OCCUPATIONAL ACCIDENTS AT A COAL MINE WATERBERG DISTRICT IN LIMPOPO PROVINCE.

BY

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[redacted]

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DECLARATION

"I declare that the mini-dissertation hereby submitted to the University of Limpopo, for the degree of Master of Public Health, **THE OCCUPATIONAL ACCIDENTS AT A COAL MINE WATERBERG DISTRICT IN LIMPOPO PROVINCE** has not previously been submitted by me for a degree at this university or any other university, that it is my work in design and in execution, and that all the material contained herein has been duly acknowledged".

________________________ ____________________

date

DEDICATION

To my beloved parents Ms Dama Ntshengedzeni Renneth, Ms. Mudau Reginah and Ms Nengovhela Caroline Musiwalo for believing, understanding and supporting me during hard times of my studies. I would also like to dedicate this mini dissertation to my wife as well as my kids, Ms Mukhumo Fulufhedzani, Dama Vhofanelwa Lombard, Dama Rialivhuwa and Dama Ngaurendiwa.

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ABSTRACT

Background

The coal mining industry is reported to be the most dangerous workplace in the world. Most of the mine workers working in underground coal mines as well as open cast mines are exposed to occupational accidents which result in injuries or death of workers, decrease in production and increasing financial expenditure. Occupational accidents are defined as unplanned occurrences often resulting in personal injuries, damage to machines, tools and equipment, and the halting of production. The most common causes of occupational accidents in coal mines are natural causes, unsafe acts in the workplace, inadequate health and safety training, workplace hazards, dust explosions, landslips, technical failures related to transport, human error and rock fall. It has been reported that there are more than 350,000 workplace fatalities and more than 270 million injuries annually worldwide.

Objectives

The objectives of this study were to determine types of health and safety training offered to mineworkers and find out types of mine hazards at a coal mine in Waterberg District of Limpopo Province.

Methods

A quantitative descriptive cross-sectional method was used in the study. The population comprised 800 mineworkers who worked at Exxaro Grootegeluk Coal Mine. Simple random sampling was used to select 286 mineworkers who participated in the study. A self-administered questionnaire was used to collect data. Statistical analysis and descriptive statistics were used to analyse data.

Results

The study findings show that the majority of mine workers at 24% who worked at the coal mine in Waterberg District in Limpopo Province were between the ages of 26 and 30 years, followed by 59 or 21% of those between the ages of 31 to 35. 107(37%) had work experience of between 2 to 4 years and 124(43,4%) completed grade 12. 95% of them received training in hazards identification while 97% know how to identify hazards in the workplace. The study further found that majority of the mine workers or

93% agree that they work in a dusty place, but are provided with dust masks. 99% agree that they always put on personal protective equipment before starting work. 97% agree that they are provided with correct personal protective equipment to perform their daily tasks.

Conclusion

The study concluded that mine workers who worked at Exxaro Grootegeluk Coal Mine are provided with health and safety related training and with correct personal protective equipment to perform their daily tasks.

Keywords

Coal mine, occupational accidents, occupational injuries and mine workers, health and safety training and personal protective equipment.

DEFINITION OF TERMS

Occupational accidents

Occupational accidents defined as the unplanned occurences,often resulting in personal injuries, damages to machines, tools, equipment and halting the production for a while (Kucuk & Ilgaz, 2016). In this study occupational accidents refers to the accidents that are taken place towards the coal mine which were not planned and resulted to the injury or death of mine workers.

Occupational Safety and Health

Occupational safety and health is an area concerned with protecting the safety, health and welfare of people engaged in work or employment (Singh & Siddiqui, 2014). In this study occupational safety and health refers to the any locations with the purpose of feeling healthy and safety of employees when are busy working.

Working conditions

Working conditions refer to the working environment and all existing circumstances affecting labour in the workplace, including job hours, physical aspects, legal rights and responsible organisational climate and workload (Ali, Ali & Adan, 2013). In this study working conditions refers to the situation or contributory factors of the work environment which affecting the employees when they are performing their daily tasks in the coal mine.

Mineworkers

Mineworkers refer to persons who work in a mine (Collins English Dictionary, 2014). In this study the mine workers refers to the employees of who work in the coal mine.

Working environment

Working environment is the environment where people work together to achieve organisational objectives and involves the physical geographical locations as well as the immediate surroundings of the workplace, such as a construction site or an office building (Awan & Tahir, 2015). In this study working environment refers to the physical locations or section where employees of coal mine work.

LIST OF ABBREVIATIONS

OA- Occupational Accidents

MW- Mineworkers

EGCM- Exxaro Grootegeluk Coal Mine

WD- Waterberg District

LP- Limpopo Province

NIOSH-National Institute for Occupational Safety and Healthy

WC- Working Conditions

WE- Working Environment

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CHAPTER 1

OVERVIEW OF THE RESEARCH STUDY

1.1 INTRODUCTION AND BACKGROUND

Occupational accidents (OA) are defined as unplanned occurrences, often resulting in personal injuries, damage to machines, tools, equipment and halting production for a while. The most common causes of occupational accidents in coal mines are natural disasters, unsafe acts in the workplace, firedamps, dust explosions, landslips, mine fires and technical failures related to transport and loss of control of the working machinery (Kucuk & llgaz, 2016). Occupational accidents in the mines also result in injuries or death of mine workers, decreases in production and increases in financial expenditure. Conditions of the work environment (WE) such as slippery surfaces often result in falls, which cause workplace injuries and deaths among mining workers. Conditions of equipment is another factor that can affect risk of occupational injuries. One study showed that the risk of hand injuries was increased by using tools and equipment that are not working properly (Azadeh-Fard, Schub, Rashedi & Camelio, 2015).

An occupational accident (OA) to mineworkers often occurs in both open cast and underground mines, and results in death, loss of consciousness, restriction of work, inability to perform job duties, loss of workdays, temporary assignment to other duties and transfer to another job or termination of a job (Cui, Tain, Qiao, Wang, Wang, Huang, Sun, Liang & Liu, 2015). The United States Bureau of Labour Statistics reported about 3 million non-fatal workplace injuries and illnesses in 2012. Fatal injuries in the same period were reported to have a rate of 3, 2 cases out of every 100,000 full-time workers (Azadeh-Fard et al, 2015).

In China, it has been estimated that there are more than 350,000 workplace fatalities (Cui et al, 2015) and more than 270 million fatal injuries annually worldwide (ILO, 2014). In 2010, there were 363,383 accidents and 79,552 fatal injuries in China. As a result, occupational injuries are a major public health problem, especially in developing countries. The mining industry accounts for a significant proportion of occupational injuries in all industry divisions. Mining, especially coal mining, has been considered one of the world’s most dangerous occupations (Cui et al, 2015).

In a mining district of western region, Ghana, mineworkers reported getting injured over the previous 10 years, and the overall injury rate was calculated to be 5.39 per 100 persons per year. The occupational injury rate was significantly higher for women, accounting for 11,93 per 100 persons per year than men, and higher to those who have little mining work experience. The most occupational mine injury activities were excavation at 58,79%, crushing at 23% and over 70% of occupational injuries were reported to be due to miners being hit by objects. The majority of injuries at 57% were lacerations, and nearly 70% of the injuries were on the upper or lower limbs. One quarter of the injured workers believe that abnormal work pressure played a role in their injuries (Calys-Tagoe, Ovadje, Clarke, Basu & Robins, 2015).

The National Institute for Occupational Safety and Healthy (NIOSH) states that one of its main missions is to reduce work-related injuries, illnesses and deaths through periodic surveillance in an effort to increase the utility of information gathered from different stakeholders regarding injuries and hazards in the workplace.The prevention and control of occupational injuries require information about leading causes of incidents (Azadeh-Fard et al, 2015).

The South African Mine Health and Safety Act No.29 of 1996 states that the main objective is to protect the health and safety of persons at the mine. The main purpose of inspection is to identify safety environmental hazards so that they can be corrected before incidents. Health and safety training must be provided to mineworkers (MW) in order to minimise occupational injuries (OI) in the mining industry. It also reported that South African mine workers were exposed to dust and noise from the mining. Mining and processing of minerals also results in occupational exposure to toxic substances such as platinum, manganese and diesel particulate (Utembe, Faustman, Matatiele & Gulumiam, 2015)

Working conditions and reported occupational accidents at a coal mine in Waterberg District prompted the researcher to find out the causes of occupational accidents.

1.2 RESEARCH PROBLEM

The researcher was motivated to undertake the study due to occupational accidents among mineworkers at a coal mine in Waterberg District in Limpopo Province. Statistics from Limpopo Provincial Department of Minerals show that in the years

2015, 2016 and 2017, there were reported occupational accidents among mineworkers, where 29 mineworkers got injured. The mine employs 800 mineworkers working in high-risk risk areas such as blasting, drilling, digging and loading. The other main issue is that the coal mining industry is reported to be the most dangerous workplace in the world.

It is very important that investing in health and safety should be prioritised. This could save the company money by reducing costs, increasing efficiency and improving the morale of employees. The researcher would therefore like to find out about the causes of occupational accidents in the mine.

1.3 PURPOSE OF THE STUDY

1.3.1 Aim of the study

The aim of this study was to determine causes of occupational accidents among mineworkers at a coal mine in Waterberg District of Limpopo Province.

1.3.2 Objectives of the study were

To determine types of health and safety training offered to mineworkers.

To find out types of mine hazards at the coal mine in Waterberg District of Limpopo Province.

1.4 RESEARCH QUESTION

What are causes of occupational accidents among mineworkers at the coal mine in Waterberg District of Limpopo Province?

1.5 LITERATURE REVIEW

The literature relevant to the study was reviewed and will be discussed fully in chapter2

1.6 METHODOLOGY

This account of the methodology is only a summary of what is comprehensively discussed in chapter 3.

1.6.1 Study Site

The study was conducted at Exxaro Grootegeluk Coal Mine, which is an open cast coal mine in Waterberg coalfield, Limpopo Province, South Africa. The mine is 25 kilometres and 16 minutes away on the western side of Lephalale. It employs 800 people who work in high risk areas like blasting, drilling, digging and loading.

1.6.2 Research design

A quantitative research approach and cross-sectional design were used to conduct the study.

1.6.3 Population and Sampling

A simple-random sampling method was used to select a sample size of 266 respondents.

