghabeh, 2012; Stranks, 2012). The GFAT is grounded on the notion that accidents are caused by human behaviour (Toft *et al.,* 2012). Moreover, the richer the climate in financial and non-financial prospects, the higher the degree of attentiveness among workers (Hosseinian & Torghabeh, 2012). Toft *et al.* (2012) posit that the outcome of alertness is a better-quality key performance indicator and consequently an accident-free work environment. Furthermore, a psychologically sound work environment motivates employees to do their best, participate, organise attainable objectives and invent techniques to achieve those goals. According to Hosseinian and Torghabeh (2012), employees can detect work-related challenges and reach the bottom.

The management system allows employees to delineate and pioneer approaches to realising their goals. Therefore, leadership in the mining sector can enhance the work environment by applying participative managerial procedures and setting well-defined goals for employees (Coulson & Christofides, 2020).

In the current study context, GFAT proposes enhanced psychological mining conditions as the basis for a healthy and safe environment. Improved psychological work conditions will enhance the level of alertness among employees in the mining sector, resulting in the attainment of the ‘zero harm’ milestone by December 2024. Consequently, management in the South African mining sector may adopt the GFAT to eliminate health and safety risks by allowing employees to participate, set goals and alert them to innovative methods for achieving health and safety goals.

3.8.4.2 Human factor models (HFM)

HFM is grounded on the notion that human errors are the primary cause of occupational accidents. However, unsafe behaviour, poor workplace design, and the environment do not recognise human limitations, which are instrumental factors (Kadiri & Chatelet, 2013). In this study, Ferrell's theory is considered relevant.

3.8.4.2.1 Ferrell’s theory

Ferrell’s theory was developed by Ferrell in 1997 based on a series of human factors. He asserts that accidents are a consequence of human inaccuracies and are due to the following underlying factors:

i Overload: the overload factor reveals a mismatch concerning the load and employee competency. Consequences of misalliance are nervousness, tiredness, and sensations that physical conditions, such as dust, noise, toxic fumes, ventilation, and poor drainage in mine shafts can worsen.

ii Incorrect response: the employee’s inappropriate reaction is instigated by the mismatched status quo where they are working.

iii Improper activity: the employee executes a task inappropriately, either due to inadequate knowledge to carry out the activity or deliberately taking a risk (Nascimento *et al*., 2013). Figure 3.3 illustrates Ferrell's accident causation model.

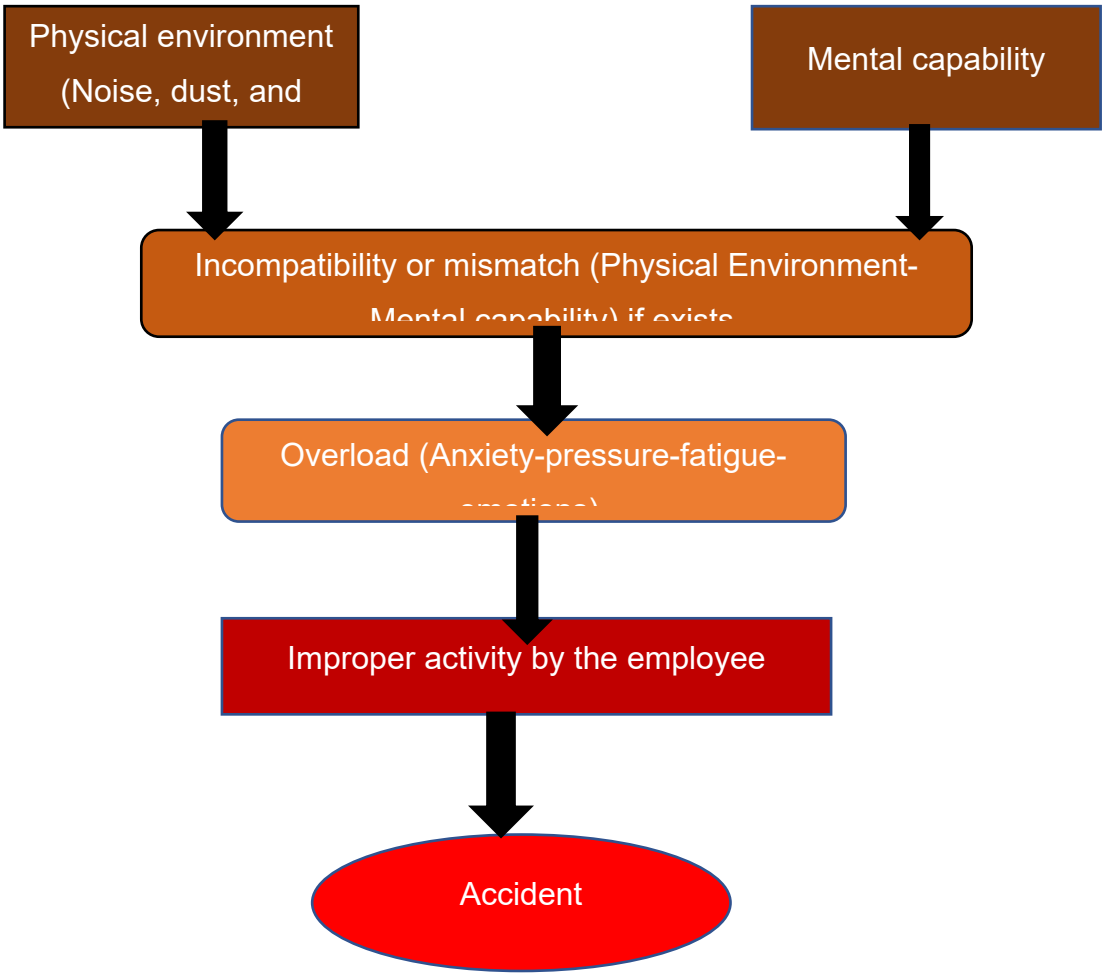

Figure 3.3: Ferrell's accident causation model.

Source: Hosseinian & Torghabeh (2012:57)

3.8.4.3 Hierarchy of causal influences

The hierarchy of causal influences model proposes that inadequate communication between work team, workplace, equipment, and material can create accident conducive circumstances (William & Hebert, 2019). The model reckons that accidents in the mining

sector, for instance, are caused by a combination of worker, workplace, equipment, and work design factors (Stranks, 2012). Figure 3.4 illustrates the hierarchy of causal influences.

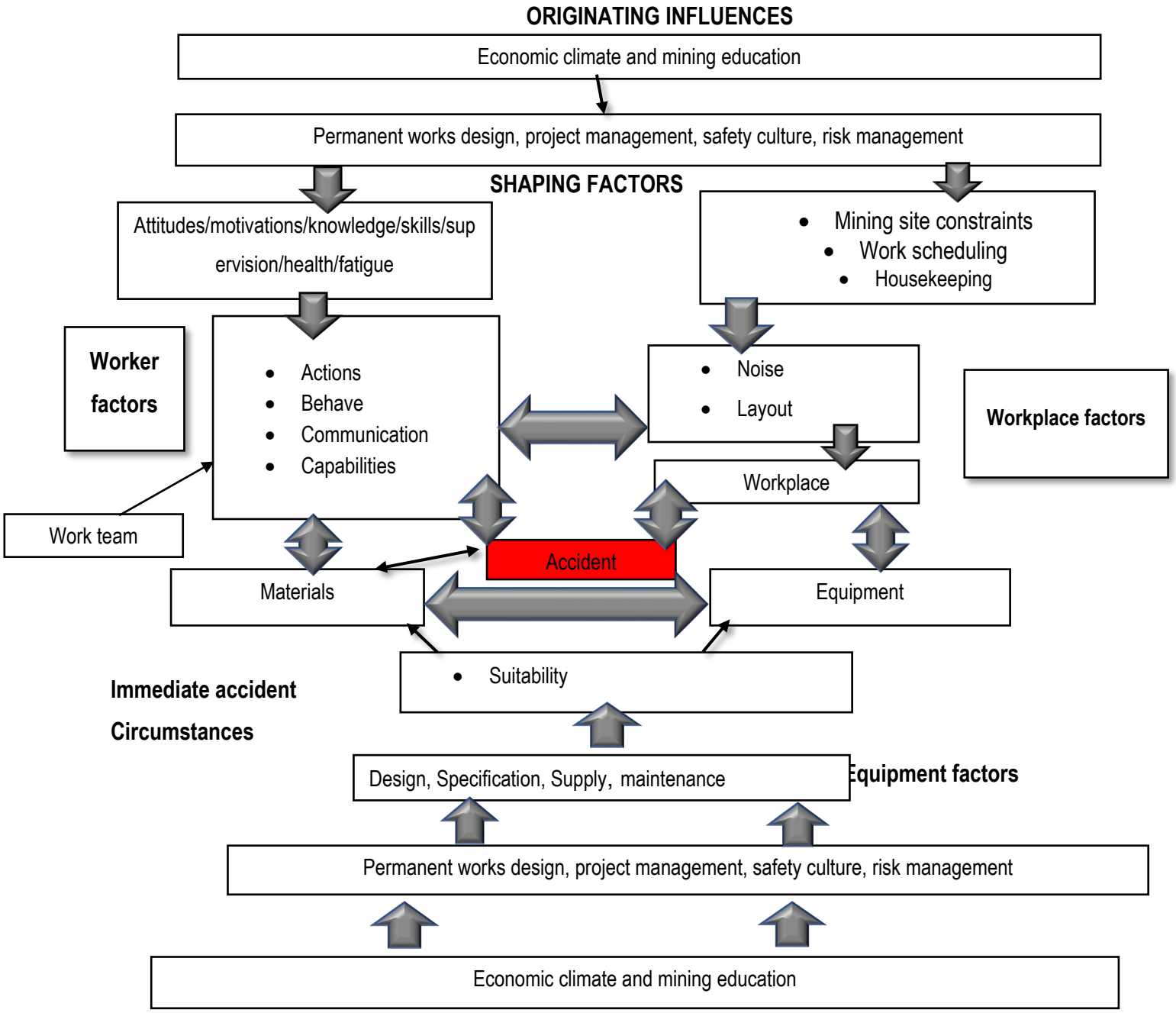

Figure 3.4: Hierarchy of causal influences

Source: Stranks (2012:18)

3.8.4.4 Behaviour-based models (BBS)

BBS is one of the vital models to consider in OHS risk management practices in mines. The Sequential Accident Model (Furnharm, 1994) emphasises that BBS approaches will not achieve intended outcomes if employees fail to embrace OHS risks in their workplaces. Hosseinian and Torghabeh (2012) posit that BBS are procedures that can improve OHS issues if affected in a supportive environment.

Hosseinian and Torghabeh (2012) suggest that incorporating the safety and health of employees into the initial phases of planning and development is the definitive goal of BBS systems. Incorporating security into planning and development pinpoints overall OHS risks associated with diverse events. As alluded to by Abbas (2018), the benefits of adopting BBS management systems entail focusing on the right numbers, building positive attitudes among employees, increasing personal safety responsibility, facilitating interpersonal coaching and teamwork, and teaching and promoting systems thinking. Therefore, the BBS model is appropriate for this study as it emphasises the need to influence the workers' behaviour towards OHS risk management concerns at the place of work. As such, the management of mining companies in South Africa must influence mining employees' behaviour towards health and safety hazards in mining.

3.8.4.5 Modified statistical triangle of accident causation (MSTAC)

According to the Modified statistical triangle of accident causation (See Figure 3.5), when a hazard happens, the triangle's base is where the risk will be positioned, known as the 'hazardous event'. Carter and Smith (2006) elucidate that the severity of the hazard determines the hazard's position in the triangle. 'Near misses' are positioned at the lower base of the triangle, meaning that a hazardous event results in no physical injury and, thus, zero severity. The middle section of the triangle signifies the area of severity larger than zero, implying that the hazardous event leads to an accident with bodily injuries. The triangle's apex illustrates the most dangerous events that result in fatality or death if an accident occurs.

Carter and Smith (2006) assert that there are two significant facets in controlling and managing hazards in hazardous industries such as mining: preventing events from occurring and controlling the severity. Based on Figure 3.5, the first step is to implement preventive control mechanisms that comprise activities to limit the entrance of hazardous events into the triangle by reducing the prospect of the hazard. According to Carter and Smith (2006), preventative control mechanisms are at the second step, which aims to limit the movement of the hazardous event up the higher section of the triangle; this step reduces the severity of the hazard if it occurs. Figure 3.5 shows the MSTAC.

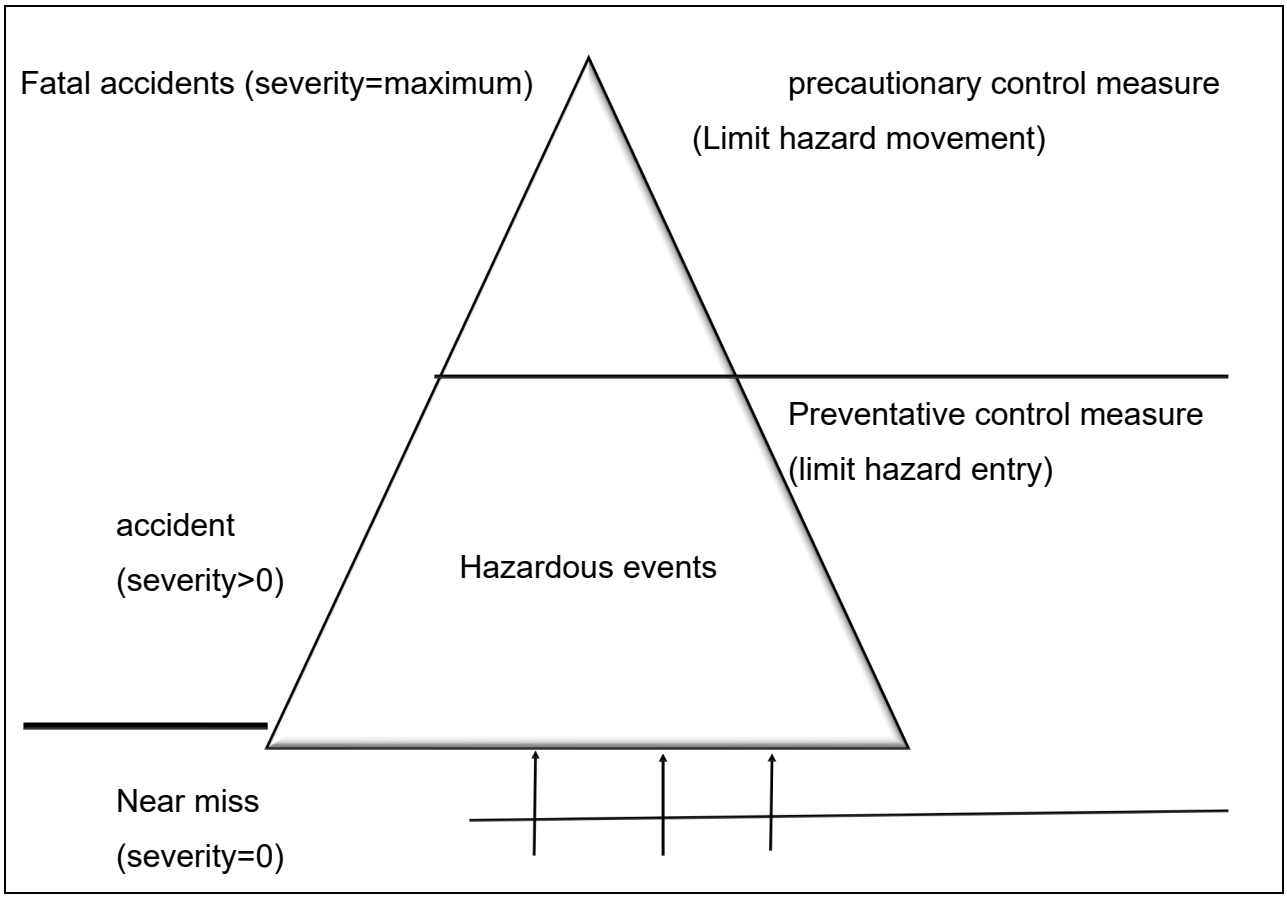

Figure 3.5: Modified statistical triangle of accident causation.

Source: Cater & Smith (2006:200)

As illustrated in Figure 3.5, mining companies' top management must identify different hazards with varying degrees of severity to develop appropriate preventive controls. In addition, mining companies in South Africa need to guarantee that preventative control

mechanisms are in place to limit the likelihood of fatal accidents and near misses from happening. As shown in Figure 3.5, fatal accidents with maximum severity have a low probability of occurring but may lead to loss of human life in the SAMS.
On the other hand, near-misses with no injuries have a high likelihood of happening. As such, mining companies are encouraged to have preventive control measures to prevent the loss of human life.

3.9 OHS Framework: International Standard Organisation (ISO) 45001:2018 – Occupational health and safety management systems.

Constantine (2019) postulates that ISO 45001:2018 can be implemented by any organisation that desires to formulate, implement, and sustain an Occupational health and safety risk management system. Also, ISO 45001:2018 improves OHS risk management by eradicating hazards, capturing opportunities, and addressing irregularity in business operations (Constantine, 2019). Furthermore, ISO 45001: 2018 stipulates requirements for the OHS management system and offers regulation for its application to allow entities to provide safe and healthy workplaces by averting occupational-related injury and disease, besides proactively enhancing its OHS risk management performance. Additionally, the National Sanitation Foundation [NSF] (2020) states that ISO 45001:2018 assists an organisation in attaining its OHS management system's anticipated outcomes. Constantine (2019) posits that, in line with the organisation's OHS policy, the expected results of an OHS risk management system entail the following:

- Persistent improvement of OHS performance.
- Regulatory compliance.
- Offer a safe and healthy workplace(s).
- Eliminate hazards and mitigate OHS risks and system deficiencies.
- Prevent occupational injuries and diseases.
- Attainment of OHS objectives.

In the mining sector of South Africa, ISO 45001:2018 implementation offers several benefits. According to NSF (2020), the standard provides a systematic approach for top

management to evaluate OHS risks and opportunities, monitor and review safety performance, and set objectives for continual improvement within an organisational context.

Implementing ISO 45001:2018 may entail, for instance, employee health promotion campaigns or monitoring the OHS effects of mining activities. Consequently, as alluded to by NSF (2020), a robust occupational health and safety management system such as ISO 45001:2018 can reduce occupational injuries and disease occurrence in the South African mining sector.

Secondly, Constantine (2019) points out that adopting ISO 45001: 2018 is a clear testimony and commitment from top management to stakeholders of the responsibility to safeguard employees from both accidents and ill health effects. The safeguarding of employees from OHS risk effects, in turn, decreases stoppages and employee loss time hours besides probable lawsuits. Thus, embracing the ISO 45001:18 by mining firms in South Africa may reduce legal and insurance costs. Additionally, Morgado, Silva and Fonseca (2019) emphasise that top management commitment guarantees to the directors, trustees, or shareholders on management controls concerning OHS risks are innate within the mining entity.

Thirdly, Constantine (2019) postulates that the ISO 45001:2018 standard encourages employee participation when ascertaining hazards and decreasing health and safety risks by implementing controls integrated within mining business processes. This approach can enhance health and safety culture, mitigate risk, and entrench best practices, leading to increased productivity and ultimately improving the firm’s financial performance. Moreover, NSF (2020) emphasised that when workers are actively involved in OHS risk management matters, an organisation will earn a positive status as a safe workplace, resulting in employee retention, motivation, and improved employee output. At the same time, Constantine (2019) affirms that employees feel mining firms in South Africa are seriously considering their health and safety needs. Furthermore, according to Constantine (2019), adopting ISO 45001:2018 by South African mining firms builds a

positive corporate culture of preventing occupational injuries and diseases, besides employee involvement.

Lastly, Morgado *et al.* (2019) advance that implementing ISO 45001:2018 by mining firms is an acknowledgement of having attained an international standard yardstick that may positively impact present and prospective customers in meeting their social responsibility obligations.

However, ISO 45001:18 is not applicable in addressing product safety, property damage, and environmental impact. Therefore, ISO 45001:2018 only applies to employees' health and safety issues. For that reason, in this study's purpose, top management of mining companies is encouraged to apply ISO 45001:2018 to mitigate the impact and frequency of health and safety risks.

3.10 Regulatory structures

Various structures were enacted in South Africa to reduce death, injuries, and occupational diseases in the SAMS. These regulatory structures include, among others, The Mine Health and Safety Act, the Mine Health and Safety Council, The Tripartite Action Plan, the Culture Transformation Framework, and The Mining Qualifications Authority (MCSA, 2020).

3.10.1 Mine Health and Safety Act (MHSA), No.29 of 1996

The MHSA No.29 of 1996 was enacted to attain objectives such as protecting the health and safety of mineworkers, obliging employees and mining companies to identify hazards and eliminate, control, and minimise health and safety risks, and providing for enforcement of health and safety measures at mines among others (MHSC, 2018). Also, the MHSA No.29 of 1996 provided the establishment of The Mine Health and Safety Inspectorate (MHSI) of the Department of Mineral Resources and Energy (DMRE), responsible for the general regulation and protection of employee health and safety in the mines besides the health of residents of communities surrounding mines affected by mining operations in South Africa (MCSA, 2020). Rendering to the requirements of the

MHSA, mines and employees signed treaties to standardise health and safety in the place of work and offer planning, decision-making, training, and auditing oversight (MCSA, 2020). As such, mining companies should appoint managers responsible for the mine's daily operations, ensuring safe operation and healthy and safe working conditions.

3.10.2 Mine Health and Safety Council (MHSC)

The MHSC was established in 1996 to direct health and safety in the mining industry and respond to safety-associated tasks (MCSA, 2020). This mining sector-funded institution was formed based on the accomplishments of decades of vital research in health and safety in mines (MHSC, 2018). The MHSC consists of a tripartite board, including agents from the government, companies and labour unions, and the Chief Inspector of Mines (CIM).

Additionally, the MHSC’s principal responsibility is to guide the Minister of Mineral Resources on OHS regulation in South African mines (MCSA, 2020). The MHSC is answerable to Parliament. Thus, the MHSC was formed to reduce occupational deaths, injuries, and diseases in South Africa's mining sector.

3.10.3 Tripartite Action Plan (TAP)

The Mining Industry Occupational Safety and Health (MOSH) Learning Hub was formed in 2009 by the Minerals Council with the sole purpose of assisting mining companies to learn from pockets of fineness in the mining sector (MCSA, 2020). It is one of the most effective programmes originated by the Minerals Council in the last ten years. Also, in the previous decade, mining firms embraced the best OHS risk management practices to mitigate OHS risks (MCSA, 2020).

One of the best practices encouraged by the MOSH Learning Hub is utilising safety nets with bolts to reduce the chances of groundfalls (MCSA, 2020). Correspondingly, proximity detection system (PDS) technology has helped prevent incidents by forewarning mineworkers about safety risks.

The MCSA encourages the industry to tirelessly explore and embrace novel and state-of-the-art technologies that will make South African mines safer than before.

3.10.4 Mining Qualifications Authority (MQA)

The MQA is vital in reducing skills deficiencies in the mining industry through capacity development and process enhancement (MCSA, 2020). Additionally, the MQA guarantees that the mining industry has adequate numbers of knowledgeable employees skilled in advancing OHS principles and processes. Also, the MQA's objectives entail supporting mining sector transformation through skills development and operating an efficient and crystal transparent CG system integrated into the legislative framework (MQA, 2020). The MQA works closely with the MHSC. As such, mitigation of OHS risks in the mining sector is one of the cornerstone aims of MQA.

3.10.5 Culture Transformation Framework (CTF)

The Culture Transformation Framework (CTF) was formulated by the MHSC and sanctioned at the 2011 Health and Safety Summit [HSS] (MHSC, 2018). According to MCSA (2020), CTF seeks to improve health and safety in mining workplaces. The CTF framework consists of eleven pillars that must be implemented by 2024. Table 3.2 outlines the eleven pillars of CTF.

Table 3.2: Pillars of CTF

Pillar	Description
01	Bonus and performance reward for prioritising safety ahead of production.
02	Risk management is designed to mitigate risk at its origin and investigate root causes.
03	The leadership pillar encourages top management and the board of directors to lead by example.
04	A leading practice is meant to provide a unified approach to identifying and facilitating the adoption of best occupational health and safety practices.
05	Diversity management is aimed at eliminating unfair discrimination in the workplace.
06	Data management is meant to monitor and evaluate the progress of CTF implementation and health and safety performance.
07	Integrating mining
08	The technology pillar enhances occupational health and safety by modernising mining operations.
09	Inspectorate
10	Tripartism
11	Regulatory framework

Source: MHSC (2018:5)

The first six pillars of CTF were implemented by the end of 2020. However, the last five CTF pillars will be implemented before 2024 (MCSA, 2020). Conversely, CTF has led to the changing of accident investigation techniques by mining companies to reduce unwarranted allegations among employees, adjusting bonuses to enhance safe production and emphasising meaningful and visibility at mining operations (MCSA, 2020).

3.11 OHS risk management empirical studies.

Concerted efforts to attain the ‘zero harm’ milestone in the workplace started as early as 200 years ago (Reese, 2018). Best OHS risk management practices became a core boardroom issue in different economic sectors, with particular attention in hazardous industries such as mining and construction. Despite considerable research on risk management worldwide, rare literature exists on the relationship between CG and OHS risk management. A plethora of studies on OHS risk management in different industries

using different methodologies with inconsistent findings were done (Lornudd, Frykman, Stenfors, Ebbevi, Hasson, Sundberg & von Thiele Schwarz, 2021; Ebbvi *et al*., 2020; Alshemeli *et al*., 2022; Teztzlaff *et al*., 2021; Salguero-Caparro *et al*., 2020; Mambwe *et al*., 2021; Khan *et al*., 2021; Ajmal *et al.,* 2022).

Lornudd *et al*. (2021), using thematic analysis based on thirty-four interviews, carried out a study to determine the influence of the board's actions and behaviours on OHS risk management performance in Australia's construction and mining industries. The study confirmed that board activities positively influence OHS risk management performance as the board of directors is responsible for the overall risk governance of firms. Additionally, Alshemeli *et al*. (2021) explored the impact of leadership behaviour and safety climate on general safety behaviour using questionnaires at a nuclear power plant in the United Arab Emirates (UAE). Based on structural equation modelling results, empowering leadership positively influences safety climate and, in turn, improves safety behaviour. On the same strand, Ebbvi *et al.* (2020) examined the impact of BoD activities on OHS risk management among Swedish enterprises using a literature review, and a positive relationship was confirmed.