1.6.4 Data collection

Data was collected using self-administered questionnaires, which were distributed to respondents personally and were collected immediately after completion.

1.6.5 Data analysis

In this study, data were analysed using SPSS (version 26), and presented using frequencies and percentages for categorical data and mean as well as standard deviation for continuous data. A comparison between groups was done using t-test for continuous data and chi-square test for categorical data. The p-value of less than 0, 05 was considered significant.

1.7 ETHICAL CONSIDERATIONS

Ethical clearance to conduct the study was granted by Turfloop Research and Ethics Committee. Permission to collect data at Exxaro Grootegeluk Coal Mine was granted by the CEO, and consent was obtained from the respondents prior to data collection.

1.8 BIAS

Bias occurs when a systemic error is introduced into sampling by selecting or encouraging one outcome or answer over others (Pannucci & Wilkins, 2010). The study bias was avoided by ensuring that the researcher does not use leading comments to respondents when distributing questionnaires. The selection bias was avoided by using a simple random sampling procedure to select respondents who qualify to participate in the study.

1.9 CONCLUSION

This chapter introduced the study, the research problem, the purpose of the study, research question and summarised the methodology of the research study. It also looked at ethical considerations and bias.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Literature review is a systematic, explicit and reproducible methods of identifying, evaluating and synthesising existing body of completed and recorded work produced by researchers, scholars and practitioners (Arlene, 2014). In this study, the researcher reviewed relevant sources of information such journals, books and articles about occupational accidents at a coal mine. The review focused on the health and safety training offered to mineworkers, causes of occupational accidents in the mines such as occupational hazards, unsafe acts, falling of rocks, fall and trips, work experience, age, human error, unsafe workplace etc.

2.2 Health and Safety training offered to mineworkers

Internationally, the moral, legal, economical and occupational safety and health have become important issues. Different companies are attempting to remain profitable in an ever more competitive, global economy. For many companies, strong safety, health and environmental programmes may actually mean survival. In the west of Australia, the first workshop which was provided to mineworkers was on hazard identification, which was a half day training session held over three days with six separate groups of employees, which was divided into 18 mixed teams of 4-6 respondents, with a total of 77 employees, 54 of which were contracting companies and 23 direct employees. The second training was about the management of hazards. The results found that the range of hazards identified was extensive and very limited. The purpose of the training was to determine underground mining staff's ability to identify hazards in the work areas and their knowledge of processes and practices available to address obvious, trivial, emerging and hidden hazards (Bahn, 2013).

In India, most mineworkers were found to be illiterate and did not receive any training before they worked in the mines. Lack of education was one of the root causes of the misery that they are facing. It was found that none of the mineworkers from the sample had received any kind of training before they started working in the mining sector. Due to this lack of training, workers were more vulnerable to occupational health problems. All the mineworkers indicated that they learnt the work while working in the mine. Some of them said that they understood the process by observing their parents working in mines while they were still children (Marthur, 2015).

In South Africa, types of training that are provided to workers should be to train them to execute particular operations in ways that combine self-protection with the avoidance of risk to fellow workers and others who may be affected, including general workers. The other type of training should be based on the induction and refresher training which should be designed for all ranks of mine officials, focussing on the problem that represents the greatest risks to health and safety. Adult or ABET training is a primary intervention to health and safety in the mining industry (Tuchten, 2012).

2.3 Causes of occupational accidents in mines

2.3.1 Occupational hazards at the workplace

The most common hazards include moving machinery, unsupported ground, faulty equipment and incorrect personal protective equipment. Additionally, only one team identified manual handling as an obvious hazard. Work safety recorded that 40, 8% of injuries in 2008-2009 were results of body stressing and poor housekeeping, which can be a cause of many slips and trips in the workplace. These occupational hazards can be physical, chemical and physiological, and can lead to workplace accidents, and impact on firms' productivity and profitability (Bahn, 2013).

In African countries such as Zimbabwe, most of the mineworkers are exposed to ergonomic hazards that are associated with mining ventures. These include musculoskeletal disorders, risks factors involving awkward body postures, manual material handling, repetitive notions, force and vibration. The ergonomic-related hazards associated with trackless mining equipment underground include restricted vision and exposure to whole body vibration, noise and dusts. Many people in Southern Africa are working in the informal mining sector without any guarantee of occupational health and safety (Jerie, 2013).

Although mining plays a prominent role in the economy of South Africa, it is associated with many toxic hazards. Mineworkers (MW) were reported to be exposed to dust from mining. Mining and processing of minerals also result in occupational exposure to toxic substances such as platinum, chromium, vanadium, manganese, mercury and diesel particulate. South Africa has set occupational exposure limits for some hazards, but mineworkers are still at risk (Utembe, Faustman, Matatiele & Gulumiam, 2015).

Additionally, during the hazards identification process, ten occupations were identified as significant noise risk exposed occupations in Limpopo Province (LP). The drill rig operator was one of the top 3 most exposed occupations with 90th percentile of 98.13dB. The drill foreman with a maximum of 99.75 Db and 90th percentile of 96. 93dB exceeds the South African Department of Minerals and Resources by 85dB (Van Coller, 2015). In south Africa most of the mineworkers found to be continuous exposed to high levels of noise over a period of time which resulted them having disabling occupational noise-induced hearing loss at the workplaces (Moroe,Khoza-Shangase,Madahana & Nyandoro, 2019)

The noise measurement of less than 85 dB(A) time weighted average is used by the Us Occupational Safety and Health Administration(OHSA) noise regulation standard No.1910.95 and has adopted as global benchmark by many countries including south Africa for occupational noise measurement. There is substantial risk for overexposure to noise in occupations working in the production area of an opencast mine (Kanji, Khoza-Shangase & Ntlahakana, 2019). Hence equipment type, maintenance of controls and employee risk reduction behaviours may be important elements of noise exposure. The development of a methodical and comprehensive hearing conservation programme is aimed at lowering the noise level in workplaces, and the prevention of occupational noise induced hearing loss at the place of work ((Van Coller, 2015)

Excessive noise is a global health hazard with considerable social and physiological impact, including the development of noise induced hearing loss. Noise is a major hazard in many workplaces. The average noise measured in various locations of Polokwane Platinum smelter was between 62,6dB (A) and 105,1dB (A). The results show that mineworkers at Polokwane Platinum smelter are overexposed to noise in certain work areas if they work eight hours in the area. Areas where the average noise level was above the noise rating limit of 85dB (A) were demarcated as noise zones as additional protective measures. It is estimated that more than 30 million workers are exposed to unsafe noise in their workplaces. Therefore, a hearing conversation programme is an important issue in the smelter as certain areas are denoted as noise areas (Mdaka, 2015).

2.3.2 Unsafe acts in the mine

In India, unsafe acts are major contributors to occupational accidents in mines. There are 66 cases of routine disruption errors, 52 cases of decision errors, four cases of perceptual errors and six cases of violations. Each of the subcategories of unsafe acts is comprehensive and classified as attention failures, postural errors, electrical errors, under skill-based errors and violation of usage of personal protective equipment (Verma & Chaudhari, 2017).

The outcome of analysis of human factors and classification system showed that unsafe acts performed by the operator are influenced by factors such as age, experience and time shift. It is noted that in the coal mining industry, 35 out of 66 incidents were found to occur because of skill-based errors, and 13 out of 52 incidents occurred because of decision errors. The role of the leader is to provide adequate training and guidance to team members to perform tasks efficiently and safely (Verma & Chaudhari, 2017).

In China, the coal mining industry remains a high risk industry and bears the worst safety record in the world. One of the most important goals of coal mining industries is to operate in a safe manner. Based on the investigation report of coal mine accidents, it is shown that accidents and injuries caused by unsafe acts accounted for 97, 67% of the total in 2011. Roof accidents hold the most proportion of the whole coal mine accident cases and cause the highest death toll. Safety policy for fulfilling this goal involves, among others, safety-oriented devices, design and compliance with safety laws and regulations. Thousands of people get killed in coal mining each year (Yin, Fu, Yang, Jiang, Zhu & Gao, 2017).

In Ghana, these mining sectors pose serious dangers to human health and environment ground failures resulting from poorly supported stopes, have led to injuries and fatalities in recent times. It is recognised that small scale underground mining in Ghana is not dated with unsafe acts and conditions, including stope collapse, improper choice of working tools, absence of personal protective equipment, land degradation and inadequate monitoring of the operation(Bansah, Yalley & Dumakor-Dupey, 2016). Lack of regulatory enforcement by the minerals commissions of Ghana are major contributing factors to environmental, safety and national security issues of the operations. The cost of unsafe workplaces is horrific in personal, economic and social terms, and therefore require immediate attention from different perspectives such as safety climate (Bansah, Yalley & Dumakor-Dupey, 2016).

In Nigeria, 86.9% of respondents indicated that accidents do occur in quarry mines. The specific types of unsafe conditions or accidents that occur in the mines which were identified by mineworkers are presented as follows: accidents from stone debris, due to occasional falls and those resulting from stone cracks. Accidents from stone debris which could be generated from explosives, and which are used to blow up heavy rocks had, at various times, hit and killed some of the quarry mineworkers (Onwe, 2014).

In some of these cases, the miners had stayed very close to the targeted areas of blasts and had been hit by stone bits which usually move in a compressed force due to the blast and force caused by dynamites. Some of the workers who had died over the years had included men and women, and in some other cases, there had been such serious hits that even workers who stayed alive might not be able to work again, especially at the quarry mines due to the extent of injury sustained (Onwe, 2014).

Another unsafe acts is that accidents occur due to occasional falls by workers from hilly valleys created by years of mining, where the workers will have to carry stone lumps from pits of surface areas. There had been several falls with stones on their heads. The pictures taken by the researcher during the research work attests to these facts (Onwe, 2014).

In South Africa, the mining industry is a very important sector in the national economy. Unsafe acts by front-line operators and latent conditions in the organisation, coupled with human error accounted for the majority of these accidents. The results showed that although human error was involved in most of the accidents, other factors such as existing conditions, unsafe leadership climate and organisational factors also contributed (Bonsu, Van Dyk, Franzidis, Petersen & Isafiade, 2017).