Tetzlaff *et al*. (2021) used inductive thematic analysis based on OHS risk management key terms extracted from a 50-year data set from the mining industry. They explored the impact of safety culture on occupational accidents. The study results found that the organisation's safety culture is a crucial determinant of the safety behaviour of individual employees. However, the study found that organisations with competing importance deviate from OHS risk management issues. Moreover, commitment to OHS risk management from all stakeholders is crucial in broadening the view further than individual employee practices.

The extant literature posits that regulatory compliance is crucial to achieving the 'zero harm' milestone by December 2024. Ajmal *et al*. (2022) and Salguero-Caparros *et al*. (2020) examined the impact of regulatory compliance on OHS risk management in the oil and gas industry and small and medium-sized enterprises, respectively. Ajmal et al.

(2022) collected data from 280 employees using a cross-sectional survey. Based on a multivariate regression analysis, the results confirmed a positive relationship between regulatory compliance and OHS risk management performance. Additionally, Salguero-Caparros *et al*. (2020) found a positive relationship between regulatory compliance and OHS risk management performance among small and SMEs based on a literature review of twenty articles, four conference papers, and one book.

A study by Khan *et al.* (2021) on the OHS risk management determinants in small construction companies in China using a critical review synthesis of health and safety literature found inadequate training and management commitment levels. Also, poor working conditions among small construction firms in China were found to be significantly contributing to poor OHS risk management practices. Using the survey method, Mambwe et al. (2021) explored the management success factors in OHS risk management in the Zambian electricity industry. Based on descriptive and inferential statistical analysis outcomes, key success influences on OHS risk management were compliance, workplace processes, policy and human resources development, and leadership involvement.

Existing literature suggests that few studies focus on the impact of CG and OHS risk management performance in the mining sector. Most studies focused on safety culture determinants: leadership behaviour, work environment, policy and human resources development, and regulatory compliance. However, few studies sought to explore the influence of CG on OHS risk management performance in different economic sectors. Therefore, this study aims to close the gap in the literature on CG/OHS relationships in the South African mining sector.

3.12 Summary

Various academics and institutions defined OHS risks in various ways. The common aspect of the definition of OHS risks is the number of employees injured, killed, or ill while performing their duties at work. OHS risks, as defined by Ali (2015), were adopted in this study.

This chapter puts much emphasis on OHS risk management in the SAMS. The chapter discussed the overview of the SAMS. The mining sector in developing and developed worlds plays an integral economic role in job creation, GDP contribution, foreign currency earnings, and infrastructure development, among other roles. The composition of the South African mining industry was also discussed in detail. The South African mining sector involves companies extracting gold, coal, chrome, platinum, lithium, copper, diamond, and uranium.

The chapter discussed the emergence of OHS risk management in the SAMS. Documented OHS risk management in the mining sector started in 300 BC by Egyptians when they developed the First Aid kit. The mining sector worldwide is pursuing to achieve the ‘zero harm’ milestone by 2024, where every miner will return home from work without getting injured, killed, or ill.

The current trend impacting the implementation of OHS risk management was also highlighted in this chapter. OHS risk management trends are part of integrated disclosure in the SAMS. Moreover, the mining sector’s OHS is driven by management commitment, labour union pressure, regulatory compliance, focus from rating agencies, and security and technological issues.

Moreover, the mining sector’s health and safety hazards were identified and consisted of chemical, biological, physical, ergonomic, psychological, and safety. Continuous exposure to these hazards by miners may lead to injuries, deaths, and diseases. Miners' most common diseases are silicosis, occupational tuberculosis, skin diseases, musculoskeletal disorders, and nervous system damage. However, the top management of mining firms must devise strategies that minimise miners’ exposure to health and safety hazards to achieve the ‘zero harm’ milestone.

Furthermore, the chapter discussed theories underpinning OHS risk management in the SAMS. Heinrich’s domino theory of accident causation, multiple causation models,

Weaver's updated model, updated domino sequence, ARCTM, human error, human factor, BBS and MSTAC models were discussed and considered appropriate as the basis of mitigating OHS risks in the South African mining sector. Although there are different theories underpinning health and safety risk management, mining firms must opt for a theory that fits their organisational context for maximum health and safety risk mitigation results.

The drive to achieve the ‘zero harm’ milestone by 2024 has been manifested by the promulgation of international standards that firms in different economic sectors should adopt partially or as a whole. Mining firms and regulatory authorities in South Africa adopted regulatory structures such as ISO 45001:2018, MHSA (No.29 0f 1996), MHSC, TAP and CTF to minimise OHS risks. However, mining firms must apply health and safety standards and quality and environmental management systems to manage OHS risks holistically. The next chapter discusses the conceptual framework for this study.

CHAPTER 4: CONCEPTUAL FRAMEWORK

4.1 Introduction

This chapter explores the literature on corporate governance (CG) and OHS risk management in the South African mining sector. CG has developed into a shared subject among academics, particularly after the global financial crisis of 2008/2009 (Arora & Sharma, 2016). CG refers to the process and structure utilised to control and manage the organisational undertakings in the direction of improving success besides corporate accountability with the definitive objective (Financial Reporting Council [FRC], 2005; Zabri, Ahmad & Wah, 2016; The Institute of Directors Southern Africa [IoDSA], 2016).

Balasubramanian and George (2012) posit that CG mechanisms are tools principals of companies employ to monitor and control agents. The CG mechanisms are used to guarantee that agents act in a manner that is in the best interest of their principals (Kyere & Igbal, 2019). From a risk management perspective, CG is critical in achieving optimum performance in enterprise-wide risk management. Embedding OHS risk management practices is not an exception (Mambwe *et al*., 2021; Ajmal *et al.,* 2022).

As per Chapter One deliberations, the major aim of this study is to investigate the impact of CG on OHS risk management in the South African mining sector. The current chapter emphasised the link between board characteristics (board size, board independence, board gender diversity, managerial ownership, and audit and risk committee size) and OHS risk management. The chapter proceeded to discuss different types of CG approaches. The proxies used by mining firms to measure OHS risk management performance were also discussed in this chapter. Furthermore, the chapter highlighted the link between CG and OHS risk management in the mining sector, resulting in the proposed conceptual framework of this study.

4.2 Corporate governance

CG is a system by which a company is directed and controlled (IoDSA, 2016). Additionally, CG is a critical facet of running a successful and sustainable business enterprise, although it is something various business owners regard as insignificant and elementary practice. Arora and Sharma (2016) assert that a company typically employs two CG mechanisms, namely internal and external mechanisms. Internal CG mechanisms entail board size, board independence, board diversity, managerial ownership, Chief executive officer (CEO) duality, executive compensation, debt holders, large shareholders, and board committees. In contrast, external CG mechanisms include a competitive market, regulators, industry associations, trade unions, and financial institutions (De Beers, 2020).

However, the relative importance of internal and external CG mechanisms depends on the institutional context. De Beers (2020) posit that Anglo-Saxon economies typically rely on external CG mechanisms, while Rhineland and Japanese governance mechanisms heavily rely on internal mechanisms. As such, South Africa is an Anglo-Saxon economy and mining firms operating in it depend on external CG mechanisms to a greater extent and internal CG mechanisms to a lesser extent. Nevertheless, both CG mechanisms impact South African mining firms' financial and non-financial performance. Internal CG mechanisms are charged with the core responsibility of setting internal controls for the company.

Similarly, these internal controls monitor the growth and operating activities of the company and take counteractive actions when the company departs from the anticipated performance standard. To uphold the company’s broader internal control mechanism, CG structures must serve its internal objectives and stakeholders (Arora & Sharma, 2016). The employees are the greatest invaluable assets and internal stakeholders. Internal stakeholders of a corporation entail employees, the board of directors, managers, and owners (Lund, 2020).

At the same time, internal CG mechanisms include board structure, board committees, management oversight, policy development, and control segregation. Internal objectives of a corporation include, but are not limited to, smooth operations, clearly defined reporting lines, and performance measurement systems. Regarding employees, the CG mechanisms are obligated to guarantee the well-being of employees by formulating and implementing health and safety risk mitigation strategies (IoDSA, 2016).

On the other hand, external CG mechanisms are controlled by those outside the company and serve the objectives of business entities (Zabri *et al.,* 2016*;* de Beers, 2020*)*. Additionally, the business objectives encompass adequate liability management and regulatory compliance. External stakeholders usually impose These external CG mechanisms on business entities through union agreements, standards, and regulatory guidelines (Zabri *et al.,* 2016). Likewise, firms report their compliance status with external CG to outside stakeholders. The management of OHS risks in the mining sector of South Africa is influenced by external CG mechanisms such as regulators, trade unions, and the Mineral Council of South Africa (MCSA). As such, internal CG mechanisms of mining firms are responsible for complying with health and safety regulations and standards to achieve OHS milestones such as ‘zero harm’ by December 2024.

The concept of CG is based on two broadly different approaches: shareholder and stakeholder approach. The shareholder approach on CG posits that corporations thrive to serve the interests of their owners. Du Plessis (2016) alludes that the shareholder approach has given birth to using shareholder value maximisation when assessing the value of listed firms.

On the stakeholder approach strand, firms aim to serve the interests of all stakeholders, and employees are key stakeholders of firms such as mining corporations. Lund (2020) alludes that the stakeholder approach to CG constitutes the fundamental tool governing the function of the existing capitalist system through the relationships between executives of publicly listed firms and all parties concerned by the company's operating activities.

Additionally, FRC (2015) alludes that all parties concerned include shareholders, employees, suppliers, creditors, customers, and society. Furthermore, CG refers to the institutional and behavioural systems that govern the relationships between the executives of the organisation and the parties concerned by its prospect, steered by those who hold legitimate rights to it (IoDNZ, 2013; IoDSA, 2016). Therefore, the stakeholder approach to CG emphasises the code of legitimate interest of parties over the legitimacy of the owners (Du Plessis, 2016).

This study explored the impact of internal CG mechanisms on OHS risk management in the South African mining sector. Internal CG mechanisms used entail board size (BS), board independence (BI), board gender diversity (BG), managerial ownership (MO), and audit and risk committee size (ARC).

4.3 OHS risk management.

In general, the principal aim of CG is to enable an operational, inventive, and judicious board that can deliver sustainable processes for an enterprise (Du Plessis, 2016). Also, CG is about building a conducive atmosphere of trust, transparency, responsibility, and accountability, which is indispensable in nurturing long-term investments, financial strength, and firm reputation, augmenting robust development and more inclusive communities (Arora & Sharma, 2016). Besides, CG aims to provide oversight, mitigate OHS risks, enhance the firm's access to outside funding, guarantee efficient distribution of resources, enhance legal and regulatory compliance, and nurture improved relations amongst stakeholders (The American Society of Safety Engineers [ASSE], 2015).

Best CG practices are expected based on sustainable long-term firm performance, including robust OHS risk management practices (Bhatt & Bhatt, 2017; Arora & Sharma, 2016). On the one hand, the key financial performance of a firm is based on the maximum expectation of liquidity, profitability, gearing, and operating efficiency levels (Arora & Sharma, 2016).

On the other hand, Anglo American (2018) alludes that non-financial key performance proxies in the SAMS include OHS risks. OHS risk management proxies commonly used in the SAMS entail, among others, fatalities and managed operations, lost time injury frequency rate (LTIFR), total injuries frequency rate (TIFR), new cases of occupational diseases (NCOD), number of employees and contractors, greenhouses carbon emissions, energy usage, and water consumption.

However, non-financial key performance indicators (KPIs) such as OHS risk management metrics can be used to evaluate the performance of internal CG mechanisms of a firm. The IoDNZ (2013) asserts that the board and directors are best placed to manage the OHS risks mining firms face effectively. IoDNZ (2013) predicates that the board should provide the necessary leadership and be responsible for major decisions that influence OHS risk management: the strategic direction and securing that the firm has appropriate staff, systems, and equipment. Thus, OHS risk management performance in the mining sector can be regarded as one of the key metrics used in measuring the internal CG mechanism's effectiveness (Dougall & Mmola, 2015; Molnar, Schwarz, Hellgren, Hasson & Tafvelin, 2019). This study examined comprehensive measures of OHS risk management in the South African mining sector, encompassing TIFR and NCOD.

4.3.1 Total Injury Frequency Rate (TIFR)

TIFR is the total number of fatalities, lost time injuries, substitute work, and other injuries requiring medical attention per million hours worked by full-time employees and contractors (Anglo American, 2018). TIFR is the most comprehensive safety measure in the mining sector as an account of the fatal injury frequency rate (FIFR) and lost time injury frequency rate (LTIFR) (Dougall & Mmola, 2015). TIFR is a lagging safety indicator as it represents the firm's historical safety performance but does not give solid grounds to forecast future incident rates (Anglo American, 2018).

However, the TIFR safety indicator is utilised as a comprehensive measure of board performance in safety management. Most mining firms set their safety performance benchmarks using TIFR, and failure to achieve set benchmarks is a clear CG dismal

performance. By 2024, mining firms across the globe should reach zero TIFR to meet the ‘zero harm’ milestone (MCSA, 2018). Furthermore, mining firms such as Anglo American, in their endeavour to achieve the “zero-harm” milestone by 2024, introduced the Safety and Sustainable Development (S&SD) risk committee in their board committees (Anglo American, 2018). The S&SD committee’s core functions are identifying critical safety health and environmental improvement opportunities, safety improvement plans, and formulation of a comprehensive framework of roles and principles and mandatory safety standards (Anglo American, 2018). Therefore, the TIFR trend reflects board performance regarding OHS risk management.

4.3.2 New cases of occupational diseases (NCOD)

“NCOD is the sum of occupational diseases due to asbestosis, noise-induced hearing loss (NIHL), silicosis, coal worker’s pneumoconiosis, chronic obstructive airways disease, occupational tuberculosis, occupational asthma, hand/arm vibration syndrome, musculoskeletal disorders, dermatitis, occupational cancers, and other occupational diseases” (Anglo American, 2018:206). The health incident rate expressed in terms of NCOD is one of the key health performance indicators utilised in the mining sector to evaluate CG’s effectiveness.

The BoD in the mining sector is responsible for protecting and improving miners' health (Dougall & Mmola, 2015; Bhatt & Bhatt, 2017). As such, CG structures in hazardous industries such as mining are mandated to prioritise health to safeguard the firms from dire consequences such as lost production hours, increased medical expenses, and reputational risk (Zhou, Cao, Yu, Wang & Wang, 2018).

4.4 Corporate governance and OHS risks.

Ajmal *et al*. (2022) posit that the underlying theme of integrating CG and OHS risk management is to rip the benefits of these two notions. According to The American Society of Safety Engineers [ASSE] (2015), the mining industry is characterised by hazardous working conditions, which negatively impact workers' health and safety, resulting in a loss of production hours. Moreover, the mining sector is regarded as a

safety-critical domain with risky operations and an atmosphere in which the operator is exposed to various risks and hazards.

Withal, the benefits of CG and OHS risk management integration in daily mining operations entails improved health and safety awareness from the board down, firm reputation, and productivity (IoDNZ, 2013: Zhou *et al.*, 2018). The ingraining of OHS risk management activities in the organisational culture of mining firms enhances statutory laws and health and safety standards compliance (IoDNZ, 2013). Embracing OHS risk management at all mining firms minimises health and safety incidences (Tetzlaff *et al*., 2021). The integration of OHS in CG activities implies the involvement of virtually all business functions of mining firms.

Numerous studies indicate that firms operating in risky and hazardous economic sectors, such as the mining sector, benefit from integrating OHS risk management in CG practices (Ebbevi *et al*., 2020). The IoDNZ (2013) stresses that the infusing of OHS risk management in the daily operations of a mining firm obliges the active involvement of effective operative governance from line managers to top management. For instance, floor managers are directly and indirectly engaged in OHS risk management by affirming their guidance, how they impact work organisations, and their approach to OHS interventions (Ebbevi *et al.,* 2020).

Nonetheless, floor managers do not operate independently. They must work with top management and employees to ensure a healthy and safe working environment. In large mining corporations, floor managers' actions are influenced by senior management and the BoD, who are responsible for allocating resources and benchmarking OHS risk management performance targets (IoDNZ, 2013). As such, the body responsible for strategic leadership and governance is the board of directors.

The BoD is mandated to ensure the entity's legal compliance and long-term value creation. It significantly affects all organisational processes and outcomes, including OHS risk management (Du Plessis, 2016). Business laws recommend the governing body's

responsibilities and obligations, and they include formulating and establishing strategic direction, setting standards and principles for operations, holding management accountable, supervising internal controls, and accounting for shareholders' and stakeholders' interests (Du Plessis, 2016; IoDNZ, 2013).

De Beers (2020) alludes that CG is about controlling and directing companies in a sustainable manner required to meet anticipated triple-bottom-line performance. In this way, CG aims to create and add value to shareholder wealth while safeguarding all stakeholders' interests and protecting the natural environment. One of the important ways in which mining firms create shareholder value is by implementing robust OHS risk management practices as a mechanism to guarantee the well-being of the employees as well as reduce the magnitude of costs associated with inadequate OHS management practices (IoDNZ, 2013; ASSE, 2015; Zhou *et al.,* 2018). According to Zhou *et al.* (2018), OHS risk incidences in the mining sector are rated as the costliest in the corporate world.

Additionally, a high rate of OHS risk event occurrences impacts mining firms directly and indirectly (Ebbevi *et al.,* 2020; ASSE, 2015). Moreover, direct costs associated with mining-related incidences include compensation, lawsuits, OHS non-compliance fines, and other benefits for injured employees as prescribed by government laws and regulations (Ebbevi *et al.,* 2020; IoDNZ, 2013). On the other hand, indirect costs encompass stoppage time for treating injured miners, disruption of mining operations, damage to property and equipment, and reputational damage, among others (ASSE, 2015; Brown, Buehler & Weria, 2017).

The most critical and daunting task facing CG in mining firms in South Africa today is establishing a shared culture of OHS risk management, where all employees should return home safe, healthy, and alive (Baxter, 2017). CG structures in the mining sector are obliged to implement OHS risk management strategies that aim to reduce occupational hazards such as poor lighting and ventilation, unsafe acts by employees, poor quality air, and occupational disease to minimise loss of employees in the SAMS both in the short and long run (IoDNZ, 2013).

The study conceptualised five internal CG and two OHS risk management proxies' relationships. CG mechanisms encompass board size, board gender diversity, managerial ownership, board independence, and audit and risk committee size, whilst OHS risk management performance is expressed in terms of TIFR and NCOD. Additionally, the conceptual framework (Figure 4.1) of the study takes into account the influence of TA and TE as control variables between CG (independent variables) and OHS risk management performance (dependent variables). As illustrated in Figure 4.1, the conceptual framework offers insight into the relationship between CG-OHS risk management performance in the mining sector of South Africa.

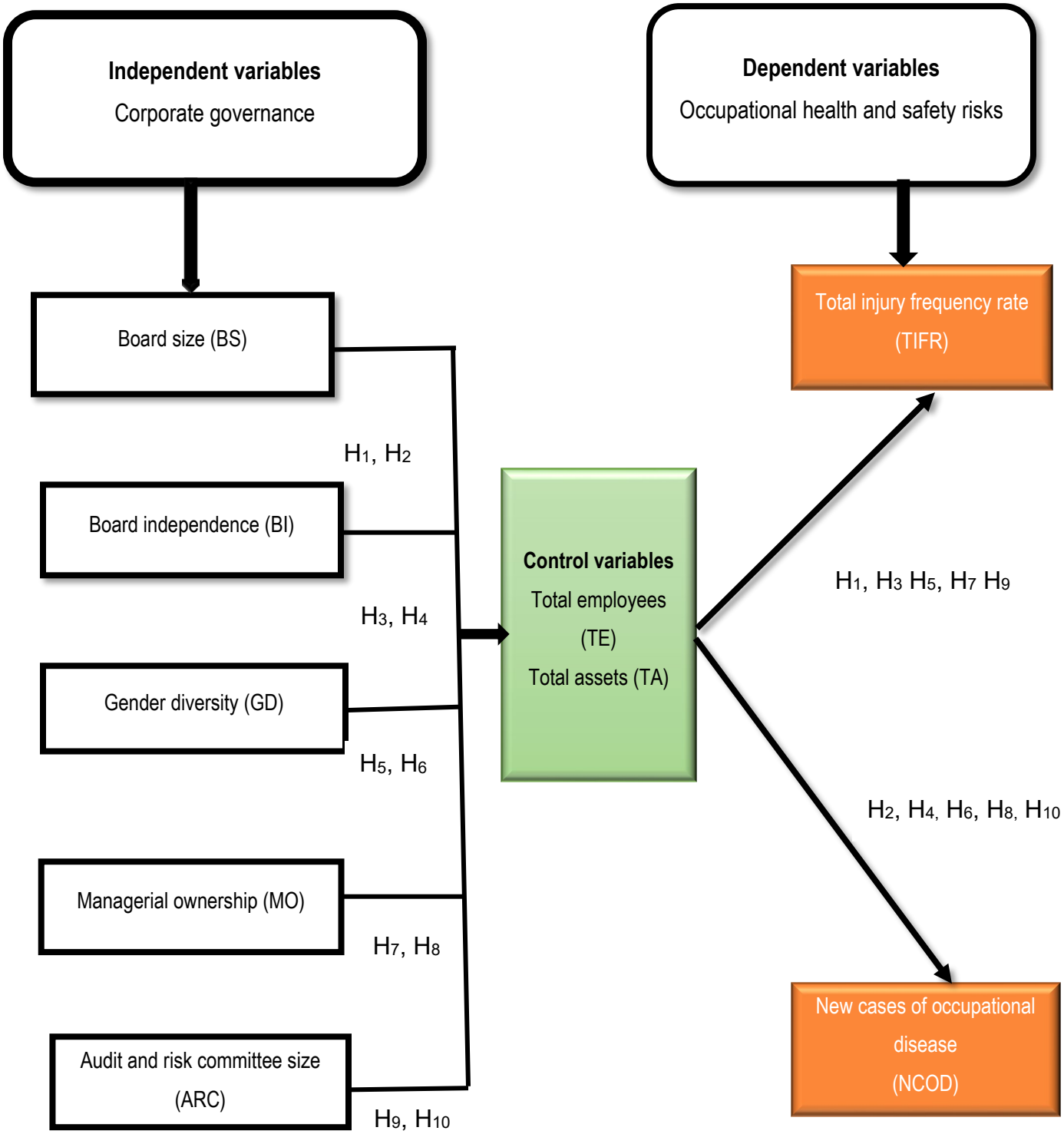

Figure 4.1: Conceptual framework showing the relationship between CG and OHS risks.

Source: Researcher's construct

Given the current considerable OHS risk prevalence rate worldwide in the mining sector, inadequacies in CG mechanisms are believed to be the major obstacle in attaining the 'zero harm' milestone by December 20124. Proponents of best corporate governance practices posit a positive relationship between CG and risk management practices brings about a positive image of the firm and, in turn, increases shareholder value (IoDSA, 2016; IoDNZ, 2013; Molnar *et al*., 2019). Ebbevi *et al.* (2019) postulate that occupational risks form part of enterprise-wide risk management's core activities in hazardous industries such as mining, and the board must guarantee the safety and health of miners.

As such, CG mechanisms in the mining sector are responsible for formulating and implementing OHS risk management mitigation strategies that aim to achieve the 'zero harm' milestone by December 2024 (MCSA, 2020). However, CG and OHS risk management performance advocates assert that the behaviour of employees and management determines the overall OHS risk management's ultimate goal of 'zero harm' (ASSE, 2015; Molnar *et al.,* 2019). Therefore, an analysis of the impacts of CG on OHS risk management is included in this study. Bhatt and Bhatt (2017) allude that best CG practices are mandatory for the sustainable performance of mining firms only if practised to promote the interests of all stakeholders, including employees' health and safety.

The impacts of CG on firm performance aspects also relate to OHS risk management (IoDNZ, 2013; Brown *et al.,* 2017). More than a few studies express that CG and OHS risk management is highly co-dependent. One good example is the study by Ebbevi *et al.* (2020), which states that the opinions regarding CG and OHS risk management are interwoven. The study suggests that directors influence OHS indirectly through culture, performance management, internal control, and organisational structure, which would impact OHS risk management practices.

By definition, OHS risk management is a manifold-disciplinary field, and it is centred on guarding the safety, health, and welfare of employees (Du Plessis, 2016; IoDNZ, 2013). Moreover, health is concerned with the physical state of affairs of both mind and body of all mining employees, including contractors, and their protection from harm in the form of injury or disease, whilst safety is concerned with physical conditions in mining industries and applies to a state where the risk of harm or damage has been removed or reduced to a tolerable level (Ebbevi *et al.,* 2020). Molnar et al. (2020) state that the protection environment has two forms. First is the internal environment in the mining firm, which is linked to the overall working conditions in the workplace. Second, unsafe environments exist in a mining firm's external environment. Physical working conditions encompass workspace, lighting, ventilation, temperature, and air quality (Baxter, 2017; IoDNZ, 2013). According to Baxter (2017), TIFR and NCOD fluctuations suggest improving the SAMS's physical working conditions. A paradigm shift in CG leads to a change in OHS risk management performance. The most important proxies for OHS risk management are NCOD and TIFR, which are the principal variables underlying sustainable and successful OHS risk management performance, with mining employees and their well-being recognized as a fundamental issue.

To ascertain the impacts of CG on firm performance, it has also become essential to determine the level of OHS risk management in South African mining firms. The rate and impact of OHS risks in the mining sector are key factors used to measure firm performance (IoDNZ, 2013). However, there are many challenges involved in CG and improving firm performance while minimizing OHS risks and increasing shareholder value.

In brief, the conceptual framework aims to highlight the relationship between CG and OHS risk management to achieve the outcome of this research. To realise the ultimate purpose of CG in the SAMS, it is indispensable for enterprise-wide risk management frameworks and policies to embed health and safety risk management practices, which are two focal concerns deliberated in this study.

Furthermore, a holistic approach towards OHS risk management within South African mining firms, with the tone being set at the board level, is a prerogative.

4.5 Summary

The chapter has reviewed the substantial collected works regarding CG and OHS risk management practices. The collected works have shown board size, board independence, managerial ownership, audit and risk committee size, and board gender diversity have a significant impact on OHS risk management performance in the South African mining sector. In due course, CG structures in the mining firms of South Africa are mandated to cultivate and implement an OHS risk management culture across the entire organisation. Also, mining firms should form BoD large enough to constitute appropriate committees, balanced in gender, a mix of skills, and executive and non-executive directors. This may lead to the ultimate goal of OHS risk management of ‘zero harm’.