The results show that while routine violations (45% of all accidents analysed) were the most common form of human error, problems in the physical environment of workers were the most common workplace factors (39.6% of all accidents analysed). Furthermore, inadequate leadership was found to be the most common systemic factor responsible for accidents (51.6% of all accidents analysed). Some workplace factors were more commonly associated with particular unsafe acts than others, and some systemic factors were more associated with particular workplace factors than others. The outcome of this study demonstrates that systemic factors, rather than human errors and violations, are chief causes of accidents in the mining sector (Bonsu, Van Dyk, Franzidis, Petersen & Isafiade, 2017).

2.3.3 Falling of rocks

The main cause of falling of rocks in mines is reported as taxonomic analysis, which identifies root causes of an incident and can provide future direction for corrective measures to reduce chances of occurrence of accidents. Human activities such as scaling, barring down, drilling or bolting and setting timbers accounted for another 34, 5 % of rock falling incidents. (Hoffmann, 2013). It has been found that workers who receive this kind of real life training are better prepared in the event of an accident. Because of risks associated with underground mining industry, it is imperative that companies that own mines demand that its employees engage in safe practices. It is in their best interest to protect the safety of their employees as injuries from falling rocks can be severe, and will almost certainly need to be covered by workers' compensation insurance (Hoffmann, 2013).

Rock falls are significant safety hazards in open pit mines and underground mine entries from open cut highwalls that need to be rigorously managed when designing portal entries for punch longwalls. The installation of restraining nets is a common practice to mitigate this hazard. The protective system, however, does not totally eliminate rockfall hazards as blocks can still detach and fall in between the net and the highwalls (Thoeni, Giacomini, Sloan, Lambert & Casagrande, 2011).

The National Institute for Occupation Safety and Health has made significant findings in the areas of best practices related training and improved fall warning devices. Improvements in technology, such as the use of personal bolter screens to prevent small falls and to reduce injuries have been found to provide significant protection to mineworkers in many instances (Rwodzi, 2011).

2.3.4 Falls and trips

Previous work has been done in the mining industry to identify contributing factors for injuries based on Mine safety and Health Administration reports of fatalities and non-fatal injuries. Although slips, trips and falls account for a large proportion of fatalities and non-fatal injuries, contributing factors associated with these incidents have not been adequately documented in the mining industry. To this end, publicly available Mine safety and Health Administration reports describing fatalities were coded to identify job categories, activities, causal factors, and contributing factors for slip, trip and fall fatalities at surface mining facilities. Labourer, equipment operator, mechanic/maintenance man and supervisor/management/trainer were job categories associated with a large proportion of fatalities. Maintenance and repair has been shown to be a hazardous task, and was found to result in slip, trip and fall fatalities. In addition, installation, construction and dismantling were common tasks at the time of incidents (DMME, 2012).

The cause of most fatalities involved in falls from height for both coal and metal/non-metal sectors relates to falling through an opening, failure of the ground/equipment, or being ejected from/thrown off of equipment being secondary causes. The most common contributing factor was the lack of fall protection or inappropriate use of fall protection. Inadequate barriers, equipment- related factors, and a lack of adequate operating procedure were also identified as contributing factors. To prevent slip, trip and fall fatalities, it is recommended that special attention be placed on maintenance, repair, construction and dismantling activities. In addition, appropriate and adequate barriers are installed when needed to prevent inadvertent access. Equipment is regularly inspected and maintained, and employees are provided with appropriate safety equipment. Safe working procedures are established and followed, and adequate training is provided (Nasarwanji, 2016).

2.3.5 Work experience

Coal mining has been found to be a dangerous occupation since the mining of coal began during colonial times. In many cases, young workers possess certain capabilities over older workers, including increased strength, speed and precision. They have less experience and training, which can hinder both their performance as well as safety. Many times, injuries and fatalities are not only a matter of youth, but are also due to inexperience. This can be attributed to a higher prevalence of temporary injuries due to inexperience (Margolis, 2010).

Ishtig, Jehan, Rehman, Sardar, Israr and Khan (2014) argue that older workers are not prone to injuries because they are able to use experience and resources more efficiently. A study conducted at a coal mine in Cherat, District of Nowshera, Khyber Pakhtunkhwa Pakistan between September 2012 and March 2013 found that often mineworkers who get injured are employees with 1-4 years of work experience, 5-8 and 15 years' work experience.

2.3.6 Age

Age is the period of time in which someone has been alive or something has existed. Mining is an economic sector with a high number of accidents. The majority of mineworkers who are injured during mine accidents are aged between 20 to 30 years. Most of the workers often experience higher injury rates during their first year in a new job. Employees under the age of 25 years are more likely to become injured on the job compared to old workers. It was found that young groups of workers were more likely to sustain work injuries than adults over 35 years. Although this indicates that young workers are more likely to become injured on the coal mining job, it clusters all older workers above the age of 35 in one group (Sanmiquel, Rossell & Vintro, 2015).

2.3.7 Human error

Historically, mining has been viewed as an inherently high-risk industry. Nevertheless, the introduction of new technology and a heightened concern for safety have yielded marked reductions in accident and injury rates over the last several decades. In an effort to further reduce these rates, human factors associated with incidents/accidents need to be addressed. A modified version of the Human Factors Analysis and Classification System was used to analyse incident and accident cases from across the state of Queensland to identify human factor trends and system deficiencies in mining. An analysis of the data revealed that skill-based errors were the most common unsafe acts and showed no significant differences across mine types. However, decision errors did vary across mine types. Findings for unsafe acts were consistent across the time period examined. By illuminating human causal factors in a systematic fashion, this study has provided mine safety professionals the information necessary to reduce mine incidents/accidents (Patterson & Shappell, 2010).

2.3.8 Unsafe workplace

An unsafe work environment occurs when an employee is unable to perform their required daily activities because physical conditions in the workplace are too dangerous. For instance, broken equipment, hazardous materials or asbestos and exposed wiring could pose an unsafe working environment for employees. Mining is notorious to be one of the most dangerous occupations, and there have been many serious accidents worldwide over the years. (Lenné, Salmon, Liu & Trotter, 2012).

Accidents that occur in mining include those that have resulted in significant loss of life over the years as well as health hazards that miners face on day to day basis. Most mining incidents occurred more frequently in operations concerning the use of surface mobile equipment and working at high places. However, injuries were more frequently associated with electrical problem operations, vehicles and machinery. In accordance with findings from previous studies on analysis of human factors classification system based analysis of aviation and medical incidents, efforts to reduce the frequency of unsafe acts should be directed to a few critical HFACS categories at higher levels such as organisational climate, planned inadequate operations and inadequate supervision (Lenné, Salmon, Liu & Trotter, 2012).

2.3.9 Natural disasters like earthquake/tremors

Thousands of human lives in mining are lost every year around the world, especially in India. Apart from significant damage on property due to natural disasters such as earthquakes, floods, tsunamis, hurricanes, landslides, heat waves and other storms, earthquake as the sudden movement of the earth’s crust causes destruction due to violent activities caused by volcanic action underneath the surface of the earth, which also causes accidents in the mining sector, resulting in injuries or fatalities to mineworkers. A disaster followed by fire and a strong explosion led to deaths of many workers because of carbon monoxide poisoning on May 13 2014 at a coal mine in Soma, Manisa, Turkey. The cause of the explosion was an underground mine fire that continued until the 15^{th} of May. The mine is situated in western Turkey. Unfortunately, from 787 workers that were underground, 301 people died in the disaster that is suspected to be caused by electrical equipment (Farahani, 2014).

Flooding is also a big danger and can occur due to uncontrolled surface runoffs such as flash flooding caused by heavy rain. These floods can also damage pit walls in underground mines, which can cause a collapse, which can be extremely dangerous, and in many cases, cause fatalities or injuries to mineworkers. The Queenlands Resources Council reported that flooding and cyclones have cost the mining industry $5 billion in lost production, and that this figure could rise with many mines still waterlogged (Goswami, Chakraborty, Ghosh, Chakrabarti & Chakraborty, 2018).

2.4 CONCLUSION

In this chapter, the researcher reviewed relevant information about occupational accidents at a coal mine in Waterberg District in Limpopo Province by focusing on the health and safety training offered to mine workers, causes of occupational accidents in mines such as occupational hazards at the workplace, unsafe acts in the mine, falling of rocks, falls and trips, work experience, age, human error, unsafe workplace and natural disasters like earthquake/tremors.

CHAPTER 3: METHODOLOGY

3.1 INTRODUCTION

This chapter focuses on the nature of the study, research design, study site, population as well as sampling procedure, inclusion and exclusion criteria and analysis plan. The chapter also discusses the validity and reliability of study, and tests the pilot study. Ethical considerations are also included in the study.

3.2 RESEARCH METHODS AND DESIGN

Quantitative research is an approach for testing objective theories by examining relationships among variables. These variables can be measured typically by instruments so that numbered data can be analysed using statistical procedures (Creswell, 2013).

The study used quantitative research as a methodology because the researcher wanted to make a broader explanation, and to come to a broader understanding of occupational accidents at Exxaro Grootegeluk Coal Mine in Waterberg District in Limpopo Province.

Research design can be defined as a plan outlining how observations will be made and how the researcher will carry out the project, which may seem similar to the descriptions (Devos, Strydom, Fouche & Delport, 2011). The study used a cross-sectional study design. Cross-sectional study defined as the type of research design in which you collect data from many different individuals at a single point in time or it also used to describe a study sample and to provide baseline information at the start of an experiment (Arlene, 2014).The researcher do not allowed doing follow-ups at the coal mine respondents because the study conducted only once.

3.3 STUDY SITE

The study was conducted at Exxaro Grootegeluk Coal Mine, which is an open cast coal mine in Waterberg coalfield, Limpopo Province, South Africa. The mine is 25 kilometres or 16 minutes away from Lephalale. It is located on the west of Lephalale and employs 800 people who work in high risk areas like blasting, drilling, digging and loading.

3.4 POPULATION

Population is a complete set of persons or objects that process common characteristics that are of interest to the researcher (Brink, Van der walt & Van rensburg, 2012). In this study, the target population was mineworkers who work in high risk areas like blasting, drilling, digging and loading at the coal mine.

3.5 SAMPLING

Sampling is a portion or a subset of a larger group called population, and is a technique from which a sample is drawn from the population (Tim, 2011). The study used probability sampling as a type of sampling method. Probability sampling refers to the gold standard of creating a representative sample (Neuman, 2014).