The chapter also discussed major approaches to CG, different forms of CG mechanisms, and their impact on OHS risk management. It was proven that the stakeholder approach to CG calls for the infusion of OHS risk management practices in the business’ daily operations, as employees are invaluable assets of mining firms.

Section 4.4 briefly reviews the CG and OHS risk management in the SAMS. It was established that CG is responsible for promoting and embracing OHS culture from top to bottom. Moreover, the chapter discussed the proxies used in measuring OHS risk management in the mining sector: TIFR and NCOD. Therefore, CG structures in mining firms are encouraged to formulate, implement, monitor, and evaluate OHS risk management strategies to achieve the ‘zero harm’ milestone by December 2024.

Reviewing the CG and OHS risk management literature offers background knowledge on the OHS of miners in South Africa. It provides a detailed understanding of CG mechanisms, approaches, and OHS risk management proxies. Therefore, this chapter is the basis for future empirical studies on CG and OHS risk management in the mining

sector. The next chapter presents the research design and methodology utilised to confirm the research hypothesis and achieve the objectives identified in Chapter 1.

CHAPTER 5: RESEARCH METHODOLOGY

5.1 Introduction

This chapter focuses on research methodology, which is essential in fortifying the exploration of the literature under study. Due to its importance, the chapter deliberates on the research design for the study, its justification, and its application. The research design, as well as methodology, assists in the planning and implementation of the study in a manner expected to attain research objectives. The chapter unfolds the research process as propounded by Saunders *et al*. (2019). Furthermore, this chapter unfolds as follows: research design, data collection, explanation of variables, econometric model estimation, diagnostic tests and data analysis techniques and procedures. Considering the research methodology adopted to examine the relationship between CG and OHS risk management, the last section of the chapter deliberates on the ethical issues.

5.2 Research design

The quantitative research design guided this study, where the importance is on quantifying both predictor and response variables and statistical testing techniques. The study is classified as quantitative since it was based on numerical data (Saunders *et al.,* 2019) in panel data. Panel data includes both longitudinal and cross-sectional time horizons. As the objective of the study was to determine the relationship between CG and OHS risk management, the research is also classified as quantitative because it was premised on positivist principles (IIelaboye & Alade, 2022; Agboola & Orege, 2019).

For this research, the deductive approach was used to determine the impact of CG on OHS risk management performance in the South African mining sector using numerical data that entails statistical analysis to test the hypothesis. Also, the deductive approach is usually utilised when the research is founded on quantitative data, as it allows the study to unfold from a broad to precise spectrum (Casula, Rangarajan & Shields, 2021). Moreover, according to Machila, Sompa, Muleya, and Pitsoe (2018), deduction from common viewpoints allows the researcher to create a theoretical framework and test the hypothesis, thus drawing a definitive conclusion. Pandey (2019) points out that sequential

steps in conducting deductive approach-based research are the investigation of theories, construction of theoretical framework or hypotheses, observation using statistical testing of hypotheses, and confirmation of a detailed deduction drawn from rational premises. The current study adopted the deductive approach as numerical data on CG and OHS risk management in the South African mining sector was collected. The relationship between the CG and OHS risk management variables was confirmed through hypothesis testing.

5.3 Data collection

Secondary quantitative data on CG and OHS risk management performance in the SAMS for 2002–2018 were collected from thirty JSE-listed firms' integrated annual reports. The time frame selection was influenced by introducing the King II report on CG, which brought about new dimensions in corporate governance to enhance sustainability. The companies include mining firms that were neither suspended nor deregistered from the JSE for the period under study. The quantitative secondary data about CG (BS, BI, BI, ARC, and MO), OHS risk management indicators (NCOD and TRIFR), and control variables (TA and TE) were recorded in the Excel spreadsheet, generating 510 observations. Moreover, the missing data on CG, OHS risk management, and control variables were extracted from the Mineral Council of South Africa (MCSA) fact sheets. Using online secondary data sources saves time, is cheap, and is convenient. This approach has been adopted by previous studies (Biruk & Gurdip, 2019; Chandramohan, 2018).

5.4 Explanation of variables

A variable is a distinct aspect upon which data have been collected, and it can be either a predictor (independent) or a response (dependent) variable (Saunders *et al.,* 2019). The study explored the association between CG and OHS risk management in the South African mining sector. Intrinsically, the appropriate independent, dependent, and control variables were selected to achieve the research objectives. Besides, a causal relationship is typically influenced by control variables that may affect dependent variables. As such, exceptional attention was given to selecting the appropriate variables.

In this study, seven variables were employed and measured as follows: BS (the number of directors), BI (the percentage of independent directors), ARC (the number of audit and risk committee members), GD (percentage of women directors), MO (percentage of internal ownership), and occupational health risks (new cases of occupational diseases) [NCOD], and occupational safety risks (total injuries frequency rate) [TIFR]. To be consistent with other studies, these variables were used in various studies on CG and OHS risk management (Rashid, 2018; Tsalis, Stylianou & Nikolaou, 2018; Fonseca & Carvalho, 2019; Mabika, 2018). CG variables are independent, whilst occupational health and risk management (TIFR and NCOD) indicators are dependent variables.

5.4.1 Independent variables

According to Saunders *et al*. (2019), the independent variable has substantial statistical power to cause an effect on the response variable. As in previous studies (Yilmaz, 2018; Kapter *et al.,* 2018; Biruk & Gurdip, 2019), CG variables such as BS, BI, ARC, GD and MO are the predictor variables.

5.4.2 Dependent variables

Corporate governance structures formulate, implement, and evaluate vital strategies for achieving organisational objectives, especially in OHS risks (IoDNZ, 2013). Effective OHS risk management in the mining sector is expressed through several indicators. Though this study utilised standard variables as given in the literature, these are total injury frequency rate (TIFR) and new cases of occupational diseases (NCOD) (Baxter, 2017; MICSA, 2021; Anglo American, 2018). Furthermore, the variables indicated provide insight into the mining sector's dedication and commitment to minimising or eliminating OHS challenges (MICSA, 2021).

5.4.3 Control variables

The severity and frequency of OHS risks in the mining sector are influenced by many factors apart from CG variables. Since the study aims to determine the effect of predictor variables on response variables, other factors should be held constant to avoid giving a

false impression of the results. However, the number of full-time and contract employees significantly influences the frequency and severity of OHS risks in the mining sector (Baxter, 2017). Additionally, TA value was utilised as the other control variable as mining firms are asset-intensive (Dougall & Mmola, 2015). TA and TE are control variables consistent with prior studies (Mukwarami, 2021; Lei, Tang, Duffield, Zhou, Hu & Yu, 2018; Hernandez, Yanez-Araque & Marcus-Garcia, 2020).

5.5 Model estimation

The study intends to establish the relationship between CG variables and OHS risk management in the SAMS. Thus, econometric models were adopted, which Saunders *et al.* (2019) describe as the suitable method of testing the hypothesis to institute relationships. The study used two dependent, five independent, and two control variables). The econometric model comprises two multivariate linear regression equations.

The two multiple linear regression equations are stated as follows:

Model 1: $Y_1 = \beta_0 + B_1BS + \beta_2BI + \beta_3 GD + \beta_4 ARC + \beta_5 MO + \beta_6 TA + \beta_7 TE + \epsilon$ (1)

Model 2: $Y_2 = \beta_0 + B_1BS + \beta_2BI + \beta_3 GD + \beta_4ARC + \beta_5 MO + \beta_6 TA + \beta_7 TE + \epsilon$ (2)

The description of the variables of the econometric models is given in Table 5.1

Table 5.1: Description of variables

Variables	Description of variables
Dependent variables	
Occupational safety risks (Y_1)	Total injuries frequency rate (TIFR)
Occupational Health risks (Y_2)	New cases of occupational diseases (NCOD)
Independent variables	
Board size (BS)	Natural log of the total number of members on the board of directors.
Board Independence (BI)	Percentage of independent directors to the total number of directors on the board.
Board Gender diversity	Percentage of female directors to the total number of directors on the board.
Managerial ownership/internal shareholding (MO)	Percentage of shares held by directors to the total number of ordinary shares in issue.
Audit and Risk committee size (ARC)	Natural log of the total number of audit and/or risk committee members.
Control variables	
Total Assets (TA)	The natural log of the total value of assets.
Total Employees (TE)	The natural log of the total number of permanent and contract employees.

Source: Researcher's compilation

5.6 Diagnostic tests

Panel data must be subjected to diagnostic tests to enhance reliable and valid results and prevent the violations of econometric model misspecifications and regression assumptions. In the current study, diagnostic tests were applied to check the presence of multicollinearity (variance inflation factor), heteroscedasticity (Breusch and Pagan test), serial correlation (Pasaran CD test), and normality. The diagnostic tests were done as in previous studies (Biruk & Gurdip, Tran, 2021 & 2019; Kapter *et al*., 2019).

5.6.1 Multicollinearity

Multicollinearity is when a strong correlation between independent variables exists. Shrestha (2020) asserts that testing for multicollinearity among independent variables is vital to avert associated adverse effects and pitfalls that may exist in regression analysis. Additionally, multicollinearity within data results in model misspecifications and ultimately biased results (Ullah, Aslam, Altaf & Ahmed, 2019). Moreover, multicollinearity within independent variables entails the numerical stability of the regression coefficient estimate and leads to severe challenges in validating the model. The degree of sensitivity to minor changes within the model increases with the degree of correlation (Doucette, 2017). Furthermore, a high degree of correlation among independent variables diminishes the statistical influence of a model, casting untrustworthiness of the p-value when identifying the statistical importance of the explanatory variables.

According to Ullah *et al*. (2019), multicollinearity can be tested using at least one of the approaches: Monte Carlo simulation, Variance Inflation Factor analysis, correlation coefficient matrix, R2 (multiple coefficients of determination), and eigenvalues. For this study, independent variables were subjected to Variance Inflation Factor (VIF) analysis since it assists in identifying the severity of any multicollinearity problems and allows the adjustment of the model (Chandramohan, 2018). Also, VIF analysis allows a fast measure of how much the predictor variable contributes to the standard error in ordinary least square regression analysis.

However, the correlation between independent variables affects the coefficients and p-values, not the prediction, accuracy of the predictions, and goodness-of-fit statistics (Kapter *et al*., 2018). Ullah *et al*. (2019) affirm that multicollinearity can be suppressed by removing at least one of the highly correlated variables, using principal component analysis and feasible generalised least squares (FGLS). In the current study, though ordinary least square was used, the FGLS method was applied to reduce the severity of multicollinearity. To be consistent with earlier studies, a VIF of five (5) was used to determine the optimum degree of multicollinearity (Chandramohan, 2018; Kapter et *al*., 2018; Biruk & Gurdip, 2019).

5.6.2 Heteroscedasticity

Heteroscedasticity exists when the standard deviations of a dependent variable, observed over different values of predictor variables, are not constant (Casini, 2021). Also, heteroscedasticity is applied when calculating the error margin among data sets, such as anticipated and actual results, since it offers a degree of deviation of data points from the mean value (Casini, 2021; Astivia & Zumbo, 2019). OLS regression analysis justifies the need to test heteroscedasticity in the current study. Moreover, heteroscedasticity can be tested using the Breusch-Pagan test (Breusch & Pagan, 1979), the white test (White, 1980), and the Breusch-Godfrey test (Breusch, 1978), among others, to complement the exploration of assumption violation within OLS regression. The Breusch-Pagan test is justified as the OLS regression model utilised to seek a linear relationship between the squared error term and the predictor variables. As such, the study applied the Breusch-Pagan test to assess whether the model errors are associated with any of the model predictors similar to previous studies (Ilelaboye & Alade, 2022; Casini, 2021; Astivia & Zumbo, 2019).

5.6.3 Serial correlation

According to Shrestha (2020), serial correlation is a statistical problem commonly associated with time series data. However, it exists in panel data where an error term transfers from one period to the next. Additionally, failure to account for serial correlation within panel data results in inefficiencies in estimating regression coefficients, biased errors, and exaggerated goodness of fit (Ghosh, 2020; Shrestha, 2020). Although serial correlation within panel data can be tested using various methods such as the non-parametric test, Durban-Watson test, Lagrange Multiple tests, and correlogram, a plot of residuals (scatter graph) was used for the study. The application of a scatter graph in determining whether error terms were randomly distributed by enumerating runs oscillating the threshold is based on the notion that it is easy and comprehensive. The study uses a multivariate regression model (Ghosh, 2020). In line with previous studies (Ilelaboye & Alade, 2022; Shrestha, 2020; Tembo, 2018), the study used a scatter graph to detect serial correlation among panel data.

5.6.4 Normality

Hernandez (2021) asserts that checking normality within a data set is one of the mainstay practices in statistics and data analysis to improve results' robustness and validity. Hatem, Zendan, Goossens and Moreira (2022) echo that normality tests determine if a data sample originated from a normally distributed population. The current study used OLS and FGLS to determine the impacts of CG on OHS risk management performance using panel data; as such, normality is one of the vital assumptions to be considered. However, violating the OLS and FGLS regression model's normality assumption produces unreliable and invalid results with underestimated regression coefficients. As Georges et al. (2022) alluded to, normality is commonly tested using two measures of shape: skewness and Kurtosis. Data is normally distributed if the skewness value of a data set is between -2 and + 2, and the kurtosis value lies between -7 and +7 (Hernandez, 2021; Hatem *et al*., 2022; Orcan, 2020; Byrne, 2010). In tandem with previous studies, skewness and Kurtosis tests were conducted to check whether normal distribution exists within the data (Ghosh, 2020; Hatem *et al*., 2022; Hagag, 2021).

5.7 Data analysis

The secondary data of CG and OHS risk management performance were presented and analysed using quantitative techniques. Descriptive and inferential analysis approaches were employed in the data analysis procedure. Quantitative data on independent and dependent variables was presented and analysed using a statistical package STATA version 16 and e-views. After data gathering, a Microsoft Excel worksheet was utilised to ensure data completeness and cleanliness before exporting into STATA Software version 16 to be consistent with previous studies (Kapter *et al*.,2018). Moreover, the data were subjected to diagnostic tests to address assumptions of regression violations, consistent with previous studies (Biruk & Gurdip, 2019). The descriptive statistical analysis technique briefly describes the statistical data for a particular sample under the study (Saunders *et al*., 2019). The outcomes from the descriptive analysis in the study offer information on measures of central tendency in the form of mean, median, maximum, minimum, and standard deviation that can be presented using tables.

Furthermore, inferential statistics permit the researcher to compare, test and forecast data from a particular sample and draw broad conclusions (Doucette, 2017). In this regard, consistent with empirical studies (Tjano, 2022; Mukwarami, 2021; Yilmaz, 2018; Kapter *et al.,* 2018), the hypotheses were confirmed through inferential testing encompassing running the multivariate regression analysis from which probability values (p-value) and correlational coefficients were used to interpret the study results.

5.8 Ethical considerations

The researcher's ethical obligation to the research participants of a study is crucial (Kessio & Chang'ach, 2020; Friedrich-Nel & Ramlaul, 2020). In the event of a conflict between the objectives and participants of the research, the participants' civil rights are given first preference. Kessio and Chang'ach (2020) emphasised that researchers must guard against physical and psychological manipulation and respect the self-worth and privacy of those under study.

Three broad categories of ethical guiding principles for any research should be considered. The guidelines are permission to conduct the research, informed consent, and confidentiality. Yet, the current study adhered to the ethical principles of authorisation to conduct research, confidentiality, justice, and benevolence. Secondary data were utilised for this study and are accessible to the public. Therefore, the University of South Africa (UNISA) Research Ethics Committee's approval was a requirement, and an ethical clearance certificate was awarded (Annexure E: Reference number: 2022/CEMS FRM/008). Nevertheless, the researcher guaranteed that no research information would be utilised for individual advantage and adhered to the code of academic confidentiality.

Kessio and Chang'ach (2020) posit that guaranteeing anonymity and the confidentiality of research participants and the data they make available are two means by which the interests of participants can be protected. During this study, data was collected from integrated annual reports of JSE-listed mining firms available in the public domain. In addition, no reference was made to any specific mining firm when presenting, analysing,

and discussing the research results. Even though the researcher guaranteed that no research information would be utilised for individual advantage and stuck to the code of academic confidentiality, the data would be kept confidential and destroyed after five years.

The principle of justice and beneficence obliges research units not to be treated deceitfully. In upholding the principle of fairness and goodwill, the researcher ensured that the study's results did not adversely impact the social being of the JSE-listed mining firms' shareholders, directors, and employees (Friedrich-Nel & Ramlaul, 2020; Kessio & Chang'ach, 2020). Moreover, the research findings and recommendations are meant to advantage shareholders, directors, and employees of JSE-listed mining firms. Furthermore, no would-be harm or distress for the mining firms is expected since their names will not be revealed.

5.9 Summary

Chapter Five deliberated on the methodology propounded by Saunders *et al*. (2019) adopted in the current study to determine the impact of CG on OHS risk management performance in the South African mining sector from 2002 to 2018, generating 510 observations. The study is based on the positivist research philosophy and applies a deductive approach. The quantitative study was undertaken based on secondary data on CG and OHS risk management variables gathered from integrated annual reports of 30 JSE-listed mining firms. The research hypotheses were confirmed using the multivariate regression model. Descriptive statistics employed in the study involve measures of central tendency and dispersion. Additionally, diagnostic tests, multicollinearity, heteroscedasticity, normality, and serial correlation addressed different forms of bias that might have occurred during the research and were discussed in this chapter.

The last section of the chapter deliberated on the principles of ethical consideration in research: permission to seek approval, confidentiality, justice, and beneficence. A comprehensive data analysis report on corporate governance and occupational health

and safety risks collected from integrated annual reports of JSE-listed mining firms is presented in Chapter 6.

CHAPTER 6: RESEARCH RESULTS AND DISCUSSIONS

6.1 Introduction

The principal aim of this study is to determine the relationship between CG and OHS risk management in the SAMS from 2002 to 2018. The focus was on understanding the underlying factors contributing to fluctuation in the OHS risk incidences. Various CG frameworks, guidelines, and recommendations were adopted to mitigate occupational injuries, diseases, and deaths in the mining sector of South Africa. Through internal CG mechanisms, mining firms in South Africa are expected to attain the 'zero harm' milestone by December 2024 (Baxter, 2021). This study section presents the CG and OHS risk management results based on quantitative data analysis.

The first section of the chapter offers a discourse of descriptive statistical analysis of CG and OHS risk management variables. The second section discusses the inferential statistical results based on the correlation matrix and multivariate regression analysis. Most importantly, the inferential statistical analysis was based on ordinary least squares (OLS) and feasible generalised least squares (FGLS). The last section deliberates on the summary of the chapter.

6.2 Descriptive statistics

This section presents the descriptive statistical outcomes of the data's general distribution pattern. The discourse mainly focused on means, maximums, minimums, standard deviations, and median values. Also, the skewness of data is discussed to offer the symmetrical nature of the data. The outcomes of the descriptive statistics for the CG and OHS risk management performance proxies spanning over 16 years of the study were presented. The findings advocate that the distribution of CG and OHS risk management performance, comprising control variables, varied substantially amongst the JSE-listed mining firms.

The difference between the mean and standard deviation of CG, OHS risk management, and control variables indicate the differing degrees of variability. The standard deviation of ARC, BI, BS, GD, TA, and TIFR is less than the mean, implying a lesser variability than MO, NCOD, and TE among JSE-listed mining firms. The symmetrical values of ARC (1.44), MO (5.11), NCOD (3.5), TA (5.4), TE (3), and TIFR (1.44) exhibit a highly positive skewness with values greater than one (+1). Also, BI had a positive skewness value of 0.02 between 0. 5 and -0.5, confirming a fair symmetrical distribution. Moreover, BS (0.59) and GD (0.71) data were moderately symmetrical, with values between -1 and +1. The kurtosis values of ARC, BI, BS, GD, and TIFR are between -7 and +7 (platykurtic), indicating the absence of outliers (Orcan, 2020; Byrne, 2010). However, the variables MO, NCOD, TA, and TE exhibited leptokurtic distribution (Kurtosis >7) features, suggesting the presence of outliers. According to Orcan (2020) and Byrne (2010), the skewness and kurtosis values of a data set range between -2 and + 2 and -7 and + 7, respectively, suggest a normal univariate distribution. Most of the variables employed in the current study exhibited skewness between -2 and +2 and kurtosis values between -7 and + 7. Therefore, the data exhibit a normal distribution.

6.2.1 Trend analysis of occupational safety risks in the South African mining sector.

The SAMS's occupational safety risk trend (TIFR) from 2002 to 2018 is presented graphically, as shown in Figure 6.1. Generally, TIFR showed a downward but fluctuating trend from 2002 to 2018. As illustrated in the graph shown in Figure 6.2, annual TIFR decreased from an average of eleven per million hours worked in 2002 to nine incidences per million hours worked in 2007. It further slightly decreased to eight incidences per million hours worked from 2002 to 2009. As of 2009, TIFR increased slightly from an average of eight in 2009 to nine incidences per million hours worked in 2011. From 2011, TIFR showed a significant decrease from nine (9) to an average of four (4) incidences per million hours worked in 2018.

The study's results confirm that BoD with at least three women performs better in risk management, supporting previous studies (El-Khatib & Joy, 2021; Perryman *et al*., 2016). Moreover, the study's findings concur with the 'tokenism' theory (Kanter, 1977) that asserts that women on board should be at least three to realise the benefits of board gender diversity (Arora, 2022; Fernando *et al*., 2020). However, results from previous studies confirm the negative or neutral relationship between GD and OHS risk management (Adams *et al*., 2014).

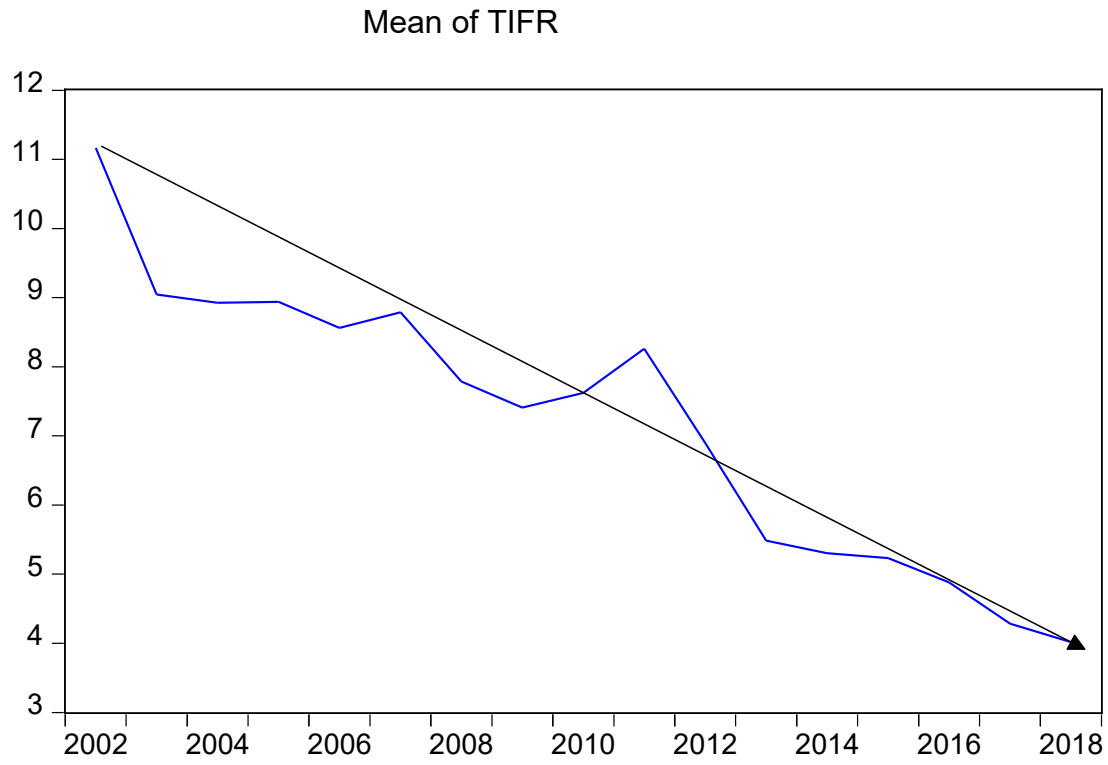

Figure 6.1: Mean of total injuries frequency rate (TIFR)

Source: Researcher's construct

6.2.2 Trend analysis of occupational health risks

As depicted by a graph in Figure 6.2, average occupational health risks in the SAMS, as measured by NCOD, fluctuated from 2002 to 2010 and from 2010 to 2016, with a sharp downward trend from 320 to 125 cases. The NCOD started to rise gradually from 125 cases in 2016 to 160 cases in 2018. Between 2002 and 2020, NCOD fluctuated between 380 and 240 cases.

The fluctuating trend during the period under study may be attributed to somewhat poor CG practices and inadequate and ineffective implementation of OHS risk frameworks and guidelines (Baxter, 2016). Additionally, inconsistency in OHS risk monitoring by internal firm structures and government agencies may have attributed to such an oscillating trend (Reese, 2018).

However, the sharp NCOD downward trend from 2010 to 2016 suggests that an increase in BI and GD contributed to the effective implementation of OHS risk management guidelines, practices, and codes for the period under study. Therefore, appointing women on corporate boards through voluntary quotas beyond tokenism (Arora, 2022) enhances CG risk management performance in JSE-listed mining companies. Also, the negative relationship between BI and NCOD put forward that increased board independence brings diversity in terms of experience. A graph shown in Figure 6.2 presents the NCOD trend in the SAMS for the period spanning from 2002 to 2018.