In this study, simple random sampling was used as a type of probability sampling because all mineworkers who worked in high risk areas like blasting, drilling, digging and loading, both male and female were selected in the study. Simple random sampling is a sample in which every subject or unit has an equal chance of being selected in the study (Arlene, 2014).

A sampling error of 0.05 was used to calculate the sample. The SLOVIN formula was used to determine the N, which was population size, n which was sample size and the E, which was a sample error. The sample size was determined as follows:

$n = N/1 + N E^2$

$= 800/1 + 800(0.05)^2$

$= 800/1+800(0.0025)$

$= 800/1+2$

$= 800/3$

$= 266.6$ sample size

As calculated above, the sample size was 266.6.

3.6 DATA COLLECTION

Data collection is defined as being a systematic gathering of information, which is relevant to the research purpose, or the specific objectives of the study. Arlene (2014) defines this technique as the processes employed by researchers through the process of research. For the study, questionnaires were used, as they are a suitable method of collecting data at one point in time. The questionnaires were relevant to the study because the researcher was able to reach a large population of mineworkers at once.

3.7 DATA ANALYSIS

After questionnaires were returned. They were screened to eliminate those that were incomplete as well as those in which the same question was answered throughout, which indicated that some of the respondents had not read the questions. This procedure was immediately followed by the capturing of data on a Microsoft Excel computer package. The Excel document was then imported into the IBM SPSS Statistics Version 26 where it was coded in preparation for data analysis. The data analysis involved several rigorous statistical tests such as reliability tests, descriptive statistics and inferential statistics**.** A comprehensive diagrammatic representation of the research path adopted for data analysis in the current study is also made in the next section.

3.7.1 Descriptive Statistics

Descriptive statistics are techniques that help to state characteristics or appearance of sample data (Zikmund, et al., 2013, p. 54). Frequency tables and the mean score ranking technique are major descriptive statistics employed in this study.

3.7.2 Frequency distributions

Frequency distributions such as percentages, graphs, line charts, pie charts, histograms and bar charts were utilised to display research findings. Frequency distributions are used to depict absolute and relative magnitudes, differences, proportions and trends (Zikmund, et al., 2013). These methods use both horizontal and vertical bars to examine different elements of a given variable (Malhotra, 2011). The use of frequency distributions was facilitated by 286 respondents.

3.8 INCLUSION AND EXCLUSION CRITERIA

3.8.1 Inclusion criteria

The study involved both male and female mineworkers who work in high risk areas like blasting, drilling, digging and loading.

3.8.2 Exclusion criteria

The researcher excluded mineworkers with one year working experience and those who were absent during the day of conducting the study.

3.9 RELIABILITY AND VALIDITY

3.9.1 Reliability

Reliability is the extent to which a measuring instrument is repeatable and consistent (Jahangiri, Rostamabadi, Malokzadeh, Sadi, Hamzavi & Maree, 2012). In this study, in order to ensure reliability, pilot testing (study) was done in a different environment from where the research conducted and the few changes on data collection instrument was made on the age section, period of working and work section.

3.9.2 Validity

Validity refers to how well an idea fits with actual reality (Creswell, 2013). The study ensures that the data collection instrument was cross-checked. The following are three types of validity:

3.9.2.1 Face validity

Face validity is a subjective judgment on the operationalization of a construct (Taherdoost, 2016). The researcher presented the questionnaire to the research supervisor to verify or cross-check if it measured what it was supposed to measure.

3.9.2.2 Content validity

Content validity is defined as the degree to which items in an instrument reflect the content universe to which the instrument will be generalised (Taherdoost, 2016). In this study, the researcher submitted the questionnaire to the supervisor to evaluate if the questions asked reflected the concepts being studied.

3.9.2.3 Construct validity

Construct validity refers to how well you translate or transform a concept, idea, or behaviour that is a construct into a functioning and operating reality, the operationalization (Taherdoost, 2016). The researcher ensured that he was available when respondents completed the questionnaire so that he could be able to give clarification and advice.

3.10 ETHICAL CONSIDERATIONS

Ethics refers to norms for conduct that distinguish between acceptable and unacceptable behaviour (Resnik, 2015). The researcher used the following four ethics:

3.10.1 Ethical clearance

In this study, the researcher obtained a clearance certificate from Turfloop Research and Ethics Committee before commencing with the study. After that the researcher also requested permission to conduct the study from the mine management and mine workers.

3. 10.2 Informed consent

This means that respondents should be given adequate information to enable them to make a decision about whether or not to take part in the study (Ritchie, Lewis, McNaughton & Ormston, 2014). The researcher informed respondents about the aim of the study as well as the rights to withdraw from the study without any penalties and the procedure as to how the research was being conducted. The research obtained consent from the respondents verbally.

3. 10.3 Confidentiality

The researcher should do everything possible to maintain confidentiality and anonymity in research. This means not disclosing who has taken part and not reporting what they say in ways that could identify them or be attributed to them (Ritchie et al, 2014). In this study, the researcher ensured confidentiality because he wanted respondents to keep the questionnaires in a proper manner and not to discuss them with any other person. The researcher also ordered not to disseminate results that have obtained. These results may also concern information that was not related to an individual. The research record be kept locked and password protection used for data stored electronically to ensure that data was safely kept from access by unauthorized persons.

3. 10.4 Anonymity

Anonymity has traditionally been considered one of the elements of research ethics, the purpose of which is to protect respondents from harm. Anonymity is defined as the process of not disclosing the identity of research participants (Vainio, 2013). The study ensured that there was no harm and did not reveal respondents' identity to anyone except the supervisor. Therefore the researcher maintained confidentiality throughout the study and also when the findings reported the respondents' particulars remained anonymous.

3.11 CONCLUSION

The chapter was about the research design and methodology. It also looked at the nature of the study, research design and study site. The population of the study was explained. The chapter also covered the sampling procedure and how the sample size was calculated, inclusion and exclusion criteria, reliability and validity of the study. Ethical considerations were also followed in a proper manner.

CHAPTER 4: DATA PRESENTATION AND ANALYSIS

4.1 INTRODUCTION

The previous chapter discussed structural and fundamental methodological components relevant to the present study. The current chapter examines approaches used in dealing with the data that was captured for the study. All data were accessed from the research questionnaires which were distributed with a view to quantitatively examining causes of occupational accidents among mineworkers at a coal mine in Waterberg District of Limpopo Province. The target sample frame consisted of mine workers working in high-risk areas such as blasting, drilling, digging and coal mining.

The current chapter begins by discussing the framework that was used to analyse and interpret the data before describing characteristics of research respondents. This is followed by an analysis of results of the study aimed at quantitatively examining causes of occupational accidents among mineworkers at the coal mine in Waterberg District of Limpopo Province. Most of the results in the current chapter are presented either through a tabular arrangement or in a diagrammatic format.

4.2 Statistical analysis

After questionnaires were returned. They were screened to eliminate those that were incomplete as well as those in which the same question was answered throughout, which indicated that some of the respondents had not read the questions. This procedure was immediately followed by the capturing of data on a Microsoft Excel computer package. The Excel document was then imported into the IBM SPSS Statistics Version 26 where it was coded in preparation for data analysis. The data analysis involved several rigorous statistical tests such as reliability tests, descriptive statistics and inferential statistics**.** A comprehensive diagrammatic representation of the research path adopted for data analysis in the current study is also made in the next section.

4.2.1 Descriptive Statistics

Descriptive statistics are techniques that help to state characteristics or appearance of sample data (Zikmund, et al., 2013). Frequency tables and the mean score ranking technique are major descriptive statistics employed in this study.

4.2.2 Frequency distributions

Frequency distributions such as percentages, graphs, line charts, pie charts, histograms and bar charts were utilised to display research findings. Frequency distributions are used to depict absolute and relative magnitudes, differences, proportions and trends (Zikmund, et al., 2013). These methods use both horizontal and vertical bars to examine different elements of a given variable (). The use of frequency distributions was facilitated by 286 respondents.

4.3 Demographical information

Section A of the questionnaire elicited information pertaining to demographic characteristics of respondents. In order to understand the general nature of respondents, their socio-demographic profiles were sought. This section of the study presents the demographic information of respondents with the intention of providing their profiles (without the names). The demographical profiles of respondents address the following attributes: their age, experience, gender, marital status, level of education, employment status and work section.

4.3.1 Age distribution of respondents

Respondents were required to indicate their ages in order to establish whether age had any impact on occupational accidents among mineworkers at the coal mine in Waterberg District of Limpopo Province.

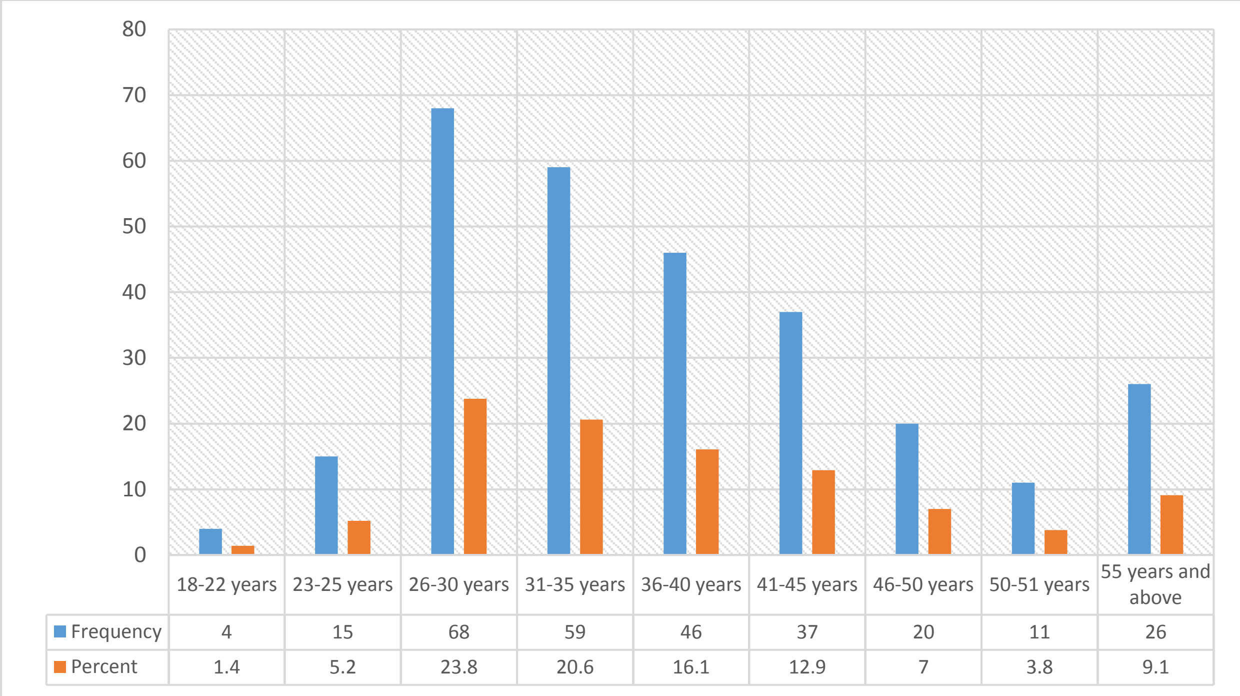


Figure 1: Age distribution of respondents

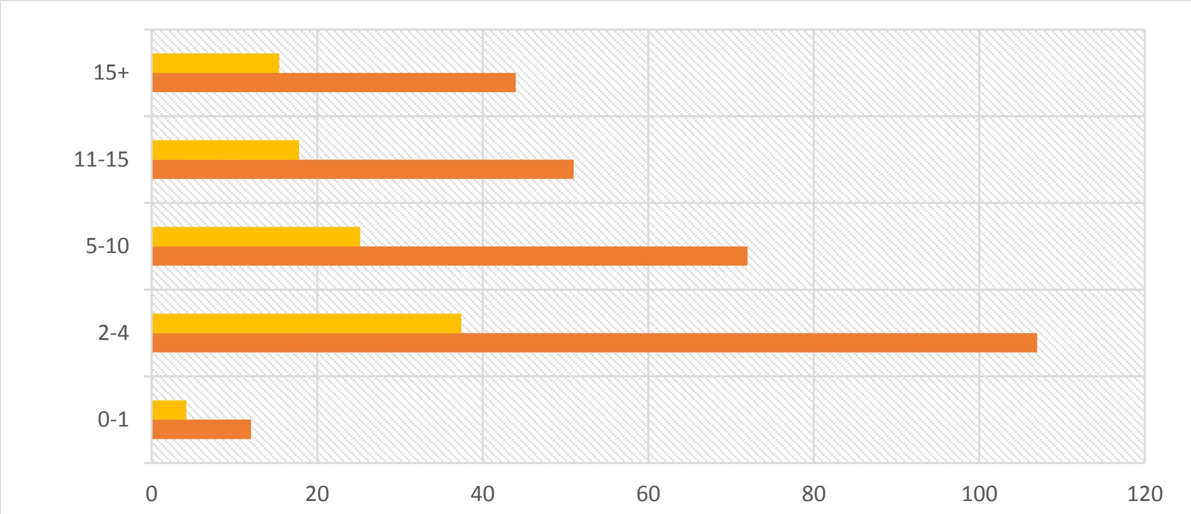
Figure 1 indicates that the majority of respondents (24%) were between 26 and 30 years of age, followed by those between 18 and 22 years at 1.4% (n=4) and between 23 and 25 years of age at 5.2% (n=15). The figure further indicates that 21% (n=59) of respondents were between 31 and 35 years of age; 16% (n=46) were between 36 and 40; 13% (n=37) between 41 and 45; 7% (n=20) between 46 and 50; 4% (n=11) between 50 and 51 years of age and 9% (n=26) of respondents were above 55 years old.

The study found that most of mine workers (N=68) who worked at the coal mine are between the ages of 26 and 30 years, followed by those between the ages of 31 to 35 (N=59). It is also found that those who were between the ages of 36-40 years are (N=46). The results show that most of the mine workers who worked at the coal mine in Waterberg District in Limpopo Province are between the ages 26 and 30 years. A study conducted by Dominguez, Martinez, Peña and Ochoa (2019) shows that in Mexico, mineworkers who were injured or had fatal cases during mine accidents are aged ranging between 30-39 years.

4.3.2 Years of working experience

The researcher solicited information on the number of years of working experience that respondents have in their current positions. A study conducted at a coal mine in

Cherat, District of Nowshera, Khyber Pakhtunkhwa Pakistan between September 2012 and March 2013 found that often mineworkers who get injured are employees with 1-4 years of work experience, 5-8 and 15 years' work experience. Figure 2 below presents results of registry officers who participated in the study.



	0-1	2-4	5-10	11-15	15+
Percent	4.2	37.4	25.2	17.8	15.4
Frequency	12	107	72	51	44

Figure 2; Years of working experience

Figure 2 shows that the majority of respondents at 107 (37%) had minimal experience between 2 and 4 years of age. This is followed by 5 to 10 years of experience at 72 (25 percent). The analysis also showed that only 12 (25%) served for 0-2 years, 51 (18%) for 11-15 years and 44 (15%) worked for more than 15 years.

The study found that majority of respondents mine workers who worked at the coal mine in Waterberg District in Limpopo Province had work experience of between 2 to 4 years while those who had a work experience of 5 to 10 years were (N=72). Often injuries and fatalities are not only a matter of youth, but are also due to inexperience. A study conducted by Kanji, Khoza-Shangase and Ntlhakana (2019) found that 58% of participants younger than 60 years and those who are 21-30 years of work experience had the highest incidence.

4.3.3 Gender of respondents

There was a need to determine the gender of respondents in order to enable the researcher to make their biographical inferences. Figure 3 depicts the gender of respondents.

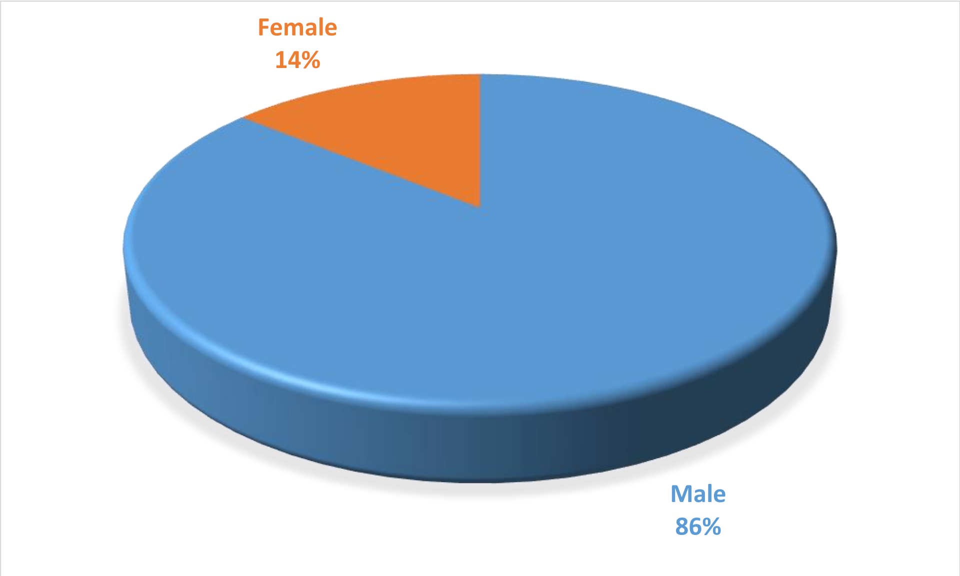


Figure 3: Gender of respondents (n=286)

Figure 3 shows that male respondents constitute 86% of the respondents, and dominate their female counterparts, who constitute the remaining 14%. These results indicate that majority of respondents in this study are males.

4.3.4 Marital status

There was a need to determine the marital status of respondents in order to enable the researcher to make their biographical inferences. Figure 4 depicts the marital status of respondents.

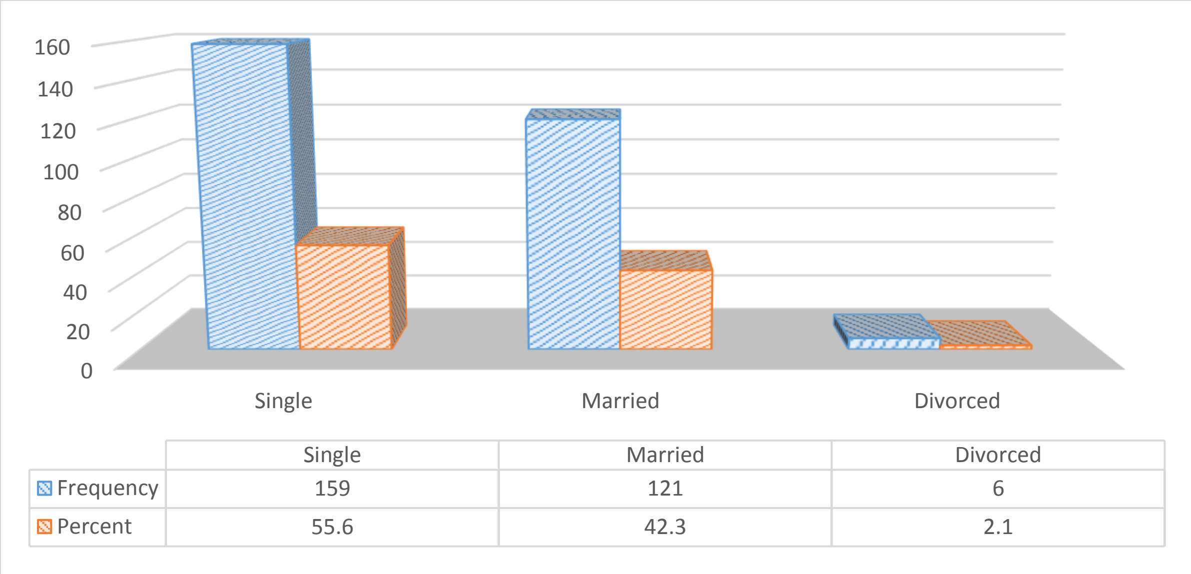


Figure 4: Marital status of respondents (n=286)

Figure 4 shows that the majority of respondents are single at 159(55,6%), compared to married respondents at 121(42,3%) and 6(2,1%) divorced respondents. The results show that majority of respondents who worked at coal mine are single. This is followed by the married ones, who are in the minority.