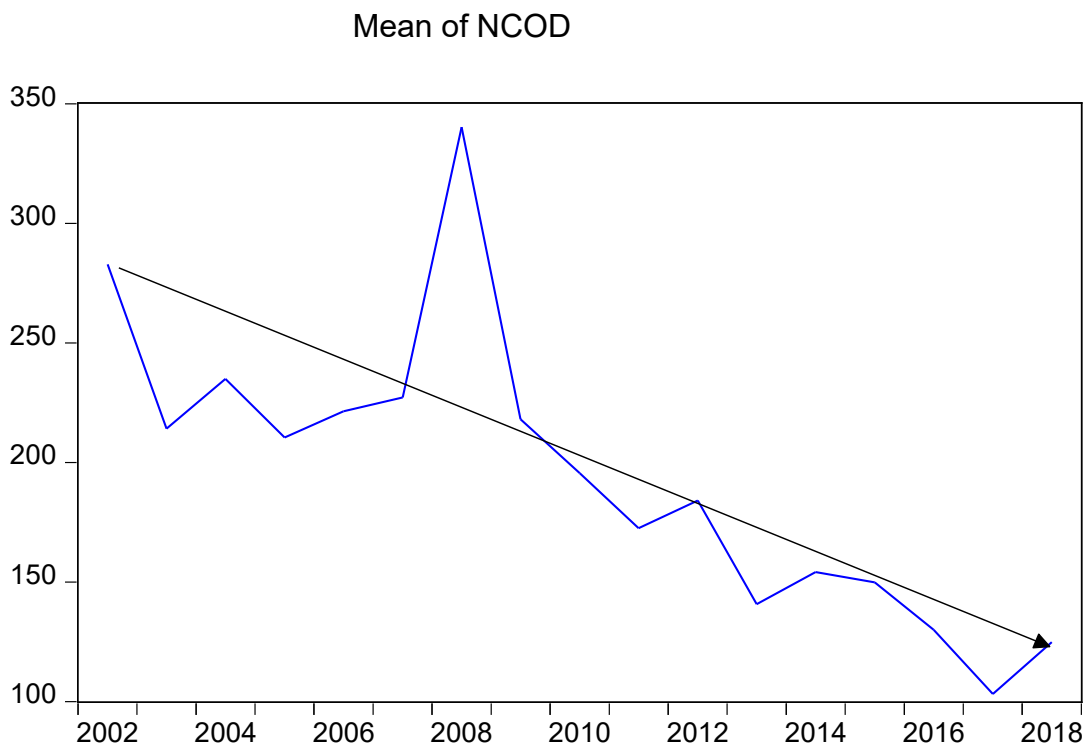

Figure 6.2: Mean of NCOD

Source: Researcher's construct

6.2.3 Trend analysis of the board size (BS)

The board size of JSE-listed mining firms, as represented by BS, showed a fluctuating but downward trend from an average of 7 to 11.6 board members from 2002 to 2018. As shown in Figure 6.3, BS increased from an average of 10.4 in 2002 to 11.5 members in 2005. JSE-listed firms characterised this period with large board sizes. From 2006 to 2009, BS decreased drastically from an average of 11.5 to 10 board members. Srivastava (2015) suggests that during this period, JSE-listed mining firms reduced their board size drastically in response to the 2008/2009 global financial crisis. The need to reduce board size was premised on the notion that a small board size improves cohesion and effective management monitoring and, in turn, improves the overall firm performance (Mustapha *et al.*, 2020). Between 2009 and 2010, BS increased slightly from an average of 10 to 10.8 in 2010. From 2010 to 2013, BS decreased from an average of 10.8 to 10 in 2013. BS increased slightly from 10 in 2013 to 10.4 on average in 2016 and dropped to 10 in 2018.

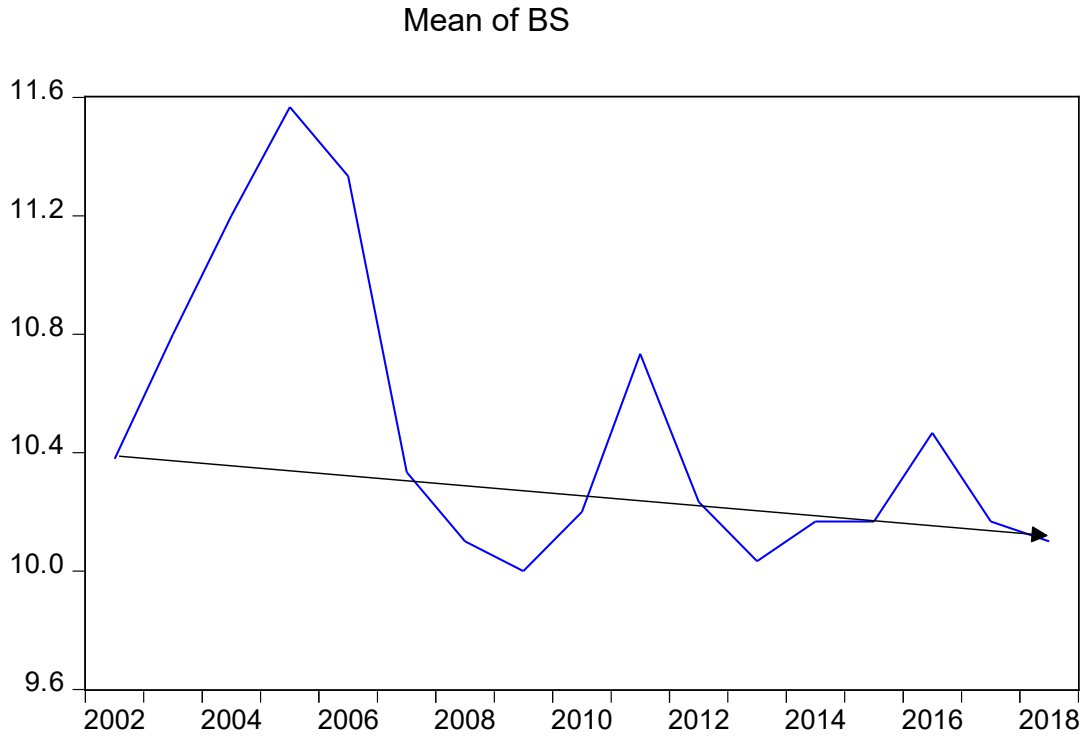

Figure 6.3: Mean of BS

Source: Researcher's construct

6.2.4 Trend analysis of board independence (BI)

The trend analysis was based on the average percentage of independent directors in BoD of JSE-listed mining firms from 2002 to 2018. In examining the impact of CG on OHS risks, the study used BI as one of the CG proxies. The general trend for BI is represented in the graph shown in Figure 6.4.

The overall trend for BI from 2002 to 2018 was upward despite some slight fluctuations. From 2002 to 2005, the average BI increased from 46% to 50%. The average BI percentage increased from 42% in 2006 to 62% in 2016 and decreased to 56% in 2018.

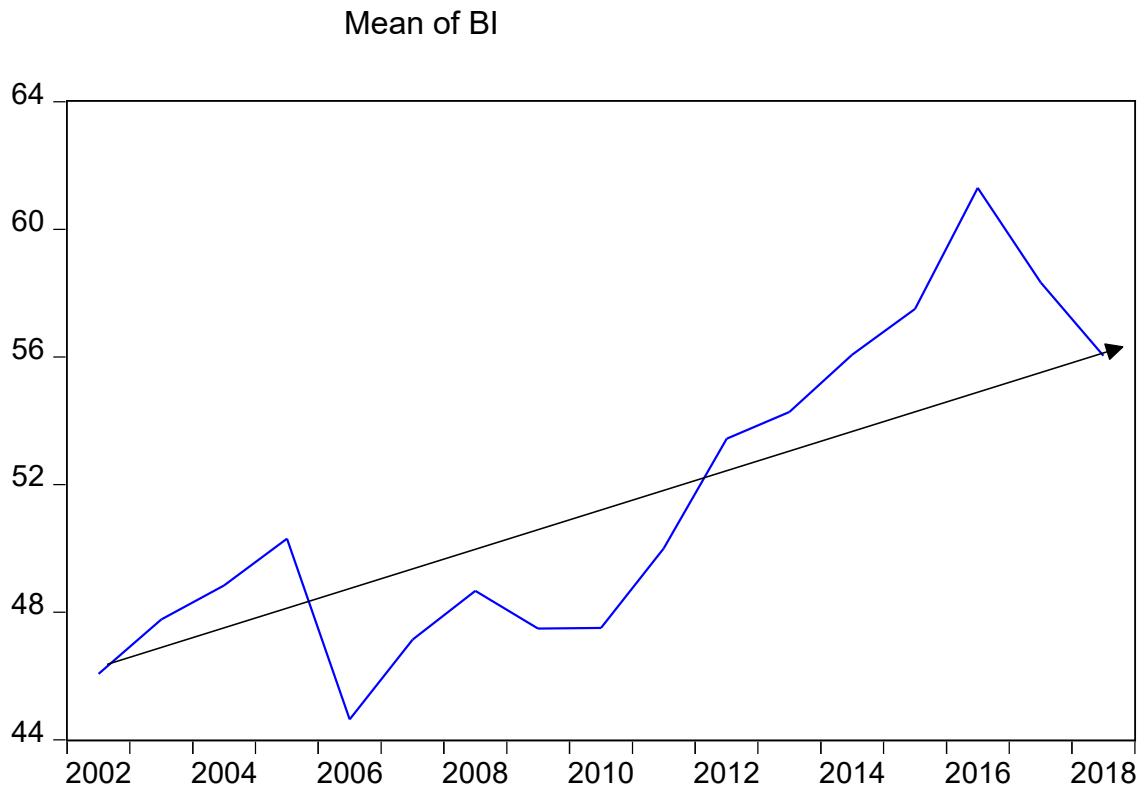

Figure 6.4: Mean of board independence (BI)

Source: Researcher's construct

6.2.5 Trend analysis of board gender diversity (GD)

Board gender diversity significantly impacts OHS risk management as women are believed to be risk averse. For this study, board gender diversity (GD) trend analysis was determined by the changes in the average percentage of women sitting on JSE-listed mining firms' boards of directors from 2002 to 2018. In seeking to establish the impact of CG on OHS risks in the SAMS, the researcher found it vital to analyse the trend for the board gender diversity, as shown in Figure 6.5.

The GD average percentage among JSE-listed firms showed a general upward trend from 2002 to 2018, fluctuating between 6% and 20%. From 2002 to 2003, the average GD percentage increased from 6% to 10%, then from 2003 to 2004, it dropped from 10% to 6%, then gradually increased from 6% in 2004 to 14% in 2007. Between 2007 and 2011, the period was marked by fluctuating women representation in corporate boards ranging between 14% and 10%. The GD percentage increased gradually from 10% in 2011 to 20% in 2016, dropping slightly to 19% in 2018.

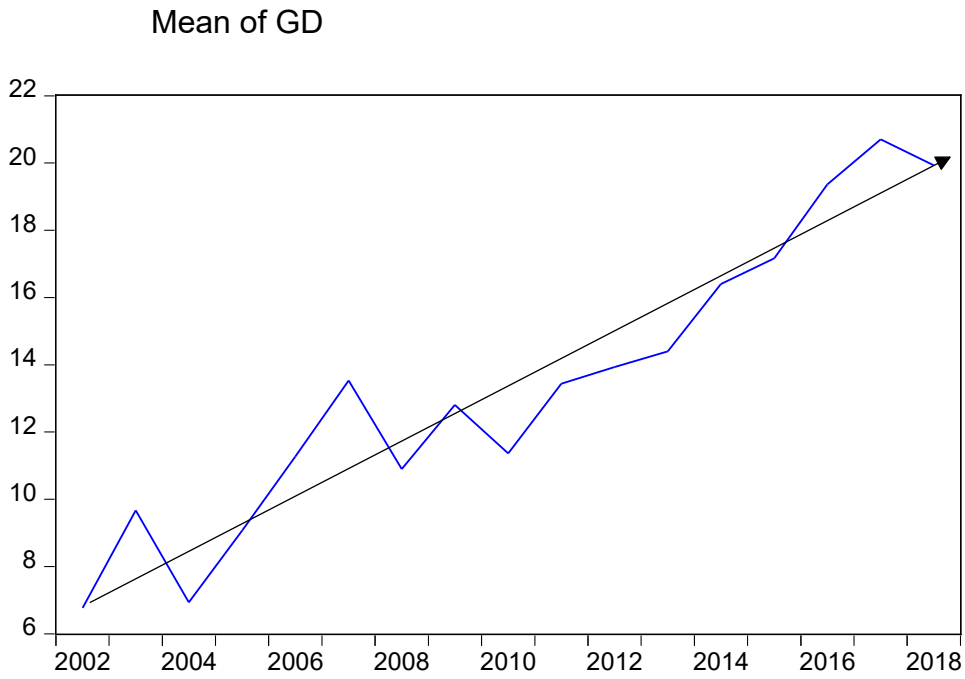

Figure 6.5: Mean of board gender diversity (GD)

Source: Researcher's construct

6.2.6 Trend analysis of audit and risk committee size (ARC)

The size of the audit and risk committee in any business, whether private or public sector entity, is critical to successfully managing enterprise risks encompassing OHS risks. For this study, trend analysis for the ARC size was done in JSE-listed mining firms from 2002 to 2018. It was found that all mining firms had fully functional ARC, with an average number of members fluctuating between 4.6 and 4.7 during the period under study. Thus, JSE-listed mining firms comply with King IV's (IoDSA, 2016) recommendation that states that the audit and risk committee have to consist of a minimum of three members. The trend for ARC is shown in a graph represented in Figure 6.6.

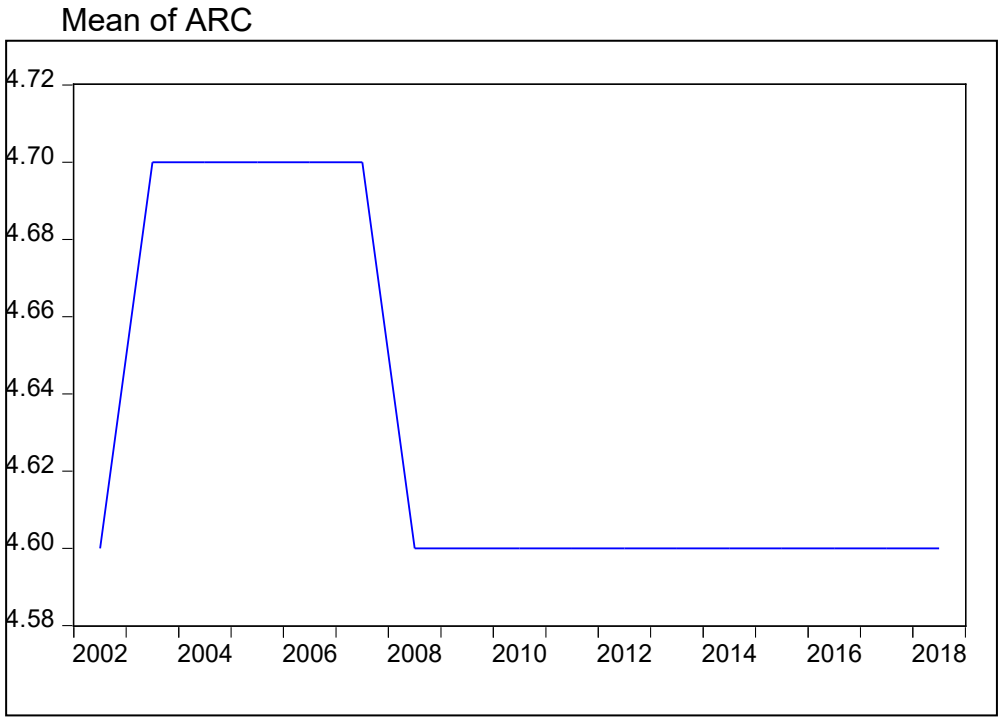

Figure 6.6: Trend analysis of audit and risk committee size

Source: Researcher's construct

6.2.7 Trend analysis of managerial ownership (MO)

Managerial ownership (MO) is one of the internal CG mechanisms that significantly influence the management of OHS risks. The graph in Figure 6.7 shows a general downward trend in managerial ownership from 2002 to 2018.

Initially, MO decreased from approximately 4.6% in 2002 to 2.9 % in 2006 on average. Between 2005 and 2007, MO sharply increased from 2. 9% to 4.7%. From 2007 to 2016, MO decreased from 4.7% to 1. 1 %, followed by an upsurge to 3% in 2018.

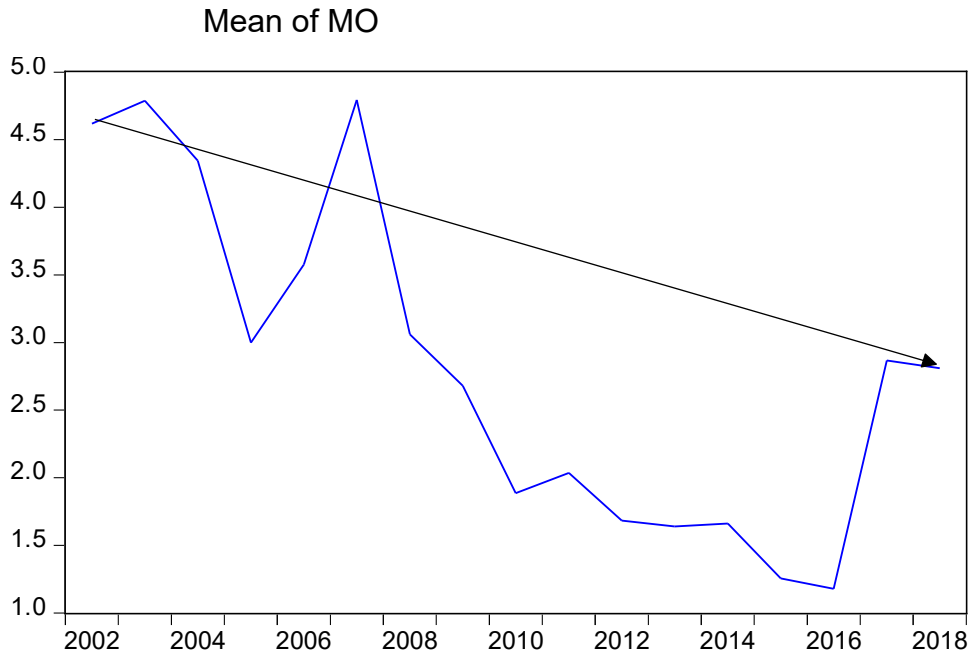

Figure 6.7: Mean of managerial ownership (MO)

Source: Researcher's construct

6.2.8 Trend analysis of asset value

Trend analysis of total assets was done based on the average value of total non-current and current assets held by JSE-listed mining firms from 2002 to 2018. The general trend for total asset value (TA) is shown in the graph depicted in Figure 6.8. The graph in Figure 6.8 illustrates that the average TA increased from R8 billion in 2002 to R11.1 billion in 2015. The general upward trend in TA from 2002 to 2018 suggests the expansion of the SAMS through investment in both current and non-current assets. The TA slightly declined from R11.1 billion in 2015 to R11 billion in 2018.

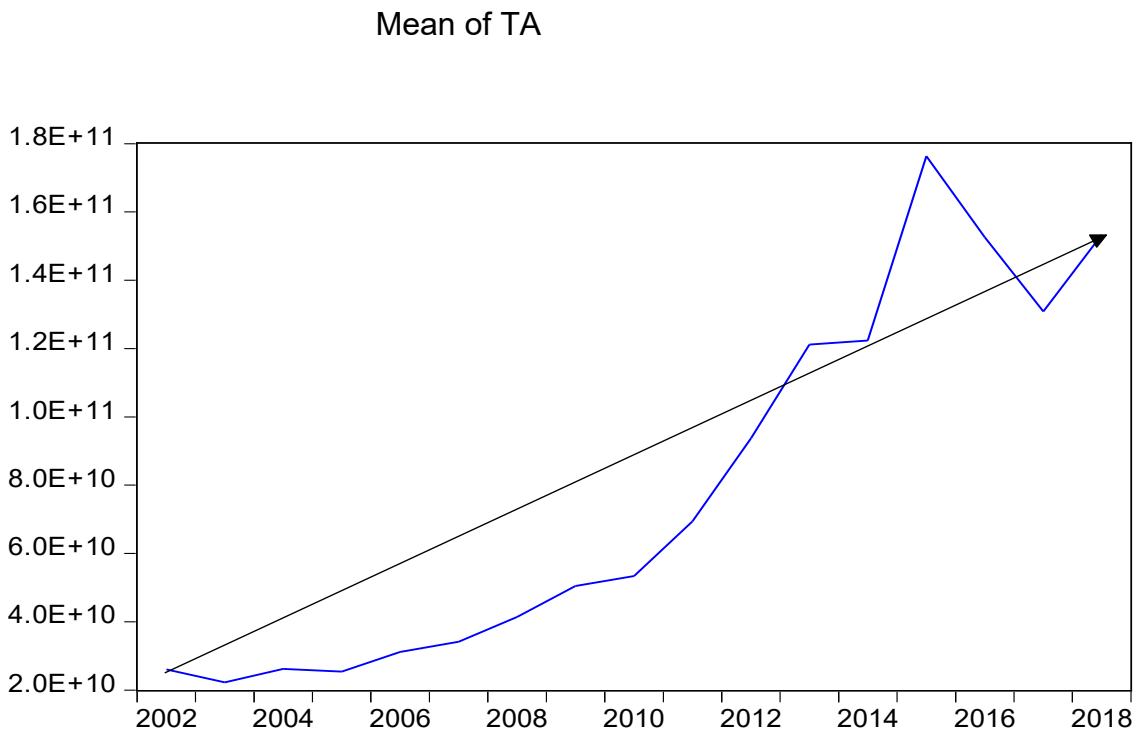

Figure 6.8: Mean of total assets (TA)

Source: Researcher's construct

6.2.9 Trend analysis of the total number of employees (TE)

OHS risks in the mining sector directly impact the well-being of employees, hence the need for trend analysis for TE in the JSE-listed mining firms. The trend analysis for TE was based on the number of permanent and contract employees. The graph in Figure 6.9 shows the general trend in average employees in the JSE-listed mining firms, depicting an upward trend from 19,000 in 2002 to 32,000 in 2011 and then decreasing to 16,500 in 2018.

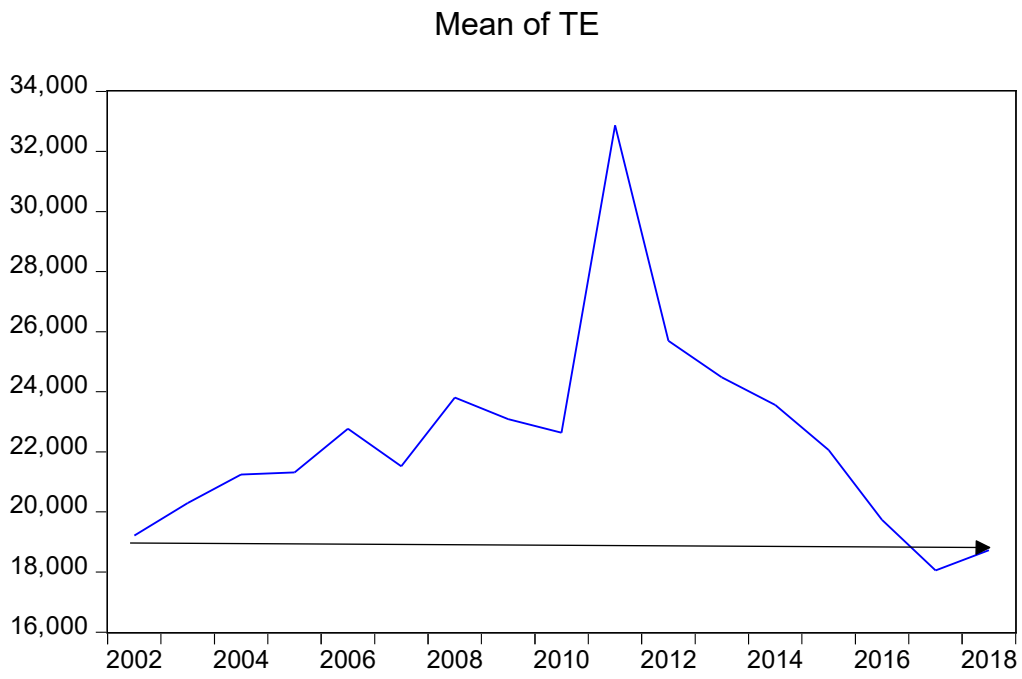

Figure 6.9: Mean of total employees (TE)

Source: Researcher's construct

6.2.10 Measures of central tendency and dispersion

In this section, the outcomes of descriptive statistics were generated from panel data collected from annual reports of 30 JSE-listed firms for the period ranging from 2002 to 2018. The descriptive statistics of nine variables employed in this study are presented in Table 6.1, with 510 observations.

Table 6.1: Descriptive statistics

	ARC	BI	BS	GD	MO	NCOD	TA	TE	TIFR
Mean	4,62	51,44	10,49	13,52	2,62	259,56	7,90E+10	22636,98	7,25
Median	4	50	10	13	0,19	67	1,48E+10	11659	5,4
Maximum	10	93	21	62	70,58	3942	1,99E+12	287043	33,91
Minimum	3	0,44	4	0	0	0	876000	176	0
Range	7	92,44	17	62	70.58	3942	1114000	286867	33,91
Std. Dev.	1,688825	16,32077	3,34763	12,6212	7,163344	501,0986	2,50E+11	28029,11	6,033076
Skewness	1,441213	0,02281	0,590221	0,710341	5,108745	3,456014	5,400063	2,973041	1,352283
Kurtosis	5,268939	2,671683	3,314727	3,121634	35,70851	17,34667	34,14243	19,96402	4,874768
Sum	2331	25976,44	5295	6829,13	1324,188	131079	3,99E+13	11431673	3661,08
Observations	510	510	510	510	510	510	510	510	510

Source: Researcher’s compilation

The data regarding occupational safety risks as measured by total injuries frequency rate (TIFR) showed a mean of 7.25 per million hours worked, while the standard deviation was 6.03. However, the standard deviation is less than the mean, indicating that most data variables are bundled around the mean. This shows a slight variability in TIFR in the JSE-listed mining firms for the period ranging from 2002 to 2018. The TIFR data ranged from a minimum of zero to a maximum of 33.91 per million hours worked.

Data on occupational health risks, as measured by new cases of occupational diseases (NCOD), showed a mean of 259.56 and a standard deviation of 501.10, as shown in Table 6.1. The standard deviation is more than the mean, inferring great variability in terms of NCOD among JSE-listed mining firms. The maximum NCOD value was 3942 and a minimum of 0.00, implying that NCOD's data range was equal to the maximum value.