4.3.5 Level of education

Respondents were required to indicate their level of education in order to establish whether educational background had any impact on occupational accidents among mineworkers at the coal mine in Waterberg District of Limpopo Province. Figure.5 depicts the level of education of respondents.

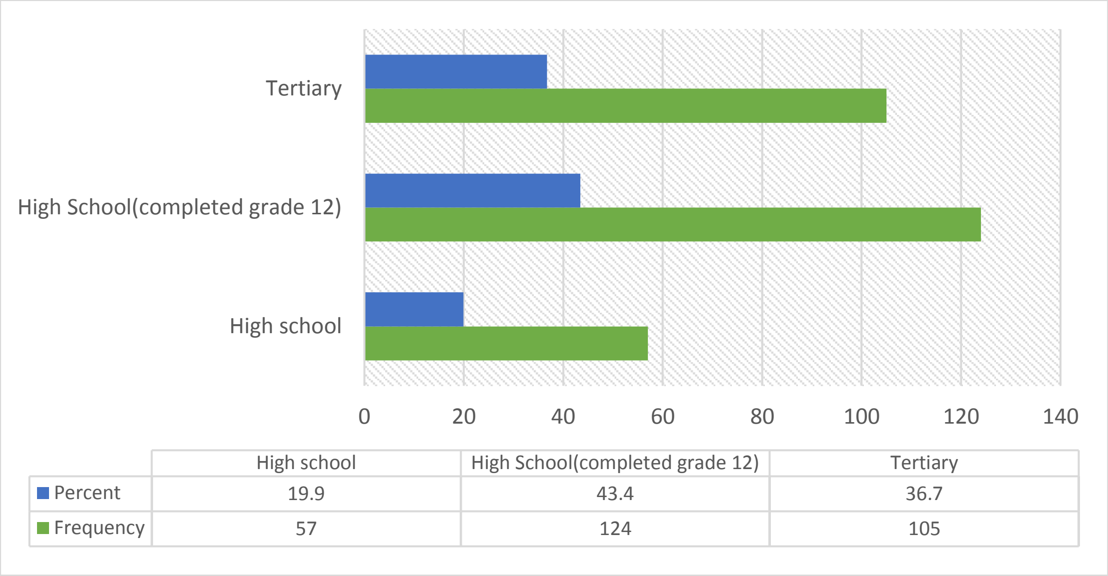


Figure 5: level of education of respondents (n=286)

Figure 5 shows that the majority of respondents (N=124) had completed grade 12. This is followed by those with tertiary qualifications (N=105). The analysis also shows that 57(19,9%) employees were not able to complete high school.

4.3.6. Employment status

There was a need to determine the employment status of respondents in order to enable the researcher to make their biographical inferences. Figure 6 depicts the employment status of respondents.

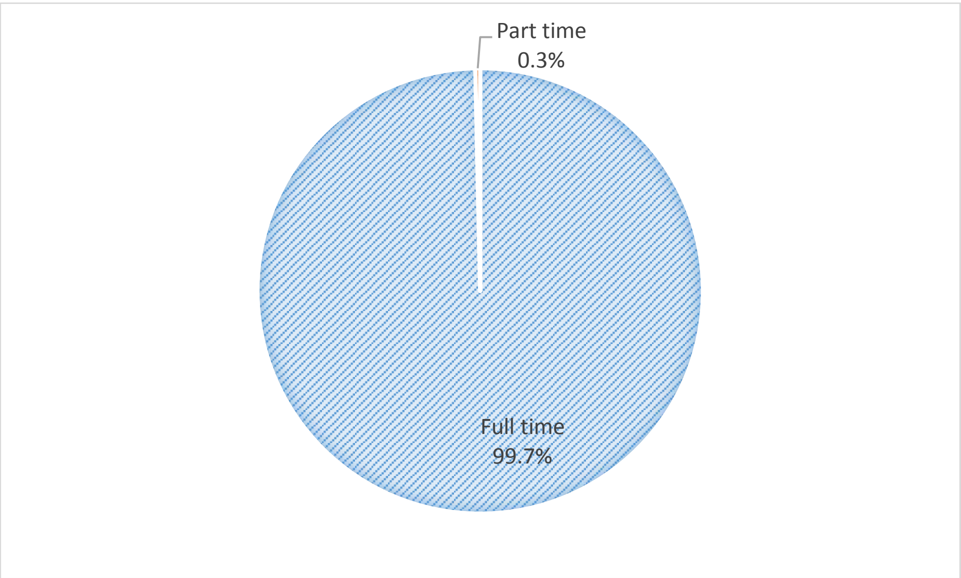


Figure 6: Employment status of the respondents (n=286)

Figure 6 shows that full time respondents constitute 99,7% of the respondents, and dominate their part-time counterparts, who constitute the remaining 0,3%. These results indicate that the majority of respondents in this study worked full-time compared with part-time respondents.

4.3.7 Work section

The respondents were required to indicate their work section in order to establish whether this had any impact on occupational accidents among mineworkers at the coal mine in Waterberg District of Limpopo Province. Table 1 depicts the work section of respondents.

Table 1: Work section of respondents (n=286)

	Frequency	Percent
Mining Operation	267	93.4%
Mining Engineering	2	0.7%
Plant Operation	16	5.6%
Plant Engineering	1	0.3%
Total	286	100%

Table 1 shows that the majority of respondents (N=267) worked at a mining operation section. They are followed by 16 respondents who worked at a plant operation section. The analysis also showed that only few (N=2)) worked at a mining engineering section and plant engineering section (N=1).

4.4 Reliability testing

Throughout the analysis, Cronbach's alpha was used as an intrinsic accuracy test measurement. Cronbach's alpha is also called a test of the homogeneity of the element. The size of the Cronbach reliability measure varies from 0 to 1. Scores close to 1 mean that the instrument has good reliability, and scores close to 0 suggest that the reliability of the instrument is very poor (Wells & Wollack, 2003:). In this study, the Statistical Package for the Social Sciences (SPSS Version 26.0) was used to test the reliability of the measuring instrument. Cronbach’s alpha test proved to be both appropriate and handy as it provided a summary of inter-correlations that existed among items on causes of occupational accidents among mineworkers at the coal mine in Waterberg District of Limpopo Province.

Table 2: Reliability testing

	Cronbach's Alpha	Average Inter-Item Correlation	N of items
Health and safety training offered to mine workers	0.457	0.135	7
Equipment and workplace design	0.584	0.149	8
Provision and use of personal protective equipment and availability of signage	0.627	0.237	6
Overall	0.672	0.107	21

From the findings given in Table 2, the alpha value of Cronbach for each test definition varies from 0.457 to 0.672 and is thus all above the appropriate value of 0.70, while the average alpha value of Cronbach is 0.672, which is in a reasonable limit as suggested by Wells and Wollack (2003). In fact, the significance of the typical inter-item correlation is higher than the minimum reasonable value of the correlation.

4.5 Summary statistics of all variables

4.5.1 Health and safety training offered to the mine workers

Respondents were required to indicate the health and safety training offered to mine workers in order to establish whether health and safety training offered had any impact on occupational accidents among mineworkers at the coal mine in Waterberg District of Limpopo Province. Table 3 depicts the health and safety training offered to the mine workers.

Table 3: Summary of responses to items measuring health and safety training offered to mine workers

Item No	Statements	Agree	Do not know	Disagree	Total
B1	I received training hazard identification	95%	2%	3%	100%
B2	I know how to manage identified hazards at work	97%	3%	1%	100%
B3	Newly appointed employees are offered induction training before they perform their duties	98%	2%	0%	100%
B4	I received training regarding the use of equipment/machinery	97%	2%	1%	100%
B5	I received training on how to handle substances at work	91%	6%	3%	100%
B6	Only those who are trained to operate machinery or handle substances are allowed to perform such duties	95%	2%	2%	100%
B7	I receive training every year at the workplace	85%	4%	11%	100%

Table 3 shows that majority of respondents (95%) agree that they receive training on hazard identification whereas few (3%) disagree, and very few (2%) do not know. The majority of respondents (97%) agree that they know how to identify hazards at work but few (3%) do not know. Most workers (98%) agree that newly appointed employees are offered induction training before they perform their duties while few (2%) do not know. Those who received training regarding the use of equipment/machinery are 97% and those who do not know are 2%.

The majority (91%) agree that they received training on how to handle substances at work compared to those who do not know (6%) and (3%) disagree. This indicates that only those who are trained to operate machinery or handle substances are allowed to perform such duties (95%) whereas those who do not know are few (2%). Most of the workers (85%) agree that they receive training every year at the workplace but few (11%) disagree, whereas 4% do not know.

The study found that majority of mine workers who worked at the coal mine in Waterberg District in Limpopo Province were receiving training of hazards identification and know how to manage and identify hazards at work. This means that the coal mine in Waterberg District in Limpopo Province complies with the health and safety training offered to mineworkers.

Tripathy and Ala (2018) also found that in west of Australia, the first workshop which was provided to coal miners was about hazard identification, and the second one was about managing workplace hazards. The total number of employees who received training were 77, 54 of which were a contracting company and 23 direct employees.

This study found that most of the mine workers who worked at the coal mine in Waterberg District in Limpopo Province are offered induction training before they perform their duties at work. The fact that the coal mining company provided health and safety training to mine workers showed the following things: reduction of cost, adherence to health and safety regulation compliance, reduction of occupational accidents, occupational injuries and occupational fatalities. Parmenter and Trigger (2018) also found that the coal miners were provided with training which was based on the induction and refresher training, which was designed for all ranks of mine officials, and focused on problems that represent great risks to health and safety.

4.5.2 Equipment and workplace design

Respondents were required to indicate their equipment and workplace design in order to establish whether these had any impact on occupational accidents among mineworkers at the coal mine in Waterberg District of Limpopo Province. Figure 9 depicts respondents' equipment and workplace design.

Table 4: Summary of responses on items measuring equipment and workplace design

Item No	Statements	Agree	Do not know	Disagree	Total
C1	Equipment that we use is serviced regularly	87%	7%	6%	100%
C2	Equipment that we use is in a good working condition	81%	4%	14%	100%
C3	Equipment that we use is relevant to the task being performed	95%	2%	3%	100%
C4	The surface at my workplace is slippery	72%	8%	20%	100%
C5	The surface at my workplace is uneven	82%	5%	13%	100%
C6	I work in a congested area	53%	16%	31%	100%
C7	I work in a noisy place but provided with hearing protection	89%	3%	8%	100%
C8	I work in a dusty place but provided with dust mask	93%	2%	5%	100%

The table above shows that 87% of workers agree that the equipment that they use is serviced regularly, 7% do not know while 6% disagree.

Most of the workers (81%) agree that equipment that they use is in a good working condition compared to those who do not know (4%). The table also indicates that 95% agree that the equipment that they use is relevant to the task being performed while 3% disagree and 2% do not know. The table further shows that 72% agree that the surface at their workplace is slippery whereas 20% disagree and 8% do not know. The majority (82%) agree that the surface at the workplace is uneven compared with 13% who disagree and 5% of respondents who do not know. A slightly higher percentage of workers (53%) agree that they work in a congested area whereas few (31%) disagree and fewer (16%) do not know. Most workers (89%) agree that they work in a noisy place but provided with hearing protection while 8% of the respondents disagree and 3% do not know. The majority of workers (93%) reported that they work in a dusty place but provided with dust masks whereas few (5%) disagree.

This study found that majority of mine workers who worked in Limpopo Waterberg District coal mine agree that they work in a dusty place but they are provided with dust masks so that they are not exposed to dust. This shows that coal mines adhere to the equipment as well as the workplace design. This also parts of the prevention of occupational health hazards at the coal mine. It reduces sick leaves, absenteeism in the workplace and occupational accidents.

Longinos, Qadris and Parlatuna (2017) also found that coal miners in Pakistan were working with dust masks in order to prevent them from exposure of coal dust. Han, Li, Yan, Xie, Wang, Wu, Ji, Zhu and Ni (2018) further found that coal miners in China wore coal dust masks to prevent them from inhaling or exposure to coal dust.

This study also found that majority of mine workers who worked at the coal mine in Waterberg District in Limpopo Province work in a noisy place but are provided with hearing protection. This means that coal mines in Waterberg District in Limpopo Province comply with the equipment and workplace design standards.

Moroe, Khoza-Shangase, Madahana and Nyandoro (2019) found that most mineworkers in South African coal mines were exposed to high levels of occupational noise but they are provided with hearing devices in order to prevent them from the disability of hearing loss caused by occupational-induced noise. Kanji, Khoza-

Shangase and Ntlhakana (2017) also found that coal miners in South Africa were provided with hearing protection devices and attend hearing conversation programmes in mines in order to reduce and prevent auditory health hazards due to occupational noise.

4.5.3 Provision and use of personal protective equipment and availability of signage

Respondents were required to indicate their provision and use of personal protective equipment and the availability of signage in order to establish whether it had any impact on occupational accidents among mineworkers at the coal mine in Waterberg District of Limpopo Province. Figure 10 depicts the provision and use of personal protective equipment and availability of signage of respondents.

Table 5:Summary of responses on items measuring provision and use of personal protective equipment and availability of signage

Item No	Statements	Agree	Do not know	Disagree	Total
D1	I am provided with correct PPE to perform my daily tasks	97%	1%	2%	100%
D2	I always have PPE to use at work	97%	0%	3%	100%
D3	I always put on PPE before I start working	99%	0%	1%	100%
D4	There is enough warning signs at my workplace	94%	3%	2%	100%
D5	Warning signs at my workplace are visible	93%	1%	5%	100%
D6	I can differentiate between colour-codes	94%	4%	2%	100%

Table 5 above shows that the majority of respondents (97%) agree that they are provided with correct PPE to perform their daily tasks, 1% do not know while 2% disagree. This indicates that 97% agree that they always have PPE to use at work compared to respondents (3%) who disagreed.

The majority (99%) agree that they always put on PPE before starting work whereas 1% disagree. The table further shows that 94% of respondents agree that there are enough warning signs at the workplace, and 2% disagreed. Most of the respondents (93%) agreed that warning signs at their workplace are visible compared to few (5%) who disagreed. The majority of respondents (94%) agree that they can differentiate between colour-codes, 4% do not know while 2% disagree.

This study found that majority of mineworkers who worked at the coal mine in Waterberg District in Limpopo Province agreed that they are provided with correct personal equipment to perform their daily tasks, and they always have personal protective equipment to use at work. This means that the coal mine at Waterberg District in Limpopo Province adhere to the provision and use of personal protective equipment as well as the availability of signage. It is also good to invest in safety protection because this minimises occupational accidents and injuries at the coal mining industry.

A study conducted by Nikulin, Ikonnikov and Dolzhikov (2019) found that most mine workers in the Russian coal mine federation were provided with correct use of personal protective equipment to perform their daily tasks at work. Longinos, Qadris and Parlatuna (2017) also found that coal miners in Pakistan were provided with hand personal protective equipment like gloves, legs personal protective equipment like safety boots, body personal protective equipment like uniforms and head personal protective equipment such as hats in order to prevent them from getting injured at the work environment.

4.6 Inferential results

Results are based on the following aim and objectives of the study.

Aim of the study

To find out causes of occupational accidents among mineworkers at a coal mine in Waterberg District of Limpopo Province.

Objectives of the study

To determine types of health and safety training offered to mineworkers.

To find out types of mine hazards at a coal mine in Waterberg District of Limpopo.

4.6.1 Analysis of Variance (ANOVA)

A one-way between subject's ANOVA was conducted to compare causes of occupational accidents among mineworkers at a coal mine in Waterberg District of Limpopo Province.

Table 6: Analysis of Variance

		Sum of Squares	df	Mean Square	F	Sig.
Health and safety training offered to mine workers	Between Groups	19.925	3	6.642	4.240	.006
	Within Groups	441.698	282	1.566		
	Total	461.622	285			
Equipment and workplace design	Between Groups	129.120	3	43.040	6.653	.000
	Within Groups	1824.254	282	6.469		
	Total	1953.374	285			
Provision and use of personal protective equipment and availability of signage	Between Groups	19.142	3	6.381	4.517	.004
	Within Groups	398.344	282	1.413		
	Total	417.486	285			

4.6.1.1 Health and safety training offered to the mine workers

A one-way between subject's ANOVA was conducted to compare causes of occupational accidents among mineworkers at a coal mine in Waterberg District of Limpopo Province. There was a significant effect on the health and safety training offered to the mine workers at the $p<.05$ level for the three work sections [$F(3, 282) = 4.240$, $p = 0.006$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the three work sections i.e mining operation ($M = 7.64$, $SD = 1.262$) was significantly different from mining engineering ($M = 9.5$, $SD = 3.536$). However, the plant's operation ($M = 7.31$, $SD = 0.602$) did not significantly differ from mining operation and mining engineering.

Taken together, these results suggest the provision of health and safety training offered to mine workers in different work sections.

4.6.1.2 Equipment and workplace design

The second objective was that there was a significant effect on the equipment and workplace design at the $p<.05$ level for the three work sections [F (3, 282) = 6.653, p = 0.000]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the three work sections i.e mining operation (M = 10.31, SD = 2.511) was significantly different from mining engineering (M = 13.00, SD = 4.243). However, the plant operation (M = 12.69, SD = 2.938) did not significantly differ from the mining operation and mining engineering. Taken together, these results suggest the provision of equipment and workplace design in different work sections.

4.6.1.3 Provision and use of personal protective equipment and availability of signage

The third objective was that there was a significant effect on the provision and use of personal protective equipment and the availability of signage at the $p<.05$ level for the three work sections [F (3, 282) = 4.517, p = 0.004]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the three work sections, i.e. mining operation (M = 6.35, SD = 1.020) was significantly different from mining engineering (M = 8.00, SD = 28.28). However, the plant operation (M = 7.31, SD = 2.750) did not significantly differ from the mining operation and mining engineering. Taken together, these results suggest the provision and use of personal protective equipment and availability of signage in different work sections.

4.7 Conclusion

The chapter presented the study data. Most of the data in the chapter were presented through a tabular arrangement or in a diagrammatic format and the data were collected using self-administered questionnaires. The study was quantitative in nature. The instrument was divided into four sections and the chapter consists of 6 tables as well as 6 figures.

CHAPTER 5 DISCUSSION OF MAJOR FINDINGS

5.1 Summary

The study results show that the majority of mine workers at 24% who worked at the coal mine in Waterberg District in Limpopo Province were between the ages of 26 and 30 years, followed by 59 or 21% of those between the ages of 31 to 35. 107(37%) had work experience of between 2 to 4 years and 124(43,4%) completed grade 12. 95% of them received training in hazards identification while 97% know how to identify hazards in the workplace. The study further found that majority of the mine workers or 93% agree that they work in a dusty place, but are provided with dust masks. 99% agree that they always put on personal protective equipment before starting work. 97% agree that they are provided with correct personal protective equipment to perform their daily tasks.

This means that the coal mine at Waterberg District in Limpopo Province complies with the health and safety training offered to mineworkers. The mine workers exposed to health hazards such as dust and noise exposure but they provided with the relevant personal protective equipment. They comply with the equipment and workplace design standards. They are also adhere to the provision and use of personal protective equipment as well as the availability of signage.

5.2 Recommendations

The study recommends that Exxaro Grootegeluk Coal Mine Company must also increase to employ/hire more female because male mineworkers are so many than female's mineworkers. The researcher recommends that Exxaro Grootegeluk Coal Mine should continue make the mine workers provided with health and safety related training and with correct personal protective equipment to perform their daily tasks. The study also recommends that each coal mine company's employers must continue implement what has been mentioned in legislations such as Mine health and safety act as well as occupational health and safety act.

5.3 Conclusion

The chapter was about the discussion of the major findings focused on summary and recommendations. The study concluded that mine workers who worked at Exxaro

Grootegeluk Coal Mine are provided with health and safety related training and with correct personal protective equipment to perform their daily tasks.it was also concluded that mine workers exposed to health hazards such as dust and noise exposure but they provided with the relevant personal protective equipment.