Board Independence (BI) data showed a mean of 51.44% and a standard deviation of 16.32, meaning the data is clustered around the mean. The average BI in JSE-listed firms is higher than in firms listed on the securities exchange in other countries. For instance, the average BI in Indonesia is 40% (Setia-Atmaja & Hidayat, 2021). The board independence showed less variability in the percentage of independent directors sitting on the boards of JSE-listed mining firms from 2002 to 2018. Thus, the lower degree of BI variability confirms that listed mining firms have a common trend of accommodating the majority of independent directors on their boards.

Board size (BS) in JSE-listed firms is prescribed by the Companies Act of 2013 and CG frameworks such as King IV (IoDSA, 2016), among others. According to the King IV (IoDSA, 2016) report on CG and the Companies Act 71 of 2008, JSE-listed firms should appoint at least three directors. The study's findings confirm that JSE-listed mining firms have a minimum of four directors and an average of 10.49 directors, compliance with the Companies Act of 2008 and the King IV report on CG. The BS data showed a mean of 10.49 and a standard deviation of 3.35, implying higher variability among JSE-listed mining firms. Thus, JSE-listed mining firms tend to have greater differences in BS, ranging from a minimum of four to a maximum of sixteen board members.

The board gender diversity (GD) data showed a mean of 13.52% and a standard deviation of 12.62%, implying that the data is clustered around the mean, confirming less variability among JSE-listed firms for the period ranging from 2002 to 2018. The maximum percentage of board GD was 62%, while the minimum percentage was 0.00.

The managerial ownership (MO) data expressed in the percentage of managerial shareholding in a business entity showed a mean of 2.62%. The mean is too low, confirming that most of the shares of JSE-listed mining firms are owned by external shareholders. However, the data showed a standard deviation of 7.16%, implying a greater variability among JSE-listed mining firms from 2002 to 2018 regarding MO.

The data for audit and risk committee size (ARC) showed a mean of 4.62 members and a standard deviation of 1.69, which is less than the mean, confirming less variability among the JSE-listed firms for the period ranging from 2002 to 2018.

The maximum total asset (TA) value was R1.99 trillion, and a minimum of R876 million. The mean for TA value was R7.9 billion, whilst the standard deviation was R24.9 billion, confirming little variability among 30 JSE-listed firms from 2002 to 2018 in asset investment. The slight variability among JSE-listed firms in total asset value reflects a narrow gap in terms of asset investment.

Total employees (TE) are one of the variables that measure the size of firms, with a maximum value of 287 043 and a minimum of 176 employees. The data for TE showed a mean of 22 636.98 employees, which is less than the standard deviation of 28 029 employees. This shows little variability among the 30 JSE-listed firms in terms of TE.

6.3 Bivariate analysis

The bivariate analysis presents information in tabular form, showing the relationship between two variables. Also, bivariate analysis of the relationship between each dependent variable and all independent variables can be conducted using the scatter plot and correlation matrix.

In the current study, the relationship between each independent and each dependent variable was done using a correlation matrix, as depicted in Table 6.2. Correlation is the strength and direction between variables measured by the correlation coefficient (Creswell, 2013). This study determined the correlation coefficients amid variables using the correlation matrix analysis, showing the relationship between variables in direction and strength.

Positive (+) and negative (-) signs represent the relationship between the variables' direction. In terms of strength, the correlation between variables is either weak or strong, as determined by the size of the correlation coefficient. A correlation coefficient value above 0.8 represents a strong relationship, whereas values below 0.8 reflect a weak linear relationship. Table 6.2 presents the correlation coefficients for each variable between -1 and 1 and p-values of less than 5% ($P<0.05$), implying that all the variables were significant and related.

Table 6.2: Correlation matrix

CORRELATION MATRIX									
	TIFR	**NCOD**	**BS**	**BI**	**GD**	**MO**	**ARC**	**TA**	**TE**
TIFR	1	0.14267	-0.10781	-0.07572	-0.1617	-0.04046	-0.00669	-0.09349	-0.07912
NCOD	0.14267	1	0.295963	0.124494	0.013826	-0.11002	-0.00174	0.025852	0.437309
BS	-0.10781	0.295963	1	0.058795	0.178437	-0.24856	0.01097	0.154226	0.405041
BI	-0.07572	0.124494	0.058795	1	0.141247	-0.14095	0.111195	0.234633	0.205907
GD	-0.1617	0.013826	0.178437	0.141247	1	-0.21086	0.028619	0.056304	0.084829
MO	-0.04046	-0.11002	-0.24856	-0.14095	-0.21086	1	-0.0257	0.046706	-0.105
ARC	-0.00669	-0.00174	0.01097	0.111195	0.028619	-0.0257	1	-0.03305	-0.05453
TA	-0.09349	0.025852	0.154226	0.234633	0.056304	0.046706	-0.03305	1	0.38577
TE	-0.07912	0.437309	0.405041	0.205907	0.084829	-0.105	-0.05453	0.38577	1

Source: Researcher's compilation

6.3.1 Bivariate correlation analysis among dependent variables

As demonstrated in Table 6.2, TIFR is positively correlated with NCOD (0.14267), confirming a weak linear relationship between the two variables. Thus, an increase or decrease in TIFR will result in a slight increase or decrease in NCOD. The positive relationship between NCOD and TIFR suggests that CG should employ measures to reduce both, as a change in one variable will result in a significant change.

6.3.2 Correlations among independent variables

As presented in Table 6.2, BS is positively related to BI (0.06) and BG (0.178437). However, this suggests that a decrease or increase in BI and BG automatically explains any increase or decrease in BS. On the one hand, BI showed a positive and weak association with BG (0.11) and ARC (0.11). On the other hand, BI is negatively correlated with MO (-0.14). Therefore, any change in BI will cause BG and ARC to change in the same direction, whilst MO will vary in the opposite direction. Correspondingly, BG showed a weak and positive relationship with ARC (0.03) and a weak negative relationship with MO (-0.21), implying that any increase in BG is likely to increase ARC size and decrease MO. The MO showed a negative correlation with ARC.

Although correlation coefficients among independent variables confirmed a weak relationship, it has been found that a positive correlation existed between BS and the two variables: BI and BG. On the contrary, BS had a negative and weak relationship with MO and ARC. However, BI showed a positive relationship with BG and ARC but a negative and weak association with MO. Furthermore, BG showed a weak and negative correlation with MO, whereas a weak and positive correlation with ARC was confirmed. Finally, a weak and negative correlation between MO and ARC was confirmed. The weak relationship among independent variables confirmed that the panel data used to determine the impact of CG on OHS risk management performance was free from multicollinearity issues.

6.3.3 Correlations between independent and dependant variables

As shown in Table 6.2, correlation analysis between each independent and dependent variable is deliberated. The correlation analysis results between OHS variables (TIFR and NCOD) and CG variables (BS, BI, GD, MO, and ARC) are discussed in this case.

6.3.3.1 Examining the relationship between BS and OHS risk variables.

Board size confirmed a negative and significant relationship with TIFR (-0.12), inferring that an increase or decrease in board size will change TIFR but in the opposite direction. Though there is no recommended optimum board size, Mahmood *et al*. (2017) posit that recommended board sizes for listed firms vary between five (5) and sixteen (16) according to the size, sector, and complexity of the firm. In the South African context, as per the Companies Act of 2008, listed companies should have at least three directors and a maximum of fifteen (15). As shown in Table 6.2, a positive and weak relationship exists between BS and NCOD (0.30), implying that an increase in BS results in a slight increase in NCOD. The results suggest that the board of directors of mining firms must be large enough to accommodate members with diversity in terms of skills, qualifications, and experience in OHS risk management.

6.3.3.2 Examining the relationship between BI and OHS risk variables.

Moreover, correlation analysis results confirmed a negative (-0.08) and weak relationship between BI and TIFR, confirming that a change in BI percentage has no meaningful influence on TIFR. However, the outcomes of the correlation analysis, as depicted in Table 6.2, confirm a positive and weak relationship between BI and NCOD (0.12). The extant literature posits that independent directors act as a monitoring mechanism for management activities, encompassing OHS risk management (Mahmood *et al*., 2017).

Moreover, the existing literature confirms that independent directors in the CG structures enhance compliance with applicable policies, laws, and standards, including OHS risk management standards and laws.

However, the positive correlation between BI and NCOD suggests that most independent directors appointed by mining firms possess no or inadequate occupational health risk

management knowledge. Given the above, increasing independent board members might increase NCOD frequency rate and impact. As such, the degree of board independence improves the execution of directors' duties and responsibilities, such as risk management and integrated reporting (Setia-Atmaja & Hidayat, 2021). Though the study confirms a weak and negative relationship between BI and TIFR, including independent and non-executive directors on corporate boards is believed to improve risk management practices and performance.

6.3.3.3 Examining the relationship between GD and OHS risk variables.

According to the outcomes of correlation analysis in Table 6.2, board gender diversity is negatively associated with TIFR (-0.01617) and positively associated with NCOD (0.013826). The negative association between GD and TIFR infers that increasing women's representation on the board improves risk management performance, and OHS is not exceptional. Since 2002, listed mining firms in South Africa have shown an upward trend regarding women's representation on BoD, resulting in TIFR decreases. The outcomes of the current study are consistent with previous studies (Perryman *et al*., 2016; Gyapong *et al.,* 2015). Agyemang-Mintah and Schadewitz (2019) confirm that positive gender diversity improves financial and non-financial performance and strengthens the corporate governance policies of firms. Okoye (2015) echoes that one of the crucial benchmarks in CG structures' performance is mirrored by OHS risk management performance.

Moreover, Perryman *et al*. (2016) point out that corporations with increased board gender diversity proved to have a low-risk appetite and high performance. Higher women's representation at the board level in the mining sector contributed positively to managing OHS risks. As such, mining firms in South Africa made significant strides in achieving the health and safety milestone of 'zero harm' by appointing qualified and experienced women on their boards of directors.

Although the negative impact of BG on TIFR, correlation outcomes in Table 6.2 confirm a positive relationship between BG and NCOD. The positive association between GD and NCOD suggests that increasing or decreasing women's representation in corporate

boards may slightly increase or decrease the NCOD frequency rate. As such, mining corporations should ensure that women appointed as board members possess relevant skills, qualifications, experience, and knowledge of enterprise-wide risk management, embroiling OHS risk management as a special requirement.

6.3.3.4 Examining the relationship between MO and OHS risk variables.

Managerial ownership (MO) confirmed a negative and significant relationship with TIFR (-0.04046) and NCOD (-0.011002). An increase in the shareholding percentage by directors translates into a slight decrease in OHS risk incidences in the South African mining sector. The results suggest that firms with poor OHS risk management tend to experience a bad reputation and, ultimately, a loss in share value. Various studies investigated the relationship between MO and firm risks with inconsistent and diverging results. Tying directors' compensation for sharing prices by exposing them to risks they can control, such as OHS risks, encourages corporate boards to implement, monitor, and evaluate comprehensive risk management strategies, policies, and guidelines to safeguard their wealth. Increasing managerial ownership reduces agency problems and costs, improving firm performance (Nugraha, 2021). The results of the study were consistent with a plethora of studies that were carried out across the world in different economic sectors (Rehman *et al*., 2021; Bouras & Gallali, 2017; Berk-Berga *et al*., 2017) confirmed a significant and negative relationship between MO and OHS risk management.

However, some studies found a positive and significant relationship between MO and OHS risk management (Jusoh, 2017; Zondi & Sibanda, 2015). Jusoh (2017) asserts that MO decreases firm performance, including OHS risk management performance, as MO increases the risk-taking behaviour of managers, consequently decreasing overall firm performance. However, the law does not require JSE-listed mining firms to use managerial ownership to mitigate occupational health risks (NCOD).

6.3.3.5 Examining the relationship between ARC and OHS risk variables.

Based on correlation analysis results, the size of ARC was negatively associated with TIFR (-0.00669) and NCOD (-0.00174). The results suggest that the size of ARC in JSE-listed mining firms is vital in mitigating OHS risks. The heightened importance of audit and risk committees in mitigating OHS risks in the mining sector has been brought about by the emergence and adoption of the new paradigm in risk management. Recently, firms have moved from a “silo” to an integrated risk management approach (IoDSA, 2016). As such, the responsibility of mitigating OHS risks is not solely upon the ARC. On that note, the ARC plays an oversight role in integrated risk management, including OHS risk, as every department of mining firms is mandated to be actively involved in OHS risk management (Perez-Cornejo & De Quevedo-Puente, 2019). Furthermore, ARC in hazardous industries such as mining is responsible for professional occupational health and safety risk prevention programs. Most importantly, the ARC fulfils its mandate of preventing OHS risk occurrence by identifying, assessing, controlling, and analysing occupational accidents and conducting regular OHS risk management audits (Perez-Cornejo & De Quevedo-Puente, 2019).

6.3.4 Correlations between control variables and dependant variables

The outcomes of the correlation analysis in Table 6.2 confirmed that TIFR was negatively associated with TA (-0.09349) and TE (-0.07912). Accordingly, the results suggest that an increase in firm size, as measured among JSE-listed mining firms in TA and TE, contributed to the slight decrease in OHS risks from 2002 to 2018. The negative relationship between TIFR and control variables suggests that CG diligently cultivated a health and safety culture among employees in the backdrop of an increased asset base. However, TE and TA showed a positive relationship with NCOD, 0.025852 and 0.437309, respectively. The positive relationship between NCOD and control variables suggests that the frequency of occupational diseases increases as more employees and assets are employed. The positive association between TE, TA, and NCOD calls for corporate governance bodies in the mining sector to apply strict and comprehensive health and safety measures that match the total number of employees and asset value.

In this light, corporate governance structures are obliged to formulate, implement, monitor, and evaluate comprehensive and robust OHS risk management practices that match the size of the workforce and asset base. Failure to match the increase in employees and asset base with appropriate and effective OHS risk management practices in the mining sector may fail to achieve pre-defined health and safety milestones, for instance, “zero harm” (Baxter, 2020).

6.3.5 Multivariate regression analysis: model estimation

The multivariate regression analysis describes the linear relationship between embroiling at least two predictor variables (Bertani, Di Paola, Russo & Tuzzolino, 2018). Diagnostic tests were conducted to guarantee the adequacy and robustness of the regression models, including serial correlation, multicollinearity, normality, and heteroscedasticity, among others.

According to Mukwarami (2021), serial correlation is common in time-series data. However, failure to consider serial correlation within panel data usually leads to inefficiencies in estimating regression coefficients and biased errors. To be consistent with earlier studies (Tran, 2021; Mukwarami, 2021; Tembo, 2018), a random order run test was performed to detect the existence of autocorrelation in the panel data set. Also, a nonparametric test was carried out to determine whether error terms were randomly distributed by enumerating runs oscillating the threshold.

Nonparametric tests were carried out and confirmed a partially random association between error terms. Also, the nonparametric tests confirmed that residuals are randomly distributed, as indicated by the number of runs above and below the threshold. In the current study, serial correlation in the panel data was not considered a threat to OLS regression model outcomes. In preventing distortions to the standard errors caused by strongly correlated predictor variables, multicollinearity tests were conducted to expose multicollinearity among independent variables. Shrestha (2020) posits that outcomes from a model with multicollinearity are likely to be undependable. Multicollinearity can be detected using correlation coefficients, variance inflation factors, and eigenvalue

techniques (Young, 2017). Also, principal components, weighted and ridge advanced regression techniques can be utilised to detect multicollinearity within predictor variables (Shrestha, 2020; Young, 2017; Keith, 2015). However, the current study adopted the variance inflation factor (VIF) to identify multicollinearity within predictor variables.

The average VIF is 1.49, much less than 10, confirming the absence of multicollinearity within the panel data. As such, standard errors of the regression models were not adversely impacted, hence reliable regression outcomes. The lack of multicollinearity within panel data confirms that independent variables are not closely associated. As such, the current study investigated the impact of CG on OHS risk management, and the results were found to be reliable and valid after testing for multicollinearity in the panel data; hence, they can be generalised to other economic sectors.

Mukwarami (2021) remarks that normality is one of the critical assumptions of panel data that must be considered with due diligence when using the OLS model. However, violating the normality assumption when using the regression model produces unreliable and invalid results with underestimated regression coefficients. Skewness/Kurtosis tests for normality indicated that panel data follows a normal distribution pattern as confirmed by the skewness value (0.061) that lies between -2 and +2 and consequently (Shrestha, 2020; Orcan, 2020), the OLS estimation model results are valid and reliable.

Furthermore, the Breusch-Pagan test was performed to assess the presence of heteroscedasticity between model errors and predictor variables. The test found the presence of heteroscedasticity. However, FGLS was performed to suppress the pitfalls of heteroscedasticity. On that note, the results based on OLS and FGLS were similar regarding direction and strength.

The similarity in OLS and FGLs confirmed that heteroscedasticity did not affect the validity and robustness of the multivariate regression outcomes. As such, panel data was confirmed to be free from regression assumption violations, and therefore, the study

utilised ordinary least square (OLS) and feasible generalised least square (FGLS) to analyse the association between CG and OHS risk management proxies with TA and TE as control variables. The results of estimated OLS and FGLS regression analysis on the impact of CG on OHS risk management are presented in Table 6.3.

Table 6.3: Regression analysis results

Ordinary least square (OLS			**Feasible generalised least square (FGLS)**	
	1 TIFR	2 NCOD	3 TIFR	4 NCOD
BS	-0.165** (-1.73)	23.92*** (3.33)	-0.165** (-1.73)	23.92*** (3.33)
BI	-0.0231* (-1.36)	1.546* (1.21)	-0.0231* (-1.37)	1.546* (1.22)
GD	-0.0780*** (-3.59)	-4.720** (-2.87)	-0.0780*** (-3.59)	-4.720** (-2.89)
MO	-0.0878* (-2.30)	-1.105* (-0.39)	-0.0878* (-2.30)	-1.105 (-0.39)
ARC	-0.0233 (-0.01)	57.69 (0.22)	-0.0233 (-0.01)	57.69 (0.22)
TA	-0.304 (-1.58)	-23.35 (-1.61)	-0.304 (-1.58)	-23.35 (-1.63)
TE	0.433 (1.72)	150.3*** (7.88)	0.433 (1.72)	150.3*** (7.88)
Cons	14.49** (2.98)	-905.5* (2.98)	14.49** (3.00)	-905.5* (-2.50)
N	510	510	510	510

t statistics in parentheses

*** $p < 0.001$, **$p<0.01$.*$p < 0.05$
Source: Researcher's compilation

The CG proxies employed are board size (BS), board independence (BI), board gender diversity (GD), audit and risk committee size (ARC), and managerial ownership (MO), whilst OHS risk management proxies are the total injuries frequency rate (TIFR) and new

cases of occupational diseases (NCOD). The regression equation incorporated total asset value (TA) and the total number of employees (TE) as control variables as in previous studies (Mukwarami, 2021; Hernandez *et al*., 2020; Lei *et al.,* 2018).

The outcomes of OLS and FGLS techniques applied to analyse the impact of CG on OHS risk management in the SAMS were similar. The study employed two dependent, two control, and five independent variables, resulting in two regression models as specified in the succeeding sub-section of the study below.

6.3.5.1 Model 1: CG and TIFR

$$Y_1 = \beta_0 + B_1BS + \beta_2BI + \beta_3 GD + \beta_4 ARC + \beta_5 MO + \beta_6 TA + \beta_7 TE + \epsilon \quad (1)$$

The multivariate regression analysis outcomes for model one (1), as shown in Table 6.3, confirmed research hypotheses (H_1, H_3, H_5, H_7, and H_9) based on OLS and FGLS. Based on model one (1) above, FGLS and OLS square results confirmed that TIFR has a negative and significant relationship with BS (-0.165**), BI (-0.0231*), GD (-0.0780***), and MO (-0.0878*). However, the results confirm a positive and insignificant association between TIFR and ARC (-0.0233). The results suggest that CG variables employed in this study negatively impact occupational safety risks. As such, improvement in BI, BS, ARC, MO, GD, and TA cascade into improved occupational safety risk management performance in the mining sector. However, reduced BS, BI, ARC, MO, GD, and TA may increase the occupational safety risk frequency rate and impact in the South African mining sector.

6.3.5.2 Model 2: CG and NCOD

$$\text{Model 2: } Y_2 = \beta_0 + B_1BS + \beta_2BI + \beta_3 GD + \beta_4ARC + \beta_5 MO + \beta_6 TA + \beta_7 TE + \epsilon \quad (2)$$

Table 6.3 presents the outcomes of a multivariate regression analysis based on FGLS and OLS addressing research hypotheses (H_2, H_4, H_6, H_8, and H_{10}). Employing FGLS and OLS, NCOD confirmed a positive and significant relationship with BS (23.92***) and BI

(1.546*) and a significant negative relationship with GD (-4.720**) and MO (-1.105*). Additionally, NCOD confirmed an insignificant relationship with ARC. On the one hand, the model's regression analysis suggests that BS, BI, ARC, and TE positively impact occupational health and safety risk management performance as measured by NCOD. On the other hand, CG variables (GD and MO), in conjunction with TA as a control variable, negatively impact occupational health risk management performance among the JSE-listed firms.

6.4 Discussion of hypotheses and implications

Multivariate regression and correlation analysis results confirm the impact of CG on OHS risk management performance among JSE-listed mining firms. Therefore, eight of the ten research hypotheses were supported. The results of regression analysis pose the following implications:

H_1: BS has a significant and negative influence on TIFR in the SAMS.

In Table 6.3, the association between TIFR and BS was negative and significant (-0.165**) at a 1% significant level. The negative association points out that increasing board size reduces TIFR. On that note, the multivariate regression analysis outcomes supported the hypothesis. As such, JSE-listed South African mining firms increased their board sizes from 2009 to 2018 to improve CG oversight on TIFR.

The current study's findings are inconsistent with Buallay *et al*. (2017) study, which found an insignificant and negative relationship between board size and risk management of firms in Pakistani and Saudi Arabia, respectively. Buallay *et al*. (2017) argue that an increase in board size benefits the firm's performance as diverse management and leadership competencies deeply characterise large boards. Therefore, an increase in board size in JSE-listed mining firms contributed considerably towards the reduction in TIFR for the period spanning from 2002 to 2018.

H_2: BS has a significant influence on NCOD in the SAMS.

The OLS and FGLS estimated a positive and significant (23.92*) relationship between BS and NCOD at a 5% significant level, suggesting that an increase in BS results in a considerable rise in NCOD. Therefore, the hypothesis was supported. Thus, larger board sizes result in poor occupational health risk management performance as measured by NCOD. On the one hand, the study's results concur with previous studies (Nomran & Haron, 2020; Endrikat *et al.,* 2021).

On the other hand, Mahrool *et al*. (2020) researched the impact of BS on firm risk, including OHS risk management performance, and found a positive association. On the other hand, Addo (2019) found no link between firm risk and internal corporate governance mechanisms (BS, BI, GD, and MO). Thus, many studies confirm inconsistent findings regarding the relationship between BS and firm risk management practices entailing OHS risk management performance.

H_3: BI has a significant and negative influence on TIFR in the SAMS.

The research results show a significant and negative association between TIFR and BI (-0.0231*) at a 5% significant level. Thus, the research hypothesis was supported by the multivariate regression analysis outcomes. The outcome shows that South African firms increased the percentage of independent directors in their efforts to decrease TIFR. The study's results are inconsistent with those of Zabri *et al*. (2016) found an insignificant and negative relationship between BI and TIFR. As such, JSE-listed mining firms increased their independent directors' representation to enhance the implementation of OHS risk mitigation strategies.

H_4: BI has a significant and negative influence on NCOD in the SAMS.

The study results did not support hypothesis four (H_4). The OLS and FGLS confirmed a positive and significant (1.546*) at a 5% significant level. The study results confirm that

an increase in BI may result in increased NCOD among JESE-listed mining firms. Thus, the results are inconsistent with the extant literature that posits that independent directors act as a monitoring mechanism for management activities, encompassing OHS risk management (Mahmood *et al.,* 2017).

H_5: GD has a significant and negative influence on TIFR in the SAMS.

The regression analysis outcomes in Table 6.3 show a negative and significant relationship between GD and TIFR (-0.0878***) at a 0.1% significant level. Consequently, the results of the study supported the hypothesis. The negative relationship between GD and TIFR infers that an increase in GD cascades into a decrease in TIFR. The results suggest that CG bodies in JSE-listed mining firms made frantic efforts to reduce TIFR by increasing the proportion of women on the board of directors. Previous studies acknowledge that women's involvement in CG structures significantly reduces TIFR (Bufarwa *et al.,* 2020). CG structures in JSE-listed mining firms thrived to achieve the milestone by increasing the representation of women on boards, thereby significantly reducing occupational safety risks (TIFR).

H_6: GD has a significant and negative influence on NCOD in the SAMS.

Perryman *et al.* (2016) point out that corporations with increased board gender diversity proved to have a low-risk appetite and high performance. As shown in Table 6.2, board gender diversity (GD) has a negative and significant association with NCOD (-4.720** at a 1% significant level. The negative association between GD and NCOD infers that increasing women's representation on the board improves risk management performance, and OHS is not exceptional. The outcomes of the current study are consistent with previous studies (Perryman *et al*., 2016; Nguyen *et al*., 2015; Gyapong *et al.*, 2015). Agyemang-Mintah and Schadewitz (2019) confirm that positive gender diversity improves financial and non-financial performance and strengthens the corporate governance policies of firms. As such, mining firms in South Africa should increase

women's representation on their boards to achieve the OHS milestone of "zero harm" by December 2014.

H_7: ARC size has a significant and negative influence on TIFR in the SAMS.

The multivariate regression analysis outcomes confirmed an insignificant and negative relationship between TIFR and ARC (-0.0233). Therefore, the results suggest rejecting hypothesis seven (7) of the study.

H_8: ARC size has a significant and negative influence on NCOD in the SAMS.

Using OLS and GFLS estimators, the association between ARC and NCOD confirmed a positive and insignificant. The results of the study do not support hypothesis eight (8).

H_9: MO has a significant and negative influence on TIFR in the SAMS.

The relationship between TIFR and MO, as shown in Table 6.2, confirms a significant and negative association (-0.0878*) at a 5% significant level. Thus, an increase in managerial ownership translates into decreased TIFR. The decrease in TIFR due to increased MO implies improving OHS risk management performance in South African mining. The results of the current study are in tandem with previous studies, which affirm that an increase in managerial ownership improves the overall performance of firms, including OHS risk management performance (Bouras & Gallali, 2017; Nugraha, 2021). Nugraha (2021) asserts that increasing MO reduces agency problems, simultaneously improving firm performance in all dimensions. Therefore, JSE-listed mining firms increased MO as one of the OHS risk mitigation strategies.