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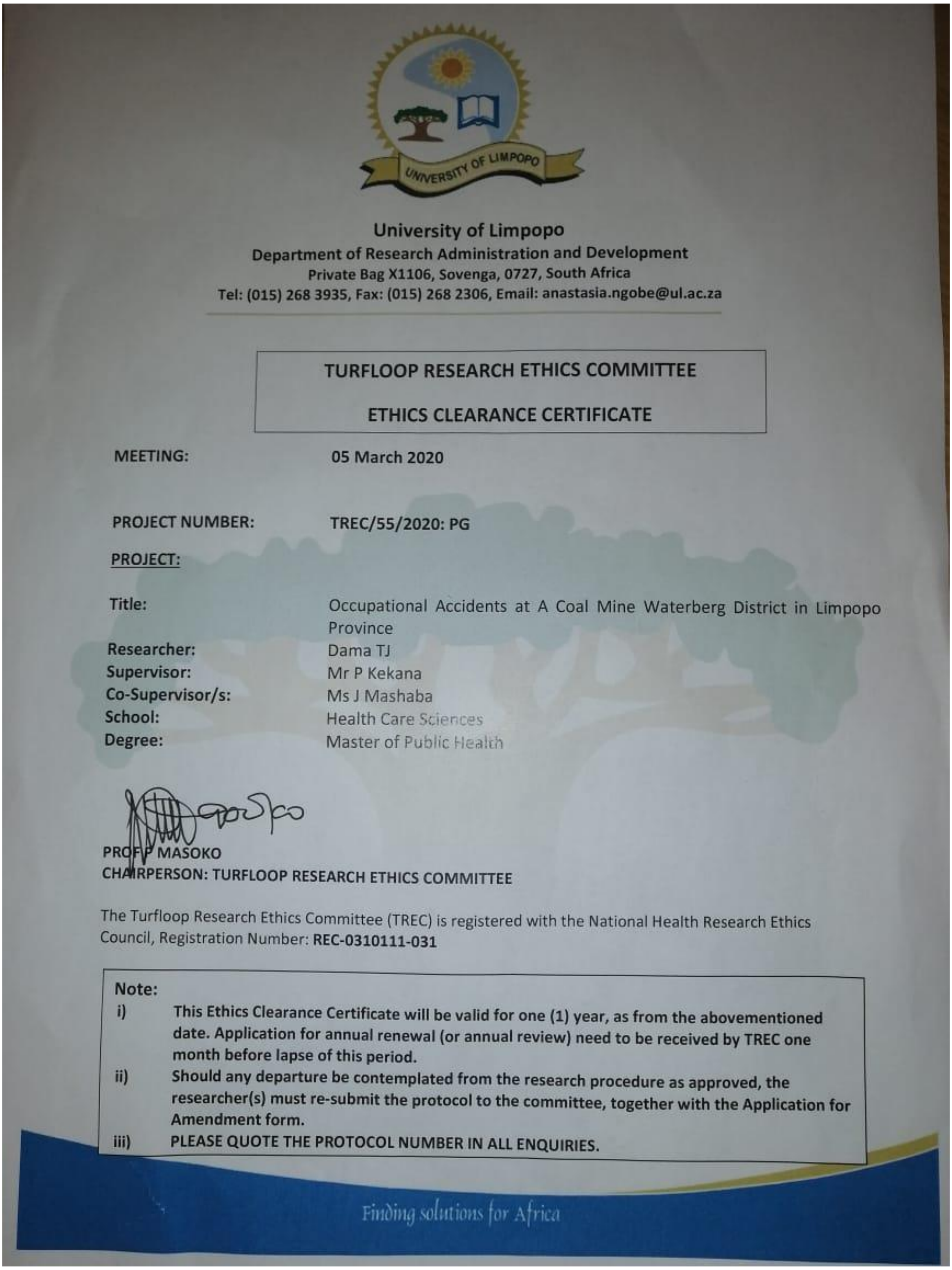
APPENDICES

Appendix 1



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TURFLOOP RESEARCH ETHICS COMMITTEE

ETHICS CLEARANCE CERTIFICATE

MEETING:	**05 March 2020**
PROJECT NUMBER:	**TREC/55/2020: PG**
PROJECT:	
Title:	Occupational Accidents at A Coal Mine Waterberg District in Limpopo Province
Researcher:	Dama TJ
Supervisor:	Mr P Kekana
Co-Supervisor/s:	Ms J Mashaba
School:	Health Care Sciences
Degree:	Master of Public Health

PROF P MASOKO

CHAIRPERSON: TURFLOOP RESEARCH ETHICS COMMITTEE

The Turfloop Research Ethics Committee (TREC) is registered with the National Health Research Ethics Council, Registration Number: **REC-0310111-031**

Note:

i) **This Ethics Clearance Certificate will be valid for one (1) year, as from the abovementioned date. Application for annual renewal (or annual review) need to be received by TREC one month before lapse of this period.**

ii) **Should any departure be contemplated from the research procedure as approved, the researcher(s) must re-submit the protocol to the committee, together with the Application for Amendment form.**

iii) **PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES.**

Finding solutions for Africa

Appendix 2

Mr. T.J. Dama
P.O Box 1104
Phangami
0904

2020.12.15

Good day,

RE: PERMISSION REQUESTED FOR CONDUCTING MASTERS RESEARCH PROJECT IN EXXARO

I hereby grant you permission to conduct your research project in Exxaro in support of you fulfilling the requirements of the Master Degree in Public Health at the University of Limpopo.

Kindly take note of the following conditions and requirements that you need to fulfill before embarking on your research in Exxaro.

- You will need to get permission to use information and/or resources from the relevant Executive Heads, explaining the intent of the research and explaining how information will be used. This can be in the form of an email, or letter, to which you will need to send a copy of consent to the talent management officer at the following email address eulen.ngobeni@exxaro.com
- You will need to get written consent from individuals who participate in focus groups or qualitative research and this must be kept on file by you, for further reference if required.
- Where research requires involvement of employees at Exxaro's business units for qualitative data, consent from the BU Manager and HR manager will be required. Again, consent of participants will be on voluntary basis
- For studies that involves quantitative research, you will need to work through the Group Manager Talent Management, who will assist you with group wide communication before contacting any sample group.
- Consent of participants will be on a voluntary basis, and no form of reward must be associated with their participation.
- The study will be conducted in an ethically sound and responsible manner.
- All information gathered will be treated as confidential and findings will be reported with the necessary discretion not to cause any harm to individuals and/or Exxaro.
- The identity of Exxaro as well as names of employees or role players will remain confidential throughout the research and dissertation.

- No publications in the form of material derived from the research project will be allowed, unless the material is in public domain, or explicit permission is granted in writing, by the relevant Executive Head from the area the information is solicited.
- The research findings (in dissertation or summary format), will be made available to the relevant Executive Heads when requested.

Yours Sincerely

Signed by:Mark Desmond Kensley
Signed at:2020-12-15 16:10:53 +02:00
Reason:I approve this document

Mark Kensley

Acting Group Manager, Talent Management

ACKNOWLEDGEMENT

I hereby acknowledge and agree to the requirements and conditions stipulated on this document regarding my research project at Exxaro

T.J. Dama

Masters student

Appendix 3

University of Limpopo
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12 April 2021

Dear Sir/Madam

SUBJECT: EDITING OF DISSERTATION

This is to certify that the dissertation entitled 'Occupational accidents at a coal mine Waterberg District in Limpopo Province' by Dama Tshimangadzo Joseph (201734634) has been copy-edited, and that unless further tampered with, I am content with the quality of the dissertation in terms of its adherence to editorial principles of consistency, cohesion, clarity of thought and precision.

Kind regards

Prof. SJ Kubayi (DLitt et Phil - Unisa)
Associate Professor
SATI Membership No. 1002606

Finding solutions for Africa

Appendix 4

SELF-ADMINISTERED QUESTIONNAIRE

SECTION A: BIOGRAPHICAL INFORMATION OF RESPONDENT

Respondent no.

Age

18-22	
23-25	
26-30	
31-35	
36-40	
41-45	
46-50	
51-55	
55-above	

Period of working

0-1	
02-4	
05-10	
10-15	
Other or Above	

Gender

Male	
Female	

Marital status:

Single	
Married	
Divorced	

Level of education:

High school	
High School(completed grade 12)	
Tertiary School	

Employment status

Full-time	
Part-time	
Weekly	
Casual	

Work Section:

Mining Operation	
Mining Engineering	
Plant Operation	
Plant Engineering	
Services	

SECTION B: HEALTH AND SAFETY TRAINING OFFERED TO THE MINE WORKERS:

PLEASE TICK ONLY THE PPLICABLE BOZ where A=Agree, DK=Do not know and D= Disagree

No	**HEALTH AND SAFETY TRAINING OFFERED**	**A**	**DK**	**D**
1	I received training hazard identification			
2	I know how to manage identified hazards at work			
3	Newly appointed employees are offered induction training before they perform their duties			
4	I received training regarding the use of equipment/machinery			
5	I received training on how to handle substances at work			
6	Only those who are trained to operate machinery or handle substances are allowed to perform such duties			
7	I receive training every year at the workplace			

SECTION C: EQUIPMENT AND WORKPLACE DESIGN

PLEASE TICK ONLY THE APPLICABLE BOX where A=Agree, DK=Do not know =and D- Disagree

	EQUIPMENT AND WORKPLACE DESIGN	**A**	**DK**	**D**
1	Equipment that we use is serviced regularly			
2	Equipment that we use is in a good working condition			
3	Equipment that we use is relevant to the task being performed			
4	The surface at my workplace is slippery			
5	The surface at my workplace is uneven			
6	I work in a congested area			
7	I work in a noisy place but provided with hearing protection			
8	I work in a dusty place but provided with a dust mask			

SECTION D: PROVISION AND USE OF PERSONAL PROTECTIVE EQUIPMENT AND AVAILABILITY OF SIGNAGE

PLEASE TICK ONLY THE APPLICABLE BOX where A= Agree, DK=Do not know and D= Disagree

	PROVISION AND USE OF PERSONAL PROTECTIVE EQUIPMENT AND AVAILABILITY OF SIGNAGE.	**A**	**DK**	**D**
1	I am provided with correct PPE to perform my daily tasks			
2	I always have PPE to use at work			
3	I always put on PPE before I start working			
4	There are enough warning signs at my workplace			
5	Warning signs at my workplace are visible			
6	I can differentiate between colour-codes			