H_{10}: MO has a significant and negative influence on NCOD in the SAMS.

Managerial ownership (MO) confirmed a negative and significant association with NCOD (-1.105*) at a 5% significant level. An increase in the shareholding percentage by directors translates into decreased OHS risk incidences in the South African mining

sector. Thus, any change in MO translates into a considerable inverse change in NCOD. The results of the study were consistent with a plethora of studies that were carried out across the world in different economic industries (Rehman *et al*., 2021; Bouras & Gallali, 2017; Berk-Berga *et al*., 2017) confirmed a significant and negative relationship between MO and OHS risk management performance.

6.5 Summary

This chapter gave detailed descriptive and inferential statistical analysis results of the study. Also, the data profile was discussed to ascertain the skewness and kurtosis of the data. Moreover, diagnostic tests (multicollinearity, normality, and serial correlation) were performed to ensure that regression assumptions were not violated to achieve efficient regression coefficients and reliable results. After diagnosing the panel data for regression assumption violations, inferential statistical approaches were performed in bivariate analysis, OLS, and FGLS. The results were presented based on descriptive and inferential statistical analysis techniques.

The descriptive statistical analysis approach was based on trend, central tendency, and dispersion measures. Trend analysis outcomes were presented in line graphs, whilst measures of central tendency (mean, mode and median) and dispersion (maximum, minimum, standard deviation, and range) were summarised in tabular format. Moreover, using bivariate analysis, all the independent variables confirmed a negative relationship with TIFR. However, NCOD showed a positive relationship with BS, BI, and ARC and a negative relationship with GD and MO. Based on OLS and FGLS results, TIFR was negatively and significantly associated with BS, BI, GD, and MO.

On the one hand, NCOD was positively and significantly related to BS, BI, and TE. On the other hand, NCOD was found to have a negative and significant association with GD. However, TIFR was found to have an insignificant and negative relationship with ARC, TA, and TE. Furthermore, NCOD confirmed an insignificant and positive relationship with ARC and TA. The next chapter discusses the summary of research findings, contributions, recommendations, and conclusions.

CHAPTER 7: RESEARCH SUMMARY, CONTRIBUTIONS, LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

7.1 Introduction and Research Summary

This study is divided into seven chapters. The first chapter discusses the introduction and background of the study. Chapters 2 and 3 explore theoretical perspectives on CG and OHS risk management. Chapter 4 discusses the literature on the link between CG and OHS risk management performance in the South African mining sector. Chapter 5 discusses the research methodology adopted in the study. Chapter 6 presents results based on descriptive and inferential statistical data analysis. Finally, chapter seven presents the final section of the study. Chapter 7 consists of four sub-sections and unfolds: Section 7.2 discusses the study's main findings. Section 7.3 gives a detailed discussion of the main contributions of the study. Section 7.4 offers a discourse on the study's limitations. Section 7.5 discusses the key recommendations for further studies, policymakers, and management and leadership of mining firms based on the study results. Lastly, Section 7.6 presents the conclusions of the entire study.

7.2 Key findings of the study

The principal purpose of the study was to determine the relationship between CG and OHS risk management in the mining sector for 2002-2018. It was done based on the following research aim and objectives:

- ***To determine the impact of CG on OHS risk management in the SAMS.***

The overall association between CG variables and OHS risk management proxies was confirmed to be negative and significant. The study results imply that, though CG mechanisms reduce the frequency and impact of OHS risks in the mining sector, a paradigm shift is required to safeguard the health and safety of miners in South Africa. The unabated occurrence of injuries, deaths, near-misses, and diseases in the mining sector proves that CG mechanisms inadequately manage OHS risks.

Furthermore, CG mechanisms in the mining sector need to implement, monitor, and modify available relevant guidelines, codes, and laws to enhance their functionality regarding key performance areas such as health and safety risk management. Without any paradigm shift in CG practices and mechanisms in the mining sector, attaining the 'zero harm' milestone will remain a dream in the pipeline. Therefore, inadequate management of OHS risks in the mining sector will remain challenging and risk miners' lives in South Africa.

- ***To investigate the relationship between BS and OHS risk management in the SAMS.***

Results outlined in Table 6.3 in the previous chapter confirm a negative and significant relationship between BS and safety risks measured by TIFR and a positive and significant relationship between BS and occupational health risks measured by NCOD. Therefore, the study outcomes allowed the acceptance of hypotheses one (H_1) and two (H_2). The negative and significant association between BS and TIFR suggests that increasing board size decreases occupational safety risks. The association confirms that board size significantly influences the mitigation of TIFR. Thus, mining firms are expected to constitute a board of directors with a desirable mix of skills, knowledge, and experience to manage safety risks effectively. However, the positive relationship between BS and NCOD is more concerning as it suggests that large boards are poor in health risk mitigation in the mining sector. A large board of directors in the mining sector is ineffective as they are slow in implementing decisions due to board conflicts and are difficult and costly to manage. In line with previous studies (PwC, 2014; Tjahjad *et al*., 2021), companies with small boards tend to outperform large ones.

- ***To determine the relationship between GD and OHS risk management in the SAMS.***

On the one hand, the study's results confirmed a negative and significant relationship between BI and TIFR. On the other hand, the BI is positively and significantly related to

NCOD. The negative and significant relationship between BI and TIFR implies that any change in BI would have an inverse effect on TIFR.

However, the positive relationship between BI and NCOD suggests that BI will likely increase NCOD, resulting in more mine workers being diagnosed with new cases of occupational diseases. However, the CG of mining firms is obliged to step up the implementation and monitoring of health and safety risk mitigation strategies by appointing skilled and knowledgeable directors. As such, the study's results lead to the acceptance of hypotheses three (H_3) and four (H_4) of the study. Thus, the study results concur with previous studies (Mohd & Ousama, 2021; Karim *et al*., 2020).

- ***To determine the relationship between GD and OHS risk management in the SAMS.***

The attainment of objective four was confirmed through testing hypotheses five (H_5) and six (H_6), and it was found that GD is negatively and significantly associated with TIFR and NCOD. The results imply that the presence of women in BoD directors improves the management of OHS risk management performance. As such, mining firms in South Africa should seek to appoint an apt number of women with appropriate skills, knowledge, and experience on their boards as one of the key strategies to mitigate OHS risks. In tandem with earlier studies, the study found that women improve OHS risk management performance (Mohd & Ousama, 2021; Bellato & Vargas, 2021).

- ***To determine the relationship between the size of ARC and OHS risk management in the SAMS.***

The audit and risk committee's primary function is to oversee any organisation's risk management function. An effective audit and risk committee is expected to mitigate any organisational risk. The study results confirmed a negative and insignificant relationship between ARC and TIFR and a positive and insignificant relationship between ARC and NCOD. The results reject hypotheses seven (H_7) and eight (H_8), hence rejecting both hypotheses.

- ***To determine the relationship between MO and OHS risk management in the SAMS.***

The study's results confirmed a negative and significant relationship between MO and OHS risk proxies (TIFR and NCOD), implying that ownership of shares by directors influences OHS risk management performance. According to the existing literature (Jusoh, 2017; Berke-Berga *et al*., 2017; Doorasamy, 2021), managerial ownership reduces agency problems as directors are encouraged to act in the best interest of shareholders, improving firm performance. Therefore, hypotheses nine (H_9) and ten (H_{10}) are supported. Moreover, offering directors share option schemes is paramount to increase their shareholding to an optimum level while motivating them to formulate, implement and monitor effective OHS risk management practices. Increasing MO might work to promote and protect miners' health and safety and improve the SAMS's overall performance.

7.3 Contributions of the research

This section focuses on the contributions of this study. The section is divided into three subsections: empirical, theoretical, and methodological contribution.

7.3.1 Empirical contribution

According to the depth of the researcher's knowledge, the study on the impact of CG on OHS risks in the SAMS is the first of its kind. However, most studies on CG focused on the impact of CG on firm performance as measured by return on assets (ROA), return on equity (ROE), Tobin's Q, profitability, and liquidity, among others. Generally, most studies dwelled on the influence of CG on the financial performance of listed firms across the globe. This study is exceptional to the South African mining sector, and its contributions are valuable in pursuing effective and new OHS risk mitigation strategies until no worker goes home ill, injured, or killed. Therefore, the study acts as a ground-breaking approach to a paradigm shift in OHS risk management that will bring a sustainable, safe, and healthy working environment to the South African mining sector. Similarly, the study will contribute towards adopting an empirical approach in OHS risk management and

understanding the fundamental reasons behind the fluctuations in OHS risk incidences against the backdrop of numerous OHS codes, guidelines, policies, and laws that govern the operation of mines in South Africa.

Different studies have confirmed that CG mechanisms improve the general firm performance (Endri & Fathony, 2019; Bellato & Vargas, 2021; Doorasamy, 2021), whereas other researchers posit that some CG mechanisms, such as board gender diversity and board size, have a weak influence on the performance of firms (Mohd & Ousama, 2021; Karim *et al*., 2020). Nonetheless, the study focused on the best ways to constitute CG mechanisms that effectively mitigate OHS risks in the South African mining sector. As such, the study introduced a new paradigm into the study area by examining the degree to which CG mechanisms influence OHS risk management performance.

The new approaches deliberated in this study concern the sustainable operation of mining firms in South Africa. They are attained by offering special attention to CG determinants to ensure the safety and health of miners. Moreover, mining firms should know how CG determinants determine the OHS risk management efficacy. Given the mining firms' obligation to safeguard the life of every miner, the study's contribution is that CG mechanisms should ensure that OHS risks are fully understood at the enterprise-wide level, and all the members of board directors and professional board committees should engross OHS risk management in their daily activities.

Moreover, the findings of the study contribute to a deeper understanding of the relationship between internal CG mechanisms and OHS risk management performance in the SAMS. Furthermore, the study adds value to how firm size, measured by total employees and asset value, acts as control variables in the relationship between CG and OHS risk management performance in the SAMS. Similarly, the study's findings contribute to the existing literature on CG and OHS risk management practices in the mining sector and other industries at large.

Furthermore, the study's results may be the foundation for future studies on CG and OHS risk management performance in hazardous industries such as mining, construction, and forestry.

Although some studies have been carried out to determine the impact of CG on OHS risk management performance in the mining sector (Khan *et al*., 2018; Mavroulidis *et al.,* 2022), according to the best of the researcher's knowledge, no studies have been done with particular attention to the SAMS context. The research by Khan *et al*. (2018) investigates the relationship between good CG and firm performance (financial and non-financial) organisations worldwide using a meta-analysis of the top twenty-ranked journals. The study found a positive relationship between good CG and firm performance, encompassing OHS risk management performance as one of the non-financial performance proxies (Khan *et al*., 2018).

The work focused on financial and non-financial performance in global firms but not South African mining firms. Mavroulidis *et al*. (2022) investigated OHS risk management in Romanian construction companies based on the three pillars of OHS risk management: legislation compliance, appropriate standards, and good corporate governance practices. Although the study by Mavroulidis *et al.* (2022) was about OHS risk management, the main focus was on construction companies in Romania. Despite numerous studies on the impact of CG on firm performance in developing countries, none focused on the South African mining sector with specific reference to OHS risk management performance.

Furthermore, in response to the reactive nature of policymakers regarding injuries, diseases, and deaths in the SAMS, the study proposed a framework that may be adopted to mitigate OHS risks and attain the "zero" milestone by December 2024.

7.3.2 Theoretical contribution

Theories are basic building blocks in research, as they offer a strong point of departure in partaking in a research journey (Remenyi, 2020). According to Damschroder (2020), theories provide a guideline for action and understanding, thus providing a spur for improving understanding within the research area. Therefore, the adopted theory's essence is crucial in any study (Van Patten *et al.,* 2020). The study harmonised manifold theories to enlighten the posited relationships between CG and OHS risk management performance variables. Thus, the study emphasises the significance of unpacking internal corporate governance mechanisms and OHS risk management performance incorporation research employing a multi-theory perspective. A balancing methodology was consequently applied in incorporating the views of the conventional CG theories (agency, stakeholder, legitimacy, stewardship theory, and enlightened shareholder theory).

The application of multi-theory to the current study is argued based on Van Patten *et al.* (2020) view that pinpointed that a single theory cannot adequately enlighten research portents and interpretation for all dependent and independent variables association. To the researcher's knowledge, no other study in the context of CG and OHS risk management among JSE-listed mining firms has adopted the multi-theory lens. In its place, earlier studies on CG have principally engaged a mono-theory approach (Khan *et al*., 2021). A study by Mukwarami *et al*. (2022) is one of the few studies that utilised the complementary approach, though the research was undertaken in the context of municipalities CG.

7.3.3 Methodological contribution

The study regarding the impact of CG on OHS risk management performance in the SAMS is considered novel in the existing CG literature. According to the depth of the researcher's knowledge, no other study has utilised a similar research method to discover ways of mitigating OHS risks in the SAMS to achieve the 'zero harm' milestone by the year 2024.

The study adopted a quantitative research method based on multivariate regression analysis to determine the influence of CG on OHS risk management performance in the mining sector, with total employees and total asset value as control variables. Given that the study was never done in South Africa, according to the researcher's depth of knowledge, its contributions to the existing research methods are entirely absorbing as it unlocked new research methods of undertaking studies that would aim to explore the association between CG and OHS risk management as mine workers continue to get injured, sick, or killed in their routine operations. Additionally, another significant methodological contribution is the period of study. The study collected CG and OHS risk management data among JSE-listed firms over 16 years. According to my knowledge, no other studies were done using 16 years focusing on JSE-listed mining firms.

Previous studies were conducted on CG and/or OHS risk management performance. However, no specific study explored the relationship between CG and OHS risk management in the South African mining sector. As such, the research methods used can serve as a foundation for future research on the impact of CG on OHS risk management in different industries.

7.3.4 Policy and managerial contribution

The study investigated the impact of CG on OHS risk management performance among JSE-listed mining firms. The significant prevalence rate of OHS risk occurrence with no end in sight in the mining sector of South Africa justified the need for this study. Despite changes in regulatory frameworks, policies, standards, codes, and guidelines on CG and OHS risk management, mining firms suffer losses due to occupational accidents and diseases.

The general decrease in OHS risk occurrence in the mining sector is attributed to policies implemented by CG structures at the firm level. For instance, CG in SAMS adopted a policy on building a safe and inclusive culture that constantly focuses on going beyond the physical by creating a psychologically safe mining environment (Anglo American,

2018). The Living also supports the safe and inclusive culture with Dignity in South Africa policy that aims to provide preventative and response strategies to address unsafe behaviour (Baxter, 2016). The policy emphasises changing the collective mindset to ensure that all mining employees at all levels are more aware of potentially unsafe situations and feel encouraged to speak up. Besides adopting the safe and inclusivity culture, CG in SAMS, in their drive to 'zero harm', firms invested in awareness and education by implementing appropriate systems and best practices in partnership with employees, regulators, and other stakeholders (Hermanus *et al.,* 2015). Also, CG in SAMS adopted voluntary initiatives, such as the tripartite alliance among industry, labour unions and government, to strengthen the drive to 'zero harm' (DMRE, 2019).

Yet, the findings of the study pose implications to both policymakers and management of mining firms in South Africa:

- Although policymakers managed to target 'zero harm' to all mining firms, mining workers are still exposed to deaths, injuries, and diseases daily. As such, the government should introduce mechanisms to impose financial penalties on firms that do not attain the milestone within the given time frame.
    - Government and other regulatory bodies should ensure that adopting different OHS standards, frameworks, and policies is not just a checklist practice by assigning independent health and safety representatives that work at the mining sites daily.
    - As the major policy maker, the government should apply the reward system to encourage the adoption of sound and effective health and safety measures by CG structures in mining firms. The reward system might entail tax reduction, production subsidies, and grants.
    - Training and development of mine workers programs should include OHS risk management as the core element and should be undertaken by every employee regularly.
    - As Baxter (2021) alludes, some mining accidents are caused by outdated and poorly maintained equipment and machinery. To that end, the government should introduce a policy that limits the life span of machinery and equipment used in

mining activities, and all mining firms should have an asset replacement reserve that government-appointed officials monitor. The policy will be aimed at getting rid of old machines and encouraging firms to invest in new technology that is safe and healthy.

- The board of directors of mining firms should comply with different codes and laws of good governance, such as the King IV report and Companies Act 71 of 2008, to uphold the principles of CG. In this regard, the BoD should consist of a majority of independent directors, a minimum of three directors, and diversity in skill, experience, gender, and age, among others. The size of the BoD is not one size fits all, but the size and nature of the company determine it. Therefore, mining firms are recommended to appoint a board of directors consisting of members with various skills and work experience, and OHS risk management should be at the core.
- To reduce occupational deaths, injuries, and diseases in the mining sector to zero, the board of directors should constitute ARC with at least three members possessing a wide range of skills, including OHS risk management, as the King IV report recommends.

- In line with legitimacy theory, the board of directors of mining firms should meet the community's expectations by safeguarding the health and safety of employees to get a social license to operate. If mining firms continue to lose their employees due to occupational hazards, they will be seen as illegitimate entities and lose their license to operate.
- Moreover, board members should ensure comprehensive reporting and recording of all the incidents, including ‘near misses’, to enhance OHS risk management performance.
- The board should infuse OHS risk management in the day-to-day activities of every mine worker. Thus, every mine worker should receive comprehensive and updated OHS risk management training and development.
- The top management of mining firms should be criminally liable if employees get involved in accidents or get sick due to poor health and safety conditions.

Furthermore, the research outcomes are valuable to regulators, policymakers, risk practitioners, and academics. Policymakers are fortified to transform best corporate governance practices into a sustainable business culture through an integrated statutory charter and governance codes to firm the oversight role.

Risk practitioners can consequently embrace and derive inferences concerning the prominence of corporate governance–OHS risk management performance. Premised on the inadequacies laid bare owing to internal CG mechanisms and inadequate codes and guidelines, the research underwrites the existing literature and operation by adopting the proposed framework, as shown in Figure 7.1.

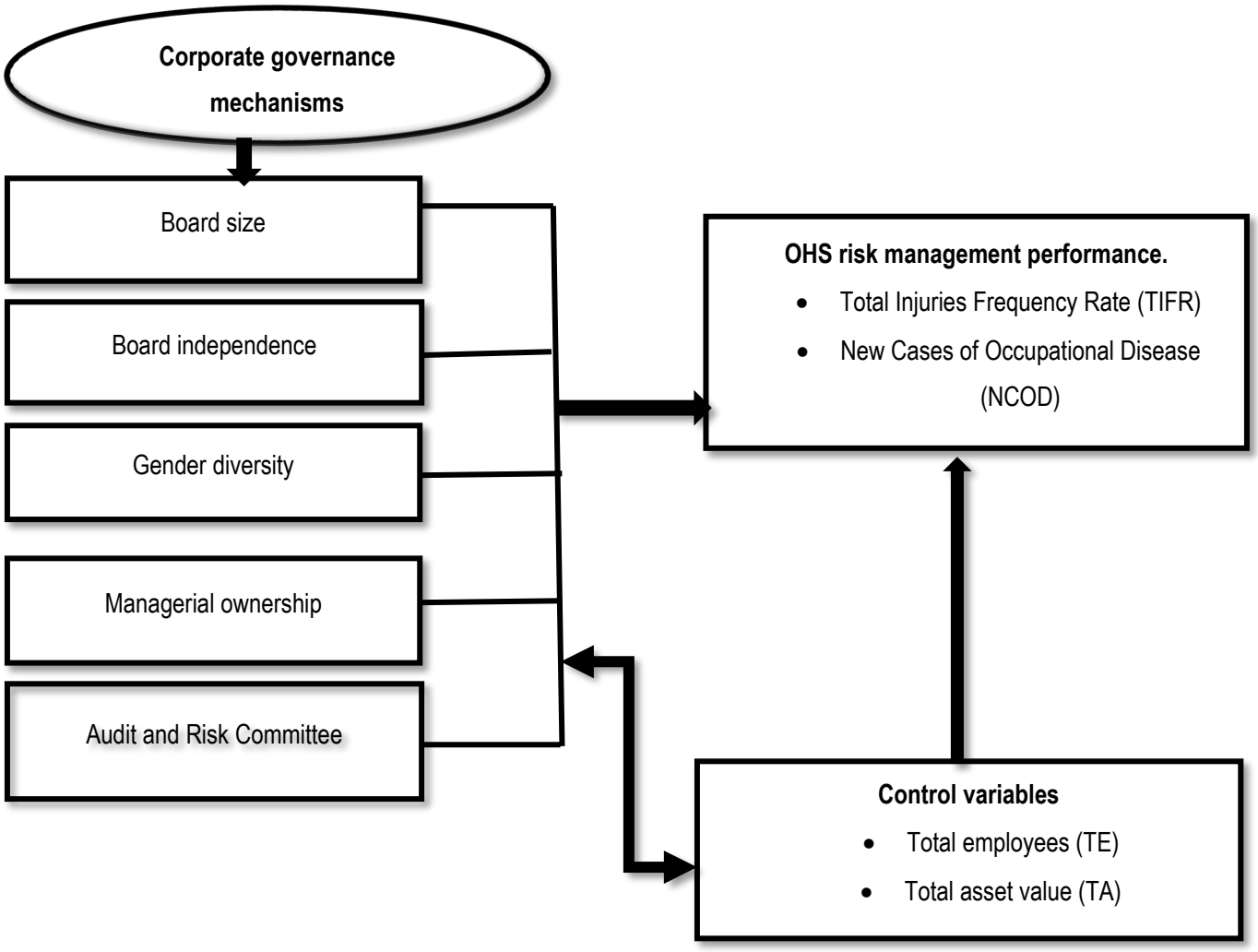

Figure 7.1: A proposed framework to understand the impact of corporate governance on OHS risk management performance.

Source: Researcher's construct

7.4 Limitations of the study

The major aim of this study was to determine the impact of CG on OHS risk management performance in the mining sector of South Africa. In undertaking the study, limited constraints were apparent. Firstly, the study was based only on the quantitative data of JSE-listed mining firms, thus excluding non-listed firms due to data availability constraints of quantitative secondary data regarding OHS risk management performance.

To circumvent the shortcoming, the study focused on JSE-listed firms on the bourse from 2002 to 2018, excluding firms suspended or registered during the study period. To that end, sixteen years was considered adequate to generalise the results. Moreover, the study utilised data for JSE-listed listed mining firms only as they are mandated to publish their integrated annual reports. Secondly, the research method employed in this study was one of the limitations. Although this research was fundamentally exploratory, there is a need for further research to answer comprehensively exploratory research questions, for instance, “why”, “how”, or “when”, to advance novel understandings into internal corporate governance and OHS risk management practices of South African mining firms.

Thirdly, CG and OHS risk management performance proxies presented another limitation to the research. On this end, due to time restraints, the proxies employed in this research excluded external CG mechanisms as well as non-recordable OHS risk incidences. To justify the exclusion of external CG mechanisms and non-recordable OHS risks, the researcher utilised internal CG proxies and TIFR and NCOD as main research variables, concurring with information available in the integrated annual reports of JSE-listed mining firms.

7.5 Recommendations

In light of the study results, the recommendations aim to fortify the influence of CG mechanisms on OHS risk management performance in the mining sector through the following:

- The government should enact comprehensive and suitable legislation to guarantee the safe behaviour of mines in conjunction with the minimum health risk. Such legislation should be enacted after consultation with the employee and employer representatives. Also, the government should continuously update guidelines, policies, and laws that ensure safe and healthy mining environments. Non-compliance should be punished by heavy fines, cancellation of operating licenses, and/or pressing criminal charges against the directors of the firms responsible.
- The government should conduct regular skills audits for the board of directors of mining firms, especially health and safety skills. Moreover, the state should introduce

the essential procedures to empower proficient authorities to investigate the roots and settings of every fatal and grave accident and ever-life-threatening incidence.

- Mining firms should constitute a board of directors that complies with relevant codes, guidelines, and laws in terms of size, independence, and diversity to ensure the health and safety of miners. Mining firms must appoint a board that suits their unique needs and requirements. The board of directors must be large enough to form professional committees comprising board members with the appropriate mix of skills, knowledge, and expertise to carry out board business. Additionally, the board must be diverse in nationality, skills, knowledge, age, gender, and race to bring diverse competencies and perceptions to improve organisational performance, especially risk management.
- Mining firms are recommended to invest in the physical and social capital that enhances OHS risk management performance. Moreover, evaluate and rebuild the incident investigation system to ensure it is timely, comprehensive, and operational. The incident investigation system should get to the underlying causes and shun pointing the finger at employees.
- The CG structures are recommended to take suitable actions to eliminate or mitigate OHS risks from contact with physical, chemical, or biological hazardous elements. Also, such measures should embrace technical and organisational realism to pertinent mining activities, to the plant, machinery, equipment, or structures. Furthermore, the steps should include using protective equipment and clothing employees.

7.6 Areas for Future Study

The findings offer recommendations for further studies on theoretical and methodological perspectives. The study explored selected CG and OHS risk management theories to address the research inquiry. On the one hand, the study utilised the agency theory, stakeholder theory, legitimacy theory, and stewardship theory to understand the underlying role of BoD in governing firms.

On the other hand, multiple health and safety theories were utilised to explore the underlying causes of OHS risk exposure in the mining sector. In this regard, future studies are recommended to embrace more CG theories, such as the token theory (Kanter,

1977), to determine the impact of board gender diversity on OHS risk management performance. To that end, the study recommends that future studies suggest hybrid theories to overcome the pitfalls of dedicated theories, such as the agency theory that focuses on the relationship between the owners and the management of companies.

The results of the study are grounded on secondary quantitative data. The researcher recommends that future studies employ primary, qualitative, and quantitative secondary data to better understand the relationship between CG and OHS risk management. Also, future studies may use different research approaches entailing mixed method approach, meta-analysis, and/or comparative studies approach to enhance the understanding of the impacts of CG on OHS risk management performance.

Although the study succeeded in establishing the impact of CG on OHS risk management, the study utilised internal CG mechanisms only. Therefore, future studies are recommended to incorporate both external and internal CG mechanisms as variables of their studies to enhance the understanding of the relationship.

Lastly, the study focused only on JSE-listed mining firms to explore the impact of CG on OHS risk management. In that regard, the researcher recommends future studies to investigate the relationship between CG and OHS risk management in the mining sector of different countries. The broadening of the study area will improve the generalisability and robustness of the findings.

7.7 Summary

The study examined the relationship between CG and OHS risk management variables and found a negative and significant relationship between CG and TIFR, while a positive and significant relationship between CG and NCOD. GD and MO were found to be significantly and negatively related to TIFR and NCOD. However, BS and BI were found to have a positive and significant relationship with NCOD. The negative and insignificant relationship between ARC size and OHS risk management confirms inconclusive results that offer further research opportunities. However, CG variables (BS and BI) with a positive association with NCOD certify that mining firms need to appoint a board of directors with the appropriate mix of skills, knowledge, and experience to eliminate or minimise OHS risks in the mining sector of South Africa.

Moreover, the agency theory (Jensen & Meckling, 1976) justifies the study's results. As agents of the corporate world, directors need to align their interests with shareholders to eliminate the agency problem and improve the overall performance of firms. The significant and negative relationship between MO and OHS risk management confirms that managers need to own company shares to align their interests with shareholders. The positive and significant relationship between BS, BI, and NCOD implies that the composition of BoD of mining firms needs members equipped with health risk management knowledge and expertise.

Considering the findings, the study offers a basis for mining firms to realign internal CG mechanisms with an operational risk management plan, especially OHS risk management, to ensure the well-being of employees. To ensure OHS risks are eliminated or mitigated to the lowest possible levels, the study contributed to the existing literature by closing a knowledge gap on the relationship between CG and OHS risk management.

Moreover, the study made a valuable contribution by proposing a framework to unpack the relationship between CG and OHS risk management to enhance the sustainable operation of mining firms in South Africa in their quest to attain the ‘zero harm’ milestone by December 2024. Intrinsically, mining firms need to realign their CG mechanisms with OHS risk management, as safe and healthy mining environments are crucial for the economic growth and development of South Africa at large.

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ANNEXURE A: RESEARCH DATA ON VARIABLES

Firm Code	Year	TIFR	NCOD	BS	BI	GD	MO	ARC	TA	TE
1	2002	7	123	14	57,0	0,00	0,24	10	8786000000	5303
1	2003	7	97	11	57,0	0,00	0,24	10	5468000000	3284
1	2004	6	234	14	57,0	21,00	0,24	10	1146000000	6789
1	2005	6	127	16	56,0	13,00	0,05	10	11766000000	10978
1	2006	7	456	17	47,0	12,00	0,05	10	14611000000	11805
1	2007	5	567	16	50,0	13,00	0,05	10	18144000000	13632
1	2008	6	2284	16	44,0	13,00	0,05	10	24878000000	17936
1	2009	4	396	16	0,4	0,13	0,05	10	25499000000	16777
1	2010	4	162	16	50,0	13,00	0,24	10	28233000000	22776
1	2011	2	271	17	47,0	12,00	0,05	10	32386000000	287043
1	2012	2	68	14	64,0	14,00	0,05	10	35316000000	26587
1	2013	2	39	15	60,0	13,00	0,05	10	38121000000	24716
1	2014	2	131	15	60,0	13,00	0,05	10	36458000000	27236
1	2015	2	119	14	57,0	14,00	0,05	10	35283000000	27276
1	2016	2	121	14	64,0	14,00	0,05	10	35127000000	23128
1	2017	1	63	17	65,0	12,00	0,05	10	32246000000	24106
1	2018	2	143	18	61,0	17,00	0,05	10	34305000000	21862
2	2002	1	1345	12	25,0	7,00	4,52	6	108824000000	122000
2	2003	1	1257	13	38,0	13,00	4,70	6	85791000000	122000
2	2004	1	2033	20	25,0	19,00	4,10	6	88595000000	127000
2	2005	1	1003	20	25,0	13,00	4,10	6	85377000000	118000
2	2006	1	1004	20	25,0	19,00	0,08	6	92282000000	77000
2	2007	1	136	13	38,0	17,00	2,50	6	93095000000	76000
2	2008	2	123	12	42,0	17,00	2,50	6	107057000000	79000
2	2009	2	490	11	45,0	15,00	2,57	6	158823000000	83000
2	2010	1	268	12	50,0	18,00	2,40	6	150453000000	77000
2	2011	2	197	13	54,0	17,00	0,09	6	184655000000	79000
2	2012	1	170	13	46,0	15,00	0,02	6	220216000000	97298
2	2013	1	209	13	38,0	21,00	0,07	6	254608000000	99500
2	2014	1	175	12	42,0	21,00	0,10	6	305760000000	72000
2	2015	1	163	12	50,0	25,00	1,20	6	444043000000	69000
2	2016	1	111	12	50,0	20,00	0,33	6	382480000000	61000
2	2017	1	96	12	50,0	25,00	0,30	6	377227000000	52000
2	2018	3	101	12	50,0	25,00	0,80	6	444917000000	47000
3	2002	11	1342	12	25,0	17,00	0,04	3	58213000000	41216
3	2003	4	1236	13	38,0	31,00	0,04	3	60120000000	58964
3	2004	4	1456	20	25,0	5,00	0,05	3	61005000000	59150

3	2005	10	876	20	25,0	5,00	0,01	3	61198000000	61198
3	2006	13	1234	20	25,0	5,00	0,03	3	46313000000	66946
3	2007	12	979	13	38,0	8,00	0,01	3	54050000000	74940
3	2008	9	914	12	42,0	17,00	0,01	3	68668000000	80446
3	2009	7	936	11	45,0	27,00	0,01	3	75821000000	64695
3	2010	6	673	12	50,0	25,00	0,00	3	83801000000	54020
3	2011	20	724	13	54,0	31,00	0,00	3	8728000000	58389
3	2012	11	683	13	46,0	31,00	0,00	3	85947000000	55118
3	2013	9	739	13	38,0	31,00	0,00	3	89027000000	48530
3	2014	6	510	12	42,0	25,00	0,00	3	89999000000	49763
3	2015	8	45	12	50,0	17,00	0,01	3	72920000000	48519
3	2016	5	28	12	50,0	17,00	0,01	3	77697000000	43904
3	2017	5	154	12	50,0	17,00	0,01	3	80818000000	27558
3	2018	5	156	12	58,0	17,00	0,01	3	85716000000	34764
4	2002	9	2256	15	73,0	7,00	0,03	4	45234000000	54032
4	2003	9	1410	14	71,0	7,00	0,03	4	47161000000	55439
4	2004	7	1345	10	50,0	10,00	0,04	4	46228000000	65400
4	2005	7	1566	17	65,0	6,00	0,05	4	52202000000	63993
4	2006	8	1836	18	78,0	6,00	0,02	4	59725000000	61453
4	2007	8	1669	12	83,0	8,00	0,07	4	68247000000	61522
4	2008	7	2162	10	80,0	0,00	0,87	4	66495000000	62895
4	2009	7	2140	8	75,0	0,00	0,80	4	82113000000	63364
4	2010	12	1731	10	80,0	0,00	0,04	4	69584000000	62046
4	2011	10	1262	10	80,0	20,00	0,04	4	78423000000	61242
4	2012	8	793	12	83,0	8,00	0,06	4	104099000000	65822
4	2013	7	778	9	67,0	22,00	0,06	4	92870000000	66434
4	2014	7	616	11	82,0	27,00	0,14	4	98921000000	58057
4	2015	7	822	11	82,0	27,00	0,06	4	93017000000	52266
4	2016	12	823	11	82,0	27,00	0,06	4	105006000000	52649
4	2017	13	778	11	82,0	36,00	0,07	4	96013000000	26245
4	2018	10	891	12	83,0	27,00	0,04	4	88020000000	18803
5	2002	6	141	10	50,0	0,00	25,00	6	18114000000	13600
5	2003	3	99	9	36,0	0,00	25,00	6	18409000000	13200
5	2004	4	67	9	56,0	0,00	50,00	6	23584000000	12000
5	2005	4	42	10	50,0	0,00	0,05	6	26337000000	10900
5	2006	13	45	18	28,0	11,00	0,00	6	31175000000	9800
5	2007	13	56	14	36,0	14,00	0,05	6	28205000000	9100
5	2008	14	43	13	38,0	15,00	0,00	6	37435000000	9500
5	2009	25	10	14	36,0	21,00	0,00	6	30784000000	9200
5	2010	23	13	11	36,0	18,00	0,05	6	31718000000	9100
5	2011	19	12	12	42,0	8,00	0,00	6	32422000000	9600

5	2012	16	11	12	42,0	0,00	0,05	6	32576000000	9500
5	2013	13	9	14	38,0	0,00	0,05	6	33100000000	8000
5	2014	16	10	12	42,0	21,00	0,05	6	33026000000	7578
5	2015	11	8	12	50,0	18,00	0,00	6	30962000000	8674
5	2016	10	1	12	42,0	25,00	0,00	6	30646000000	9231
5	2017	8	3	14	50,0	34,00	0,00	6	31196000000	8913
5	2018	7	2	12	58,0	33,00	0,00	6	28560000000	8837
6	2002	5	10	7	14,0	0,00	45,00	4	73000000	297
6	2003	3	9	6	14,0	0,00	35,01	4	87000000	345
6	2004	4	8	6	67,0	0,00	0,00	4	68000000	347
6	2005	5	11	6	67,0	0,00	27,83	4	89000000	356
6	2006	2	23	7	67,0	0,00	27,83	4	91000000	361
6	2007	3	34	7	67,0	0,00	27,83	4	94000000	367
6	2008	3	45	6	67,0	0,00	27,83	4	95000000	387
6	2009	5	33	7	50,0	0,00	27,83	4	174000000	402
6	2010	5	23	4	50,0	0,00	14,04	4	479000000	425
6	2011	6	14	6	50,0	0,00	0,00	4	1106000000	433
6	2012	9	7	6	67,0	17,00	0,00	4	1036000000	461
6	2013	3	18	7	57,0	14,00	0,00	4	1016000000	461
6	2014	11	54	6	67,0	0,00	0,00	4	1011000000	358
6	2015	13	41	6	67,0	0,00	0,00	4	998000000	474
6	2016	17	37	6	67,0	0,00	0,00	4	1026000000	472
6	2017	12	44	6	67,0	0,00	0,00	4	726000000	423
6	2018	15	59	6	67,0	0,00	0,00	4	67600000	440
7	2002	19	94	8	38,0	0,00	0,00	5	2003000000	2576
7	2003	11	97	8	25,0	0,00	0,00	5	3627000000	2900
7	2004	14	103	7	29,0	0,00	0,34	5	4227000000	3756
7	2005	11	76	7	29,0	0,00	0,32	5	3237000000	3002
7	2006	9	87	7	29,0	0,00	0,37	5	3908000000	3123
7	2007	16	69	8	25,0	0,00	0,61	5	5323000000	4234
7	2008	19	14	8	25,0	0,00	0,61	5	10123000000	10928
7	2009	17	19	8	25,0	0,00	1,00	5	11161000000	11004
7	2010	17	29	8	38,0	0,00	0,98	5	12350000000	12996
7	2011	16	27	9	56,0	11,00	1,03	5	13600000000	18351
7	2012	14	17	9	33,0	0,00	0,83	5	17500000000	11456
7	2013	6	75	8	38,0	0,00	0,82	5	16100000000	10580
7	2014	6	66	8	38,0	0,00	0,83	5	19000000000	14034
7	2015	9	113	9	56,0	22,00	0,89	5	19513000000	14655
7	2016	10	66	9	56,0	22,00	1,00	5	20829000000	11841
7	2017	1	21	9	44,0	22,00	0,91	5	39645000000	14263
7	2018	1	52	9	44,0	22,00	0,88	5	41667000000	14275

8	2002	4	97	8	25,0	0,00	0,02	4	9444000000	17654
8	2003	3	123	8	25,0	25,00	0,00	4	10657000000	18756
8	2004	7	165	11	55,0	0,00	0,00	4	9432000000	19538
8	2005	5	126	11	45,0	0,00	0,00	4	8968000000	21582
8	2006	0	77	12	33,0	33,00	0,19	4	10081000000	24488
8	2007	1	44	12	50,0	25,00	0,00	4	19509000000	24018
8	2008	1	23	11	55,0	0,00	0,00	4	22008000000	25361
8	2009	0	45	11	45,0	0,00	0,00	4	22715000000	32256
8	2010	0	34	13	54,0	8,00	0,00	4	24142000000	34597
8	2011	0	19	13	62,0	15,00	0,00	4	24553000000	30900
8	2012	0	23	15	60,0	13,00	0,00	4	26411000000	33221
8	2013	1	44	13	69,0	15,00	0,02	4	28960000000	28296
8	2014	1	56	13	68,0	23,00	0,00	4	30988000000	31768
8	2015	2	134	14	71,0	21,00	0,19	4	27519000000	25466
8	2016	1	103	12	75,0	25,00	0,17	4	25332000000	16948
8	2017	1	113	12	75,0	25,00	0,02	4	17687000000	13786
8	2018	1	98	8	63,0	25,00	0,02	4	1507000000	11344
9	2002	7	868	13	85,0	0,00	0,60	3	309705000000	51037
9	2003	5	226	12	83,0	8,00	0,80	3	218021000000	62054
9	2004	5	197	11	82,0	0,00	0,50	3	311476000000	73070
9	2005	4	152	11	82,0	0,00	0,10	3	261503000000	72000
9	2006	9	124	14	71,0	14,00	0,14	3	328453000000	104000
9	2007	7	264	13	15,0	15,00	0,04	3	442109000000	98947
9	2008	6	207	13	92,0	0,00	12,64	3	554098000000	102732
9	2009	6	215	14	86,0	7,00	0,65	3	709718000000	98990
9	2010	5	164	11	82,0	9,00	0,64	3	674387000000	98133
9	2011	5	85	13	85,0	8,00	0,64	3	721266000000	105341
9	2012	5	547	13	85,0	8,00	0,67	3	1003892000000	125183
9	2013	5	176	12	83,0	17,00	0,63	3	1230334000000	128826
9	2014	4	210	15	93,0	20,00	0,64	3	1573181000000	123803
9	2015	4	502	12	83,0	25,00	0,52	3	1927253000000	106879
9	2016	4	281	12	83,0	25,00	0,61	3	1576127000000	65263
9	2017	4	332	9	89,0	33,00	0,08	3	722499000000	60644
9	2018	4	289	10	80,0	30,00	9,00	3	1085027000000	62476
10	2002	11	248	8	25,0	0,00	0,00	4	66567000000	13275
10	2003	13	301	8	50,0	0,00	10,23	4	54345000000	12461
10	2004	9	191	8	25,0	0,00	7,00	4	47634000000	14321
10	2005	9	178	8	50,0	25,00	23,00	4	43256000000	15200
10	2006	4	203	8	50,0	25,00	25,00	4	56432000000	16400
10	2007	5	231	8	25,0	25,00	11,00	4	35674000000	15500
10	2008	4	194	8	25,0	25,00	13,00	4	34567000000	15432

10	2009	3	197	8	25,0	25,00	9,10	4	49849000000	16543
10	2010	7	203	10	20,0	0,00	11,70	4	36307000000	14321
10	2011	6	197	9	56,0	11,00	9,10	4	36348000000	13241
10	2012	5	294	9	44,0	11,00	6,64	4	46465000000	14532
10	2013	4	295	9	44,0	11,00	6,40	4	36367000000	13452
10	2014	3	175	9	44,0	11,00	0,00	4	29621000000	17651
10	2015	2	97	9	33,0	0,00	0,00	4	219093000000	29871
10	2016	3	107	8	40,0	0,00	11,92	4	185295000000	37654
10	2017	4	151	8	60,0	0,00	11,86	4	302582000000	45200
10	2018	4	145	8	50,0	0,00	0,00	4	322770000000	45669
11	2002	5	34	5	40,0	0,00	0,00	6	199000000	1002
11	2003	8	14	5	40,0	0,00	12,60	6	114000000	978
11	2004	6	20	4	75,0	0,00	7,95	6	68000000	1130
11	2005	6	6	4	50,0	0,00	14,03	6	80000000	1240
11	2006	8	2	4	50,0	0,00	12,68	6	87000000	1232
11	2007	4	18	8	63,0	13,00	70,58	6	1186000000	1871
11	2008	8	43	5	60,0	0,00	1,08	6	6967000000	3321
11	2009	6	34	8	63,0	0,00	1,09	6	4839000000	1998
11	2010	4	14	9	33,0	0,00	0,80	6	5802000000	2567
11	2011	2	9	11	45,0	0,00	0,80	6	4112000000	2103
11	2012	1	8	9	44,0	0,00	1,00	6	4458000000	2150
11	2013	4	4	7	43,0	0,00	0,80	6	3949000000	1067
11	2014	3	10	7	43,0	0,00	1,70	6	3633000000	153
11	2015	6	17	10	60,0	0,00	1,10	6	4744000000	181
11	2016	5	26	8	63,0	0,00	1,10	6	3756000000	171
11	2017	3	4	9	67,0	0,00	1,30	6	4461000000	170
11	2018	0	7	12	50,0	0,00	0,26	6	3335000000	300
12	2002	7	345	9	56,0	0,00	6,70	3	1615000000	21000
12	2003	3	278	8	75,0	0,00	3,49	3	1506000000	18766
12	2004	3	178	9	78,0	0,00	1,08	3	1790000000	12986
12	2005	3	267	7	57,0	14,00	0,94	3	947000000	3481
12	2006	3	229	6	17,0	0,00	2,90	3	1606000000	7740
12	2007	5	225	7	57,0	0,00	0,07	3	1947000000	7971
12	2008	4	281	8	63,0	0,00	0,47	3	2262000000	7627
12	2009	4	297	6	50,0	0,00	0,04	3	2626000000	6715
12	2010	3	240	6	67,0	0,00	0,07	3	258000000	6409
12	2011	5	136	6	67,0	0,00	0,15	3	2289000000	6875
12	2012	2	23	6	67,0	0,00	0,15	3	2492000000	2222
12	2013	1	3	7	71,0	0,00	0,18	3	2669000000	2752
12	2014	1	3	7	71,0	0,00	0,22	3	2441000000	2329
12	2015	1	9	6	67,0	0,00	0,27	3	2503000000	2474

12	2016	1	6	6	67,0	0,00	0,27	3	2419000000	2561
12	2017	2	17	7	57,0	14,00	1,49	3	2287000000	2215
12	2018	2	10	7	71,0	0,00	0,30	3	2360000000	2304
13	2002	3	87	16	44,0	6,00	0,04	4	10208000000	9636
13	2003	3	90	15	40,0	7,00	0,38	4	12439000000	10574
13	2004	3	33	18	33,0	6,00	0,02	4	12969000000	9691
13	2005	3	34	16	88,0	0,00	0,02	4	12303000000	10097
13	2006	2	27	13	31,0	0,00	0,01	4	14483000000	8814
13	2007	2	7	13	31,0	0,00	0,01	4	15175000000	8688
13	2008	2	22	12	33,0	13,00	5,22	4	23185000000	10458
13	2009	1	20	14	29,0	0,00	5,20	4	23229000000	11180
13	2010	1	90	12	33,0	7,00	0,41	4	28609000000	10937
13	2011	1	137	12	33,0	7,00	6,10	4	36439000000	10513
13	2012	1	118	13	31,0	8,00	5,90	4	42417000000	7627
13	2013	1	87	14	50,0	7,00	5,51	4	49506000000	7920
13	2014	1	52	14	59,0	21,00	5,49	4	47429000000	7803
13	2015	1	60	15	40,0	13,00	0,79	4	52626000000	7794
13	2016	0	52	14	57,0	14,00	0,00	4	34527000000	6648
13	2017	1	57	12	58,0	17,00	0,00	4	30770000000	22000
13	2018	1	65	14	64,0	36,00	0,10	4	24621000000	22000
14	2002	15	76	15	76,0	13,00	0,11	4	54210000000	34267
14	2003	16	66	16	66,0	13,00	10,06	7	57340000000	38763
14	2004	19	36	18	36,0	0,00	18,58	7	63456000000	38910
14	2005	15	37	15	37,0	0,00	8,33	7	67350000000	41719
14	2006	14	58	14	58,0	13,00	0,11	7	145567000000	71930
14	2007	12	35	12	35,0	13,00	8,33	7	45196000000	21161
14	2008	10	61	10	60,0	0,00	8,84	7	58483000000	25918
14	2009	9	36	8	36,0	0,00	0,11	7	82476000000	21854
14	2010	13	278	13	27,0	0,00	0,11	7	85347000000	25737
14	2011	12	337	12	50,0	0,00	18,58	7	598847000000	34765
14	2012	13	314	13	54,0	0,00	17,50	7	849790000000	41400
14	2013	9	234	9	56,0	0,00	10,06	7	1431572000000	43371
14	2014	6	40	12	40,0	13,00	8,84	7	1044302000000	35338
14	2015	5	127	12	50,0	13,00	8,34	7	1987663000000	23046
14	2016	4	89	14	86,0	13,00	8,33	7	1710758000000	18867
14	2017	3	46	13	54,0	22,00	8,33	7	1807455000000	13533
14	2018	3	32	12	50,0	22,00	8,33	7	1698470000000	16875
15	2002	18	36	12	58,0	0,00	0,10	6	20371000000	50003
15	2003	14	33	12	58,0	0,00	0,10	6	19218000000	48000
15	2004	15	37	12	58,0	0,00	0,10	6	23203000000	45652
15	2005	14	36	15	47,0	0,00	0,10	6	23997000000	43942

15	2006	14	51	15	47,0	0,00	0,01	6	31635000000	48467
15	2007	12	94	11	64,0	0,00	0,02	6	53925000000	43820
15	2008	9	1892	15	47,0	0,00	0,02	6	62916000000	49325
15	2009	4	25	12	58,0	25,00	0,02	6	66276000000	51122
15	2010	4	1431	12	58,0	25,00	0,03	6	71061000000	47268
15	2011	5	1225	14	50,0	14,00	0,01	6	83352000000	46378
15	2012	5	801	12	58,0	17,00	0,01	6	95046000000	48120
15	2013	5	20	9	78,0	22,00	0,05	6	52093000000	16852
15	2014	5	77	9	78,0	22,00	0,05	6	72352000000	15440
15	2015	3	49	13	54,0	20,00	0,10	6	90928000000	16850
15	2016	2	51	13	54,0	19,00	0,09	6	86975000000	18091
15	2017	3	37	11	64,0	17,00	0,09	6	88246000000	18594
15	2018	2	39	11	64,0	18,00	0,09	6	80571000000	17611
16	2002	27	2106	9	44,0	0,00	3,14	5	14368000000	42157
16	2003	24	1476	19	53,0	11,00	1,84	5	15185000000	41157
16	2004	20	2999	15	53,0	13,00	0,02	5	30062000000	39345
16	2005	17	3133	15	53,0	13,00	0,06	5	33815000000	51610
16	2006	17	3942	9	44,0	22,00	0,01	5	34168000000	53570
16	2007	15	1079	10	50,0	20,00	0,01	5	36949000000	54440
16	2008	6	1864	12	67,0	17,00	0,05	5	36742000000	47038
16	2009	9	2618	12	67,0	17,00	0,05	5	38025000000	45685
16	2010	8	3126	14	50,0	14,00	0,02	5	39223000000	42597
16	2011	8	1313	16	63,0	25,00	0,02	5	36834000000	33935
16	2012	7	1916	13	62,0	15,00	0,02	5	43200000000	36915
16	2013	5	1100	15	73,0	20,00	0,05	5	42229000000	36424
16	2014	8	975	15	80,0	20,00	0,06	5	36229000000	34686
16	2015	9	890	15	80,0	20,00	0,07	5	36137000000	31012
16	2016	6	804	15	80,0	33,00	0,15	5	37030000000	30441
16	2017	7	1066	14	71,0	14,00	0,17	5	38883000000	30990
16	2018	6	1165	14	71,0	14,00	0,18	5	39523000000	38471
17	2002	5	23	19	53,0	11,00	1,02	10	5252000000	2324
17	2003	6	13	21	48,0	10,00	0,09	10	5152000000	1878
17	2004	12	55	21	29,0	10,00	1,52	10	5352000000	1978
17	2005	8	54	21	29,0	10,00	1,52	10	5395000000	1899
17	2006	7	46	21	29,0	10,00	0,04	10	6135000000	1865
17	2007	9	59	12	33,0	8,00	0,04	10	6330000000	1902
17	2008	6	3	12	33,0	17,00	0,06	7	7671000000	2342
17	2009	6	11	10	50,0	20,00	0,09	7	6914000000	2345
17	2010	9	0	11	45,0	18,00	0,90	7	7358000000	2516
17	2011	7	3	13	54,0	15,00	0,06	7	7519000000	2190
17	2012	5	4	12	50,0	17,00	0,08	7	7485000000	2137

17	2013	5	13	13	54,0	15,00	0,09	7	5730000000	1876
17	2014	3	2	13	54,0	15,00	0,10	7	6269000000	1920
17	2015	5	2	12	42,0	17,00	0,20	7	6657000000	1972
17	2016	1	9	14	57,0	14,00	0,26	7	6956000000	1934
17	2017	3	2	15	53,0	13,00	0,33	7	7225000000	2020
17	2018	1	3	14	50,0	14,00	0,36	7	6511000000	2039
18	2002	2	260	10	50,0	10,00	0,10	5	14772000000	25430
18	2003	1	289	15	53,0	25,00	0,10	5	16269000000	28400
18	2004	1	297	16	56,0	19,00	0,10	5	17203000000	27856
18	2005	25	276	13	54,0	23,00	0,01	5	21003000000	26900
18	2006	22	345	13	54,0	23,00	0,01	5	23304000000	29458
18	2007	22	402	13	54,0	15,00	0,00	5	49960000000	30808
18	2008	17	360	13	54,0	15,00	0,00	5	62109000000	54991
18	2009	14	471	13	54,0	31,00	0,00	5	57680000000	53261
18	2010	15	506	10	40,0	20,00	0,00	5	62571000000	44129
18	2011	13	407	14	57,0	21,00	0,01	5	67604000000	58389
18	2012	11	452	11	82,0	18,00	0,01	5	72246000000	55118
18	2013	11	384	12	67,0	25,00	0,01	5	80302000000	57367
18	2014	12	304	13	69,0	23,00	0,00	5	79867000000	55783
18	2015	10	353	13	69,0	23,00	0,01	5	77215000000	54748
18	2016	1	232	12	75,0	33,00	0,01	5	85016000000	50720
18	2017	1	287	12	50,0	17,00	0,01	5	80814000000	27559
18	2018	1	684	12	50,0	25,00	0,01	5	437986000000	40079
19	2002	4	44	16	75,0	6,00	0,04	3	10208000000	9636
19	2003	2	33	18	50,0	6,00	0,04	3	12342000000	10543
19	2004	4	23	18	72,0	6,00	0,02	3	13164000000	9691
19	2005	3	34	16	81,0	0,00	0,02	3	14782000000	10097
19	2006	2	27	10	50,0	10,00	0,00	3	6869000000	8430
19	2007	2	2	10	50,0	10,00	0,00	3	9878000000	6743
19	2008	5	5	10	50,0	40,00	0,00	3	16703000000	10852
19	2009	6	13	10	50,0	40,00	0,01	3	17807000000	11345
19	2010	6	25	10	50,0	40,00	0,01	3	27875000000	11800
19	2011	5	35	10	50,0	40,00	0,01	3	34413000000	11898
19	2012	4	25	10	70,0	40,00	0,01	3	37029000000	11773
19	2013	4	34	11	55,0	36,00	0,01	3	44538000000	11977
19	2014	4	14	11	55,0	36,00	0,00	3	50899000000	12744
19	2015	5	28	10	60,0	40,00	0,00	3	48511000000	10593
19	2016	4	12	11	73,0	36,00	0,10	3	57212000000	8332
19	2017	3	2	13	62,0	38,00	0,10	3	62466000000	10727
19	2018	2	5	12	58,0	42,00	0,10	3	63065000000	12050
20	2002	20	701	10	50,0	0,00	0,40	4	7125000000	19565

20	2003	21	661	10	60,0	0,00	0,11	4	10117000000	20296
20	2004	21	811	8	50,0	0,00	0,44	4	8633000000	20902
20	2005	18	564	9	67,0	0,00	0,90	4	9878000000	22370
20	2006	13	908	9	67,0	11,00	1,12	4	10993000000	23144
20	2007	11	994	11	73,0	9,00	1,31	4	16659000000	24072
20	2008	6	762	10	80,0	10,00	1,34	4	13939000000	25274
20	2009	6	517	9	56,0	11,00	1,45	4	19386000000	21944
20	2010	6	556	11	55,0	9,00	1,78	4	18267000000	23900
20	2011	5	562	11	27,0	9,00	1,86	4	18772000000	27789
20	2012	5	560	10	50,0	10,00	1,98	4	21445000000	28230
20	2013	3	480	9	67,0	22,00	1,75	4	26888000000	28230
20	2014	5	502	8	25,0	25,00	1,80	4	30025000000	28264
20	2015	6	477	7	57,0	29,00	1,86	4	31868000000	26872
20	2016	5	487	9	44,0	11,00	0,11	4	33131000000	24552
20	2017	5	398	8	50,0	25,00	0,09	4	12398000000	24713
20	2018	4	305	7	43,0	29,00	0,07	4	14535000000	23142
21	2002	34	291	10	20,0	0,00	0,50	5	744000000	1145
21	2003	16	176	10	50,0	0,00	0,90	5	789000000	1700
21	2004	17	178	10	50,0	20,00	0,50	5	876000000	1879
21	2005	11	103	9	44,0	25,00	0,42	5	2023000000	4384
21	2006	8	78	10	50,0	20,00	0,42	5	2107000000	5674
21	2007	4	45	10	50,0	40,00	0,46	5	2586000000	7567
21	2008	5	8	10	50,0	30,00	0,42	5	3754000000	9794
21	2009	5	6	10	70,0	30,00	0,42	5	3404000000	9572
21	2010	4	21	10	70,0	30,00	0,46	5	3818000000	10715
21	2011	4	8	12	50,0	42,00	0,46	5	3922000000	12955
21	2012	4	3	12	67,0	45,00	0,06	5	4292000000	13098
21	2013	4	4	12	50,0	42,00	0,11	5	5004000000	15528
21	2014	5	4	11	45,0	45,00	0,26	5	5401000000	13385
21	2015	4	1	10	55,0	56,00	0,11	5	5358000000	13599
21	2016	4	3	8	50,0	62,00	0,11	5	5962000000	14381
21	2017	4	2	8	50,0	62,00	0,11	5	6355000000	15245
21	2018	3	0	10	50,0	50,00	0,10	5	6580000000	15940
22	2002	4	243	10	80,0	20,00	0,05	6	2297000000	8230
22	2003	3	203	9	22,0	11,00	0,05	6	2093000000	7475
22	2004	2	167	8	38,0	25,00	0,03	6	2173000000	8360
22	2005	3	155	10	20,0	20,00	0,03	6	2243000000	8098
22	2006	2	150	10	20,0	20,00	0,09	6	2742000000	8473
22	2007	2	160	9	22,0	22,00	2,30	6	3334000000	8379
22	2008	2	124	8	38,0	25,00	1,90	6	4120000000	9068
22	2009	1	136	10	40,0	20,00	8,10	6	9348000000	8462

22	2010	1	136	13	31,0	15,00	0,00	6	100879000000	8562
22	2011	1	111	13	46,0	15,00	0,10	6	11930000000	8927
22	2012	2	129	14	50,0	14,00	0,30	6	12244000000	9163
22	2013	2	113	10	60,0	20,00	0,10	6	14358000000	9148
22	2014	2	117	9	56,0	11,00	0,10	6	14741000000	8788
22	2015	2	147	9	56,0	11,00	0,06	6	19151000000	10080
22	2016	2	101	10	60,0	20,00	0,09	6	18913000000	11312
22	2017	1	103	10	60,0	20,00	0,02	6	19502000000	12405
22	2018	1	129	11	27,0	27,00	0,10	6	22320000000	13258
23	2002	17	145	7	43,0	14,00	11,10	3	871000000	1004
23	2003	16	156	7	43,0	29,00	9,08	3	756000000	974
23	2004	11	101	5	40,0	0,00	19,30	3	901000000	1242
23	2005	14	78	7	43,0	0,00	6,70	3	945000000	1320
23	2006	13	57	5	40,0	0,00	7,30	3	876000	1433
23	2007	24	98	5	40,0	0,00	0,33	3	802000000	1556
23	2008	22	75	7	29,0	0,00	0,12	3	946000000	1491
23	2009	21	88	7	29,0	0,00	0,01	3	1038000000	1708
23	2010	23	97	7	29,0	0,00	0,02	3	1097000000	1795
23	2011	23	78	6	33,0	0,00	3,12	3	1257000000	1757
23	2012	15	89	7	29,0	43,00	1,20	3	1567000000	1820
23	2013	13	47	8	50,0	0,00	0,04	3	4664000000	4345
23	2014	10	32	8	63,0	25,00	0,78	3	4408000000	5773
23	2015	11	31	7	57,0	29,00	0,17	3	4546000000	5421
23	2016	15	56	6	67,0	17,00	0,17	3	5029000000	6062
23	2017	14	34	6	67,0	17,00	0,16	3	5307000000	5284
23	2018	13	76	6	67,0	17,00	0,18	3	4889000000	4840
24	2002	7	43	6	33,0	0,00	5,54	3	800000000	1734
24	2003	9	32	6	33,0	33,00	0,00	3	934000000	1782
24	2004	9	54	6	33,0	0,00	3,84	3	977000000	1800
24	2005	11	46	6	67,0	0,00	0,00	3	1020000000	2110
24	2006	13	54	6	67,0	0,00	0,00	3	1120000000	2530
24	2007	18	47	6	33,0	0,00	3,84	3	1431000000	2741
24	2008	18	45	6	33,0	0,00	3,15	3	1736000000	2824
24	2009	19	30	6	33,0	0,00	0,00	3	2178000000	3519
24	2010	25	15	6	33,0	0,00	0,00	3	14551000000	5344
24	2011	27	11	6	57,0	0,00	7,01	3	15344000000	5231
24	2012	30	7	6	57,0	0,00	3,84	3	16540000000	5575
24	2013	17	12	6	57,0	14,00	0,00	3	21781000000	7156
24	2014	8	18	7	57,0	0,00	0,00	3	19871000000	8206
24	2015	8	13	7	57,0	0,00	3,15	3	20233000000	8271
24	2016	7	5	7	57,0	14,00	3,15	3	18662000000	10768

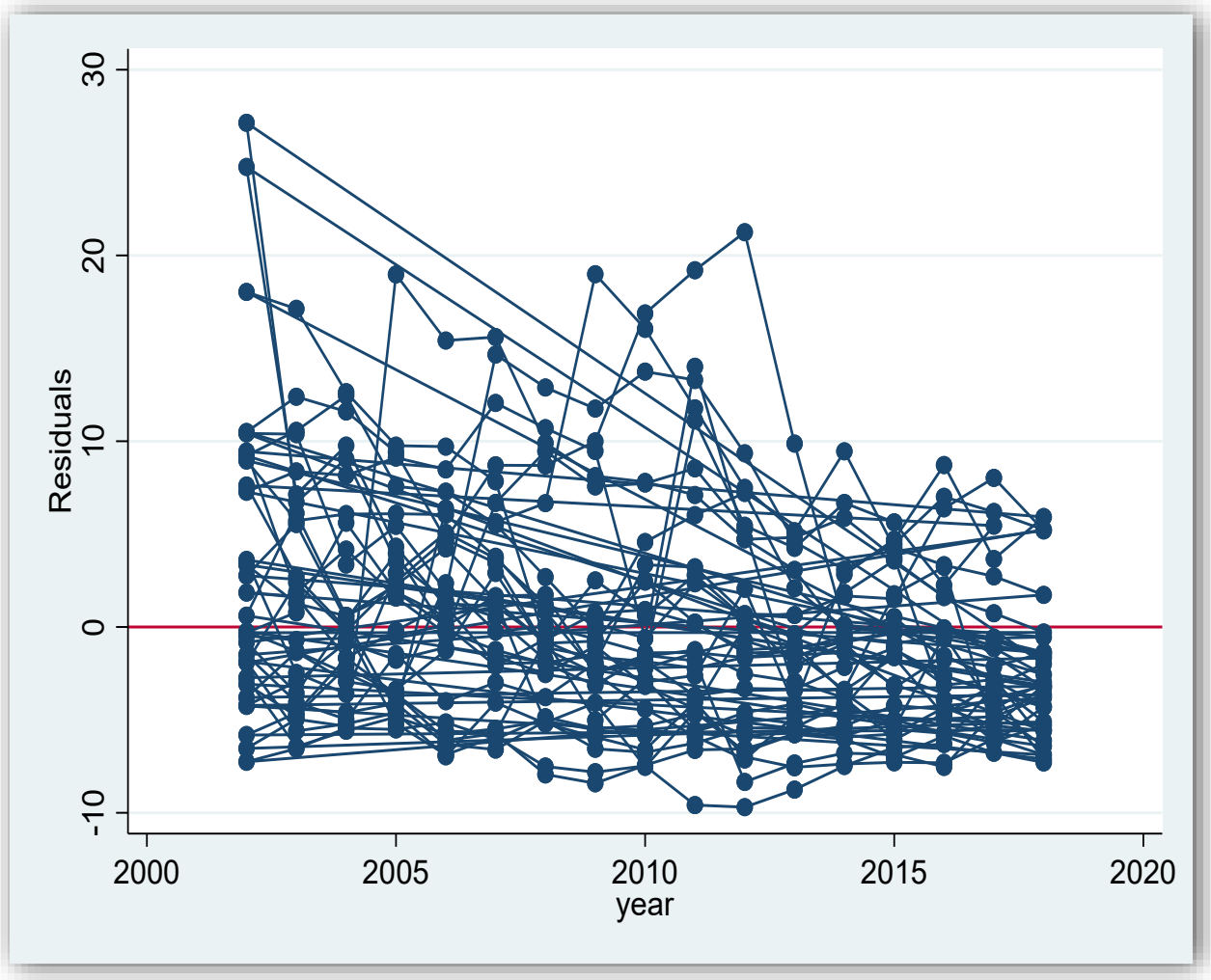
24	2017	7	4	7	57,0	14,00	3,84	3	24576000000	11169
24	2018	6	10	7	57,0	14,00	3,84	3	22812000000	9486
25	2002	15	37	5	40,0	20,00	1,70	3	456000000	975
25	2003	16	45	7	43,0	14,00	2,30	3	586000000	1127
25	2004	17	44	7	43,0	0,00	2,11	3	692000000	2037
25	2005	16	45	13	46,0	15,00	1,26	3	760000000	2726
25	2006	17	75	8	56,0	0,00	1,46	3	779000000	2158
25	2007	21	66	9	56,0	0,00	1,01	3	908000000	4241
25	2008	20	35	9	56,0	0,00	0,97	3	1029000000	4766
25	2009	18	25	9	56,0	0,00	0,87	3	796000000	3636
25	2010	9	45	8	50,0	0,00	0,88	3	569000000	6155
25	2011	13	34	5	40,0	0,00	1,13	3	214000000	7546
25	2012	11	7	4	50,0	0,00	1,01	3	218000000	8765
25	2013	9	23	5	40,0	0,00	4,02	3	204000000	10433
25	2014	9	14	5	60,0	0,00	4,02	3	177000000	11324
25	2015	7	8	5	60,0	0,00	4,02	3	182000000	11451
25	2016	6	2	10	60,0	30,00	1,01	3	171000000	11659
25	2017	4	0	8	75,0	38,00	1,01	3	167000000	12435
25	2018	5	7	5	60,0	0,00	0,00	3	169000000	13410
26	2002	7	67	9	33,0	33,00	0,38	4	4320000000	3451
26	2003	12	77	9	56,0	33,00	0,36	4	4560000000	3756
26	2004	9	65	10	50,0	0,00	0,28	4	5675000000	4001
26	2005	9	81	10	50,0	20,00	0,25	4	6743000000	4320
26	2006	7	67	10	60,0	20,00	0,16	4	5670000000	4351
26	2007	7	68	9	66,0	33,00	0,23	4	9004000000	5754
26	2008	7	56	9	66,0	33,00	0,20	4	8756000000	6003
26	2009	6	59	9	66,0	0,00	0,19	4	7278000000	6564
26	2010	5	48	9	56,0	22,00	0,19	4	18451000000	7671
26	2011	17	57	10	60,0	30,00	0,36	4	19493000000	8760
26	2012	11	68	10	60,0	30,00	0,28	4	20101000000	8205
26	2013	11	86	10	50,0	20,00	0,25	4	20818000000	7929
26	2014	12	115	11	64,0	36,00	0,16	4	23504000000	8900
26	2015	11	33	11	64,0	36,00	0,23	4	19759000000	7000
26	2016	7	75	11	64,0	36,00	0,20	4	20318000000	7400
26	2017	10	77	10	70,0	40,00	0,19	4	22145000000	8372
26	2018	8	70	9	78,0	36,00	0,19	4	25511000000	9508
27	2002	16	12	9	33,0	0,00	0,14	3	1541000000	743
27	2003	11	5	6	67,0	0,00	1,14	3	1431000000	783
27	2004	8	8	6	67,0	0,00	1,61	3	1563000000	875
27	2005	3	10	9	67,0	0,00	1,61	3	1616000000	845
27	2006	2	13	9	33,0	0,00	1,70	3	1358000000	891

27	2007	2	15	9	67,0	0,00	1,17	3	1509000000	902
27	2008	1	9	11	18,0	0,00	0,17	3	1545000000	960
27	2009	0	7	11	55,0	0,00	1,17	3	985000000	987
27	2010	0	6	11	55,0	0,00	1,61	3	1008000000	1001
27	2011	0	4	6	17,0	0,00	0,14	3	923000000	630
27	2012	0	13	5	20,0	0,00	0,14	3	951000000	672
27	2013	0	23	6	33,0	0,00	0,14	3	990000000	645
27	2014	0	24	6	50,0	17,00	0,14	3	951000000	625
27	2015	1	19	7	56,0	14,00	0,14	3	1020000000	624
27	2016	1	10	11	45,0	9,00	0,14	3	891000000	477
27	2017	2	7	7	14,0	0,00	51,13	3	681000000	490
27	2018	2	9	7	29,0	0,00	55,18	3	981000000	176
28	2002	34	37	12	50,0	25,00	1,10	5	424000000	3478
28	2003	16	38	12	42,0	0,00	0,90	5	443000000	4112
28	2004	17	24	12	50,0	15,00	0,82	5	657000000	4283
28	2005	11	29	8	25,0	25,00	1,61	5	785000000	4384
28	2006	8	23	10	40,0	30,00	0,50	5	868000000	5411
28	2007	7	12	12	50,0	30,00	0,42	5	964000000	5351
28	2008	5	8	10	40,0	30,00	0,42	5	1286000000	10188
28	2009	5	6	10	40,0	30,00	0,42	5	1272000000	9256
28	2010	5	21	10	50,0	40,00	0,46	5	1360000000	10503
28	2011	4	8	12	50,0	42,00	0,46	5	1352000000	12955
28	2012	1	46	7	43,0	14,00	0,46	5	1340000000	13210
28	2013	0	78	8	63,0	25,00	0,51	5	1326000000	14231
28	2014	1	115	9	56,0	22,00	0,26	5	1360000000	11342
28	2015	1	12	8	63,0	25,00	0,28	5	1345000000	11245
28	2016	0	41	9	56,0	22,00	0,32	5	713000000	10001
28	2017	3	27	8	38,0	25,00	1,10	5	910000000	9123
28	2018	4	34	8	38,0	25,00	1,17	5	1234000000	10241
29	2002	4	12	10	30,0	0,00	0,30	4	2341000000	1002
29	2003	5	13	10	40,0	0,00	0,11	4	1987000000	987
29	2004	7	7	10	40,0	10,00	0,44	4	2031000000	1932
29	2005	5	2	10	40,0	20,00	0,22	4	1453000000	751
29	2006	6	0	10	30,0	20,00	0,11	4	1320000000	875
29	2007	5	14	10	30,0	30,00	0,36	4	1224000000	785
29	2008	5	13	10	30,0	10,00	0,44	4	1394000000	876
29	2009	4	15	10	40,0	40,00	0,22	4	1395000000	756
29	2010	4	11	10	40,0	10,00	0,22	4	1884000000	765
29	2011	3	8	10	40,0	10,00	0,11	4	3313000000	1230
29	2012	5	9	10	60,0	30,00	0,22	4	4861000000	978
29	2013	5	0	10	50,0	20,00	0,18	4	5043000000	665

29	2014	4	6	10	50,0	0,00	0,18	4	5432000000	675
29	2015	2	5	10	50,0	0,00	0,41	4	7451000000	745
29	2016	7	0	10	40,0	10,00	0,31	4	7579000000	621
29	2017	3	0	10	30,0	10,00	0,36	4	7980000000	525
29	2018	3	12	10	40,0	20,00	0,22	4	8971000000	689
30	2002	11	243	7	57,0	14,00	13,20	3	840000000	18743
30	2003	9	154	7	57,0	14,00	14,50	3	761000000	17541
30	2004	8	95	7	43,0	29,00	0,00	3	900000000	21340
30	2005	10	87	8	50,0	25,00	4,30	3	742000000	19871
30	2006	12	134	7	43,0	14,00	16,40	3	780000000	21340
30	2007	7	176	8	63,0	38,00	11,20	3	1001000000	28456
30	2008	5	55	7	43,0	0,00	0,00	3	941000000	26542
30	2009	3	46	8	50,0	25,00	10,40	3	756000000	24536
30	2010	2	65	7	43,0	0,00	9,08	3	602000000	23450
30	2011	5	76	8	25,0	0,00	9,60	3	971000000	27810
30	2012	3	49	7	29,0	0,00	8,00	3	1186000000	34561
30	2013	4	54	7	29,0	0,00	7,50	3	1543000000	27651
30	2014	4	51	7	29,0	0,00	6,20	3	2312000000	41000
30	2015	3	37	7	29,0	0,00	5,20	3	1843000000	34765
30	2016	2	57	8	75,0	13,00	4,12	3	1903000000	35000
30	2017	2	34	7	71,0	14,00	0,00	3	1943000000	41000
30	2018	2	68	8	50,0	13,00	0,00	3	2000000000	44000

ANNEXURE B: DIAGNOSTIC TESTS

Annexure B1: Serial correlation (Scatter graph)



Annexure B2: Multicollinearity test (variance inflation factor analysis)

Variable	**VIF**	**1/VIF**
LgTa	2.42	0.412641
LgTe	2.14	0.466293
Bs	1.51	0.663510
Mo	1.12	0.896054
Gd	1.11	0.901120
Bi	1.11	0.902451
Arc	1.03	0.967758
Mean VIF	1.49	

Annexure B3: Normality test outcomes

Sktest myresidual					
Skewness/Kurtosis for normality----joint--					
Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	Chi2(2)	Pr>ch1
Myresidual	509	0.061	0.5210	5.31	0.1320

Annexure B4: Heteroscedacity tests

Estat hettest
Bresnsch-pagan/Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: Fitted values of tifr
Chi2 (1)-33.16
Prob > chi2-0.000

Source: Author's construct

ANNEXURE C: DESCRIPTIVE STATISTICS

	ARC	BI	BS	GD	MO	NCOD	TA	TE	TIFR
Mean	4,615842	51,4385	10,48515	13,52303	2,622154	259,5624	7,90E+10	22636,98	7,249663
Median	4	50	10	13	0,19	67	1,48E+10	11659	5,4
Maximum	10	93	21	62	70,58	3942	1,99E+12	287043	33,91
Minimum	3	0,44	4	0	0	0	876000	176	0
Std. Dev.	1,688825	16,32077	3,34763	12,6212	7,163344	501,0986	2,50E+11	28029,11	6,033076
Skewness	1,441213	0,02281	0,590221	0,710341	5,108745	3,456014	5,400063	2,973041	1,352283
Kurtosis	5,268939	2,671683	3,314727	3,121634	35,70851	17,34667	34,14243	19,96402	4,874768
Jarque-Bera	283,1465	2,311915	31,40464	42,78045	24708,05	5336,233	22861,64	6799,273	227,8694
Probability	0	0,314756	0	0	0	0	0	0	0
Sum	2331	25976,44	5295	6829,13	1324,188	131079	3,99E+13	11431673	3661,08
Sum Sq. Dev.	1437,473	134249,2	5648,139	80284,49	25862	1,27E+08	3,14E+25	3,96E+11	18344,59
Observations	510	510	510	510	510	510	510	510	510

ANNEXURE D: INFERENTIAL STATISTICAL OUTCOMES

Annexure D1: Correlation matrix

CORRELATION MATRIX									
	TIFR	NCOD	BS	BI	GD	MO	ARC	TA	TE
TIFR	1	0.14267	-0.10781	-0.07572	-0.1617	-0.04046	-0.00669	-0.09349	-0.07912
NCOD	0.14267	1	0.295963	0.124494	0.013826	-0.11002	-0.00174	0.025852	0.437309
BS	-0.10781	0.295963	1	0.058795	0.178437	-0.24856	0.01097	0.154226	0.405041
BI	-0.07572	0.124494	0.058795	1	0.141247	-0.14095	0.111195	0.234633	0.205907
GD	-0.1617	0.013826	0.178437	0.141247	1	-0.21086	0.028619	0.056304	0.084829
MO	-0.04046	-0.11002	-0.24856	-0.14095	-0.21086	1	-0.0257	0.046706	-0.105
ARC	-0.00669	-0.00174	0.01097	0.111195	0.028619	-0.0257	1	-0.03305	-0.05453
TA	-0.09349	0.025852	0.154226	0.234633	0.056304	0.046706	-0.03305	1	0.38577
TE	-0.07912	0.437309	0.405041	0.205907	0.084829	-0.105	-0.05453	0.38577	1

Annexure D2: Regression analysis outcomes

Ordinary least square (OLS			**Feasible generalised least square (FGLS)**	
	1 TIFR	2 NCOD	3 TIFR	4 NCOD
BS	-0.165** (-1.73)	23.92*** (3.33)	-0.165** (-1.73)	23.92*** (3.33)
BI	-0.0231* (-1.36)	1.546* (1.21)	-0.0231* (-1.37)	1.546* (1.22)
GD	-0.0780*** (-3.59)	-4.720** (-2.87)	-0.0780*** (-3.59)	-4.720** (-2.89)
MO	-0.0878* (-2.30)	-1.105* (-0.39)	-0.0878* (-2.30)	-1.105 (-0.39)
ARC	-0.0233 (-0.01)	57.69 (0.22)	-0.0233 (-0.01)	57.69 (0.22)
TA	-0.304 (-1.58)	-23.35 (-1.61)	-0.304 (-1.58)	-23.35 (-1.63)
TE	0.433 (1.72)	150.3*** (7.88)	0.433 (1.72)	150.3*** (7.88)
Cons	14.49** (2.98)	-905.5* (2.98)	14.49** (3.00)	-905.5* (-2.50)
N	510	510	510	510

t statistics in parentheses

*** $p < 0.001$, **$p<0.01$.*$p < 0.05$

ANNEXURE E: ETHICAL CLEARANCE

UNISA university of south africa

UNISA DEPARTMENT OF FINANCE, RISK MANAGEMENT AND BANKING ETHICS REVIEW COMMITTEE

Date: 22 APRIL 2022

ERC Ref #2022/CEMS/FRMB/008
Name : Mr LC Chikosi
Student #: 45187886
Staff #:

Dear Mr L C Chikosi

Decision: Ethics Approval from 22 April 2022 to 31 March 2027

Researcher(s): Name Mr LC Chikosi

E-mail address 45187886@mylife.unisa.ac.za, telephone 0784449496

Supervisor: Name: Prof A Mutezo

Email address: muteza@unisa.ac.za, telephone 012 429 4595

Working title of research:

The impact of corporate governance on occupational risks in the South African mining sector

Qualification: Doctor of Philosophy in Business Management (Finance)

Thank you for the application for research ethics clearance by the Unisa DFRB Ethics Review Committee for the above-mentioned research. Ethics approval is granted for the period 22 April 2022 to 31 March 2027

*The Low **risk application** was **reviewed** by the DFRB Ethics Review Committee 22 April 2022 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment*

The proposed research may now commence with the provisions that:

1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa

2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the DFRB Committee.
3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data requires additional ethics clearance.
7. No fieldwork activities may continue after the expiry date (2027). Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

The reference number 2022/CEMS/FRMB/008 *should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Yours sincerely,

Chair of DFRB ERC : Prof K Tsaurai
E-mail: tsaurk@unisa.ac.za
Tel: (012) 429-2140

Executive Dean : Prof T Mogale
E-mail: mogalmt@unisa.ac.za
Tel: (012) 429-4805

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa