AN ASSESSMENT OF THE CAUSES OF ACCIDENT AT RIOZIM'S DALNY MINE IN CHAKARI, ZIMBABWE.

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APPROVAL FORM

The undersigned certify that they have read and recommend to Midlands State University to accept a dissertation entitled "An assessment of the causes of accidents at RioZim's Dalny mine in Chakari, Zimbabwe", by R142277B in partial fulfilment of the requirements for the Bachelor of Science Honours in Geography and Environmental Studies

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DEDICATIONS

This dissertation is dedicated to my family and relatives for the unwavering support, love and prayers it would have been impossible to reach this far. You were my pillars of strength when I couldn't go on mother and father.

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I would like to express my heartfelt gratitude to my supervisor Professor M. Matsa for the unwavering support, patience and guidance. Through his assistance I have become a better equipped graduate and researcher. I would also like to thank GES staff for their nurturing assistance over the past four years. I would also like to thank the Dalny Mine management for granting me the permission to carry out this research.

I would also want to thank my family, friends and relatives for the support, financial assistance, encouragement and believing in me that I can make it, and I did. I love you all.

Above all I would like to thank God My Father for the wonderful gift of life, being with me all along for the duration of my course at Midlands State University, strengthening and guiding me. Without Him I would not have reached this far.

ABSTRACT

The research was carried out at Dalny mine with the aim of understanding the causes of accidents at the organisation. The objectives of the study included the identification of the causes of accidents, establishment of the trends on the occurrence of accidents at the mine and to evaluate the level of awareness of employees on the causes of accidents. A descriptive research design was used and a sample of 92 employees was selected. The research encompassed both qualitative and quantitative techniques and the use of primary and secondary methods for collecting valid and reliable data pertaining to the research. Primary data was obtained through questionnaires, field observations and interviews whilst secondary data was obtained from the organisations HSE records. Statistical Package for Social Sciences (SPSS) was used to analyse both quantitative and qualitative data. The major findings were that accidents at Dalny mine were caused by unsafe conditions and to a lesser extent by unsafe acts. The causes of such accidents were attributed to lack of adequate training on accident causal factors, poor standard working procedures, unrealistic production targets and ignorance to HSE issue. The research revealed that accidents negatively impact gold production at Dalny Mine as there are frequent stoppages of production operations. There is also a high rate of lost time and increased absenteeism. The study tested whether there is a significant relationship between level of education and employees knowledge on causes of accidents. Results indicated there is no significant relationship ($p > 0.05$; $p=0.21$) between level of education and employees knowledge on the causes of accidents. The study recommends that employees at Dalny mine need to attend courses on Safety, Health and Environment offered by organisations like NSSA so that they will be well versed in HSE issues. Safety, Health and Environmental standards like the OHSAS 18001 and ISO 9001 should be implemented in order to improve the safety system of Dalny mine. These recommendations were forwarded to the organisation so that they can have an accident free workplace.

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List of Acronyms

HSE	Health, Safety and Environment
ILO	International Labour Organisation
ISO	International Standards Organisation
LTIFR	Lost Time Injury Frequency Rate
NSSA	National Social Security
OHSAS	Occupational Health Safety Assessment Series
PPE	Proper Protective Equipment
SPSS	Statistical Package for Social Sciences

CHAPTER ONE: INTRODUCTION

1.1 Background

Mining accounts for about 1 per cent of the global workforce but is responsible for up to 5 percent of fatalities at the work (at least 15 000per year or 40 per each day) (ILO, 2015). Mining accidents are tough in nature and it has been proven that these accidents are caused by a number of factors (Weng et al, 2016). Human errors is one of mines major accident causes although there are a number of other common causes such as leaks of poisonous gases such as hydrogen sulfide or explosive gases or explosive natural gases, especially firedamp or methane, dust explosion collapsing of mine stopes, mining seismicity, flooding, or general mechanical errors from improperly used or malfunctioning mining equipment (such as safety lamps or electrical equipment (Boniface et al, 2013). Kamalinia et al (2013) postulated that accident causation exercises have been conducted and technological advancements were incorporated into the exploration of minerals but accidents are still occurring across the mining industry. Therefore, it means that addressing mining accidents calls for a broader approach that incorporates different stakeholders across mining sectors.

Mining is an occupation recognized as being liable to accidents, injury and disease. Despite considerable effort in many parts of the industry to improve its safety record, mining remains the most hazardous occupation in most countries where it exists (Colemen and Kerkering, 2007; Travelyan et al 2016). An accident is an undesired event giving rise to death, ill-health or injury (BS 8800:2004). Hinze (2000) adds that an accident does not necessarily result in injury, it can also result in damage to the equipment, material and the environment. Nevertheless, those accidents that result in injuries could especially receive the greatest attention.

Mining related accidents usually lead to loss of property, injury/death of personnel and pollution of the environment. In the past mining accidents have led to the shut down and threats to shut down of mines (Ryan, 2008; Ross, 2017). In China between January 2001 and October 2004, there was 188 accidents that lead to a death toll of more than 10, about one accident every 7,4 days (Lafraniere, 2010). The Courrières mine disaster was the worst ever pit mine disaster in Europe. It caused the death of 1 099 miners (including many children) in Northern France in 1906.

The mining industry is one of the most hazardous workplaces to be as compared to any other industry as this can be noted from the previous documented disasters that have occurred worldwide that include among others the Tanzanite mine disaster of 2002that claimed 65 lives after the floods swept into the mine tunnel (Boniface et al., 2013), the Coal brook South Africa, where 437 miners were trapped (Progund, 2010), later on 417 died of methane poisoning in 1960.

In Zimbabwe the Kamandama Hwange Colliery of June 1972 that claimed the lives of 426 miners is worth mentioning (Maunganidze et al.,2013). In another incident at least 78 workers narrowly escaped death at Mimosa Platinum Mine in Zvishavane, after being trapped 100meters underground for nearly 24 hours after a fire broke out in the shaft in May 2012 (Freeman, 2012) and also the recent disaster that occurred on June 10 2010 at Golden Valley Mine Kadoma where 7 died (Kamwenda, 2014). This therefore shows that the mining environment is very risky. The injury rate among mining workers has significantly increased from 131/1000 in 1998 to 789/1000 workers in 2008 and the proportion of severe occupational injuries in the sector increased from 18% in 2008 to 37% in 2010 (Chimamise et al., 2013).

More than 5000 people were injured in work related accidents according to the NSSA report of 2014. The rate of occupational injuries in Zimbabwe is very high standing at 2.27 against an expected standard of less than 0.7. The NSSA (OSH) Director describe the workplace in Zimbabwe as generally hazardous following the death of 98 workers in 2014 and most of workers that died are involved in mining (The Chronicle, 2015). According to NSSA on Guard publication of June 2013, close to twenty-one workers are injured in every eight hour shift and almost two workers are killed on the job in Zimbabwe. For the past 20 years (1993-2003), a total of 192 deaths were recorded from the mining sector in Zimbabwe (NSSA Annual Statistics, 2000-2013). The NSSA Director concluded that accidents are attributed to low investments in occupational safety, health, non-compliance to rules, regulations and low levels of awareness on OSH issues.

The RioZim group operates Dalny Mine which has been leased to the group for processing ore from Cam and Motor Mine Open Pit in Kadoma since March 2014 hence it seeks to resuscitate operations at the mine initially through open pit mining and thereafter underground mining. At the plant the initial process is reducing the ore sizes and this include several processes, the first

being ore crushed at the grizzly which is fed into the plant by conveyor belts. In the plant there are several chemicals that are used in the extraction of gold such as cyanide and caustic soda. The engineering department offers services at the mine which include plumbing, welding, carpentry amongst others. Considering that Dalny Mine uses the International standards: OHSAS 18 001 there is therefore need to maintain and continuously improve its safety and health performance. The mining industry has its history of accidents but accessed reports have shown that no fatality has ever occurred. Measures like wearing proper protective clothing/equipment, fining employees that engage in shortcuts when doing their task and training and awareness sessions have been put in place at the organisation as a way to prevent accidents from occurring. In the organisation's Health, Safety and Environment policy, the mine committed itself to abide by legal requirements which includes improvement of safety and health standards of employees. Regardless of all these standard work procedures, systems and measures taken to prevent the occurring accidents, one notes that accidents still occur at an alarming rate. This persuaded the researcher to unveil the causes and determine the level of awareness on the causes of accidents at the mine.

1.2 Statement of the problem

Since the re-opening 2014 after its closure in 2012, Dalny Mine has recorded a rise in the number of accidents that had during the period 2014 to 2017 February. In 2014 sixteen accidents were recorded, twenty-five in 2015, twenty- eighty in 2016 and already in 2017 during the period from January to February, ten accidents were recorded at the organisation hence the accident is extremely high. A Lost Time Injury Frequency Rate (LTIFR) which is above the standard of 0.7 set by the National Social Security Authority was recorded. A LTIFR of 0.77 was recorded in 2014,0.81 in 2015 and 0.9 in 2016. A number of accidents have occurred resulting in disabilities of injured workers, leaving behind families without breadwinners and poverty stricken. According to HSE policy of RioZim health, safety and environment concerns take precedence over all other concerns. However, reality on the ground is that production concerns takes precedence over the health, safety and environment issues despite the fact that there are a number of accidents occurring. There is need to know the root causes of the accidents so as to minimise and prevent them from occurring. This therefore gives the researcher the zeal to assess the causes of accidents so that the results of the research will help in giving solutions to the existing

problem of having a lot of accidents and incidents at the workplace. Standard work procedures have been documented, enforced and pre-task risk assessments are being done before work commences yet mining accidents still occur at an alarming rate hence the need to put an end to this.

1.3 Objectives

1.3.1 General objective

- ➢ To assess the causes of accidents at Dalny Mine

1.3.2 Specific Objectives

- ➢ To identify the causes of accidents
- ➢ To evaluate the trends on the occurrence of accidents at Dalny
- ➢ To determine the level of awareness of the causes of accidents at the mine

1.4 Hypotheses

H_0 There is no significant relationship between level of education and knowledge on the causes of accidents

H_1 There is a significant relationship between level of education and knowledge on the causes of accidents

1.5 Justification of the study

A great deal of research has been done in the Safety, Health, Environment and Quality (SHEQ) field worldwide to date including at RioZim Dalny Mine on the causes of accidents in the mining industry although accidents still occur. Understanding the causes of accidents is a vital decision which aims to achieve zero harm to the workers, machinery and to the environment at Dalny Mine. The researcher is motivated by the fact that the number of accidents at the organisation have been increasing resulting in lost shifts, loss in production and disabilities hence this has to come to an end.

The results if this study would be adopted by the organisation to help improve its production, as well as the safety and health of all its employees at the workplace. In addition, the results if the research will help identify areas that need attention and they will not only help RioZim organisation but other mines on how to prevent such accidents. Results from this study can be used to raise awareness among employees at Dalny Mine on the risks that they face every day thereby stimulating participation in safety programmes as well as enhancing behaviour based safety (BBS).

The Health, Safety and Environment department of Dalny Mine will also have a chance, through this study's recommendations to review their system and put in place measures that can prevent accidents from occurring at an alarming rate and the lives of employees at risk of accidents. If recommendations are taken into consideration, the burden of accidents will be reduced and the company's corporate image will be boosted. The results will be of great importance to the mining board of knowledge in accident prevention and control as well as mining is an important component of the economy of Zimbabwe.

1.6 Study Area

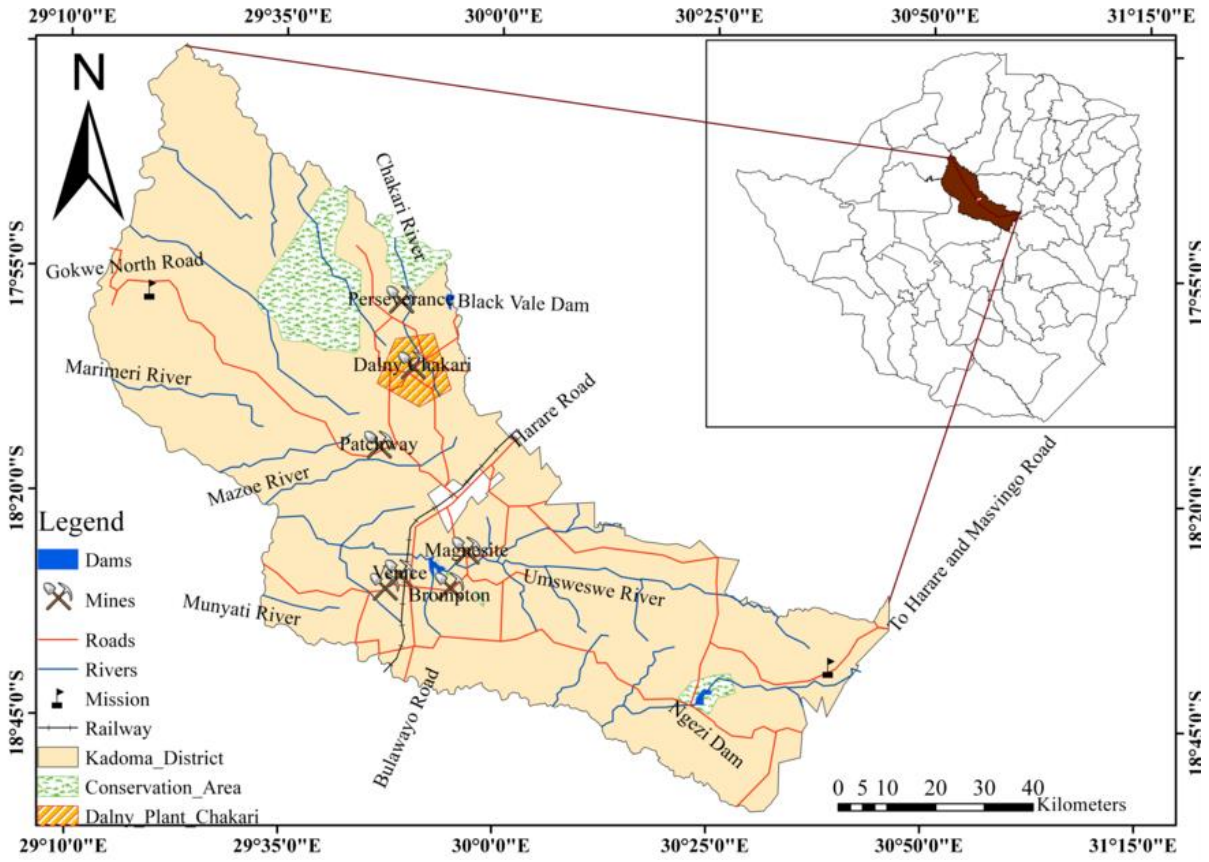


Fig 1. 1 Location of Dalny Mine

1.6.1 Location and physical description of the study area

Dalny mine comprises the main Dalny Mine and numerous smaller spatially distributed mines over a 14km claim holding. Since 2013 Dalny Mine has been under care and maintenance with the most of the shafts having been closed in the early2000s. Dalny Mine Complex Plant is currently on lease to RioZim for processing ores from Cam and Motor Open Pit in Kadoma since March 2015. Due to diligence carried out by RioZim at Dalny indicate gold resource potential both near the surface and middle levels of the ground workings. RioZim seeks to resuscitate operations at the mine initially through open pit and thereafter underground mining.

Dalny Gold Mine is located 29051'0" E/ 180 04'30" S (Michael, 2012), 34 kilometres west of the town of Chegutu, and 35 kilometres north of the city of Kadoma in Mashonaland West Province of Zimbabwe. Geologically, the mine lies in the offshoot of the renowned gold bearing Lily Shear Zone, that trends from Kwekwe in the South to past Chakari North.

The Chakari area lies within the typical Granite-Greenstone terrain. The Zimbabwe Craton consists of various granite and gneissic bodies and greenstone belts that outcrop along the broad north-east trend through the centre of the country (Dirks et al, 1997). The greenstone belts include ultramafic to felsic volcanic rocks. In addition, volcanoclastic to epispastic rocks are widespread within the greenstone belts, as are banded iron information's (BIF) and various sub volcanic mafic to ultramafic igneous intrusions The greenstone belts are typically folded and faulted with metamorphic grade and intensity of deformation of thee greenstone belts varying across the Zimbabwe Craton but mainly in the lower to medium green schistose faces. Lode deposits in Zimbabwe vary from gold-quartz with only minor sulphide minerals to gold bearing massive sulphide with only minor quartz.

The area is characterized by low rainfall régimes of approximately 750mm per year. In summer the maximum temperatures are in the range of 27C -38C, while the minimum temperatures are usually below 5C (Chinamatira, 2016). In winter, maximum temperatures are usually in the range of 15-27 and the minimum can be as low as -2c. The soils are red clay in nature and they support growth of a lot of vegetation. The original vegetation type as indicated by the surrounding farmland and isolated stands within the mined area as savannah grassland and Brachystigia woodland. The vegetation has however, fast disappeared as a result of mining and agriculture which has been the major land uses around the area. The remains of the original vegetation are evidence of the surviving isolated woodlots.

1.6.2 Socio-economic description of the study area

According to the ZimStat (2012), the Kadoma-Chakari area has a total population of 6 354 people. Of these 3 227 (51%) are males and 3 127 (49%) are females. The community in the Kadoma-Chakari small scale mining area is of mixed ethnicity (Mtetwa,2007). The dominant languages spoken in order of popularity within the sample are Shona (mother language of 53%), Chewa (37%) and Ndebele (9%). Education is seriously affected as students of school-going age 9 (late primary age and secondary school level age engage in mining. Health facilities are an issue of concern as the nearest health centre in Chakari, located less than 10kilometres from the mine is not accessible other than to current workers at the mine meant for Dalny Mine employees. Most people have to travel to Chegutu or Kadoma for treatment.

The main occupation in Chakari is small-scale gold mining (Shava et al 2007; Mpofu and Mpofu, 2017). As a result, mining provides the main income for the livelihood sustenance in the area. Extractions of the ore body by small- scale miners is highly labour intensive and, as a result, the labour force is pre-dominantly male. Women are engaged in occupational activities like vending (selling surplus food crops like maize, vegetables and cigarettes in different mining sites). The majority of the people stay in the mining compounds (high density area) that belong to Dalny Mine and resettled farmers live in the surrounding farms in farmhouses, farm compounds and other temporary hoses built of dagga and poles. A minority group stay in a suburb close to the mine known as the Low Density Village (LDV). The mining compound houses are built of bricks and asbestos and corrugated iron sheets roofs. There is poor sanitation in the compound as the sewage systems are not functioning properly and also toilets are sometimes blocked. Most miners grow their own maize or purchase it from the surrounding farming communities. However, most food is purchased from either Kadoma or Chegutu and its brought in Chakari by vendors.

CHAPTER TWO: LITERATURE REVIEW

2.1 Overview of mining accidents

An accident is an unplanned or unintended event leading to damage, injury or death. When dealing with accidents in industries, they are referred to as occupational to as occupational accidents. By definition, occupational accidents are an unlooked for mishap or untoward event or

process of working arising out of and in the course of a worker's employment, which was not expected or designed by the worker and which results in injury to him (NSSA,1990; Chimombe, 2016). The same term was defined by Hafida (2017) as an unplanned, undesirable and non-controlled event. An accident does not necessarily result in injuries, it can also result in damage to equipment and material. Nevertheless, those accidents that result in injuries receive the greatest attention.

Mining is an ancient occupation long recognized as being dangerous liable to injury and disease (Ahmed, 2017). The accident and ill-health record of mining sector compares poorly to that of other economic sectors such as manufacturing, construction and rail, leading to mining reputation as the most hazardous industrial sector (Hermanus ,2007). The average annual rate of fatal injuries per 100 000 workers in the mining industry is high (30.3%) compared to other sectors such as construction (15.3%) transport and public utilities (13.4%) and manufacturing (14.3%) in Britain (Baipayee,2000; Sirrs, 2016).

Human error accounts for 88% of industrial accidents, which means that modifying human behaviour is one of the most effective ways of improving safety (Mining Safety, 2015). This shows why accidents continue to occurring industries because the behaviour of employees is not being dealt with. Accidents continue to occur with an alarming regularity worldwide despite improvements being made in the environment to reduce accidents. According to the International Labour Organisation (2013) accidents that happen due to occupational related injuries in the world are continually increasing. The statistics from ILO (2013) indicate that 20.2 million people die each year from work related diseases whilst 321,000 people die each year from occupational accidents. Ana estimated 160million non-fatal work related accidents are also recorded per year whilst 317 million non-fatal occupational accidents per year worldwide.

Every 15seconds, 151 workers experience work related accidents (ILO.2013). furthermore, the continent of Africa experiences more than 54 000 occupational injuries annually (Boniface et al, 2013). Data for other developing countries is not available but the mass media provides some indication of the current status of the global mining industry painting rather in a dismal picture according to National Social Security Authority NSSA statistics, at least 5941 people were injured and 34 died due to work related accidents in 2014 (Katongomara, 2014). Thy were 33 deaths and 5666 injuries recorded in 2013. In 2012 107 fatalities against 5141 injuries were

recorded with 16 298 injuries being recorded in the last three years. Based on these statistics, it can be concluded that there is need to introduce better ways promoting a safe work environment through both employee and managerial involvement.

2.2 Causes of accidents

According to the domino theory, 88% of all accidents are caused by unsafe acts of people, 10% by unsafe actions and 2% by "acts of God" (Jovanović et al 2004). These accidents arise as a result of plethora of hazards present at the workplace. Table 2.1 gives an illustration of hazards found at the workplace.

Table 2. 1 Hazard type and examples

Hazard type	Examples
Physical	➢ Noise ➢ Radiation (ionized and non-ionized)
Chemical	➢ Chemical disinfectants and solutions ➢ Exposure to toxic chemical agents via inhalation, skin absorption or ingestion
Physcosocial	➢ Poor human relations ➢ Excessive hours or overtime
Mechanical	➢ Dangerous moving parts of machinery ➢ Poorly maintained machinery and equipment
Biological	➢ Flora and fauna, food contamination ➢ Pathogens

Source: Finnish Institute of Occupational Health (2009).

These hazards determine the dangers that an employee will be exposed to. However ultimately unsafe behaviour and unsafe conditions are the major causes of accidents at the workplace. Magyar (2006) supports this by saying accidents are the result of human error, and they may involve unsafe behaviour or an unsafe condition, or a combination of both.

2.2.1 Unsafe conditions and dangerous equipment

An unsafe condition is a condition in the work place that is likely to cause property damage or injury (Lagrandeur, 2013). Unsafe conditions include machines without guards which largely contribute to injuries that occur due to entanglements and loss of fingers, poor lighting which reduces visibility, poor floor condition such as slippery floors, defective vehicles such as vehicles with oil leaks or defective horn and absence of safety signs. The absence of safety signs especially puts employees in a precarious position as it forces them to venture into certain jobs and acts without knowing the inherent dangers. Other unsafe conditions include defective machines such as conveyors that constantly jam and working on machines that are not secured tightly.

Defective conveyors pose a threat of trapping the worker leading to either body or hand injuries. Poor housekeeping is another unsafe condition leading to accidents. Gordon (2014) elucidates that housekeeping is one of the most accurate indicators of the company's attitude towards production, quality, and worker safety and poorly kept up area leads to hazards and threats everywhere. Poor housekeeping sets the stage for tripping and falling hazards. Congestion in the workplace is another unsafe condition which result in accidents as highlighted by Lagrandeur (2013). Congestion limits the working space and employees become more susceptible to occupational injuries and accidents.

Provision of personal protective equipment is key in protecting the health of employees, however, another unsafe condition is created when employees are not given the required protective equipment for their tasks. To exemplify this, working in dusty condition without dust masks puts the employee at risk of contracting respiratory diseases. Thus without adequate and appropriate PPE employees are exposed to hazards which are highly detrimental their health. Unsafe conditions do not work in isolation in causing accidents, unsafe behaviour of employees also come into play.

2.2.2 Behavioural causes (unsafe acts, at risk behaviour, poor decisions)

The majority of workplace accidents are caused by human factors rather than machine faults, making safety consciousness, training and procedures the key element in promoting safety at work (NSSA, 2012). Some behavioural causes of accidents include operating machinery at unsafe speed, working without adequate personal protective equipment, ignoring safety procedures, taking shortcuts, using defective equipment, not paying attention to a hazard, making devices inoperable, operating machinery without authority and negligence by management. These are explained in detail below.

The absence of operative risk management programmes also leads to accidents in the mining sector. Safety assessments done do not uncover all risks associated with the job to be done. At times risk assessments are not prioritized. Studies by Cholamandalama Risk Services (2013) shows that in the mining industry risks are not recognized, evaluated and managed in a correct manner. Ineffective risk assessments are a minor cause of the high prevalence of accidents in the industry.

Employees in industries normally find themselves working under pressure so as to meet targets by managers and supervisors resulting in them working unsafely by taking shortcuts. Gordon (2014) explains that when worker take shortcuts at work, especially when they are working around dangerous machinery or lethal chemicals, they are only exposing themselves to a potential catastrophe. This pressure created around the employee to meet deadline create diversion of attention and that the lack of attention can be very detrimental to safety (Holcium, 2010). Stress may arise from unrealistic demands placed on workers. Stress can also be from the source outside the job, for example, family.

Operating machinery at an unsafe speed is a risky behaviour. By speeding drivers believe that they can save a lot of time and do their work in a short period of time. His risk is normally faced by truck drivers working in industries. Another reason is that when driving other drivers will be engaging in the same at-risk behaviour, implicitly encouraging the driver to continue speeding (Perdue et al 2007). Moreover, employees in most organisations, despite being given personal protective equipment, decide not wear the PPE. The reasons for not wearing vary from PPE

being uncomfortable to basing o the fact that work experiences tell them they have worked it and have not been hurt.

Naman et al (2014) postulates that over buoyancy in experiences workers in the mining industry is one of the major causes of accidents. Over confidence in workers is caused by experience and prestige by the worker that he or she has done the work for a long period and never get injured. Over confidence in employees at the workplace has negative effects on production. Once employees are over confident they tend to ignore safety work procedures which cause workers to expose themselves and other workers working in the same vicinities to risks (Carabelli 2014)

Negligence by management also puts employees at risk of being involved in accidents. Management is responsible for providing policies, standard work procedures and supervision. However, lack of supervision and lack of procedures is one of the causes of accidents. The situation in industries according to Frederick and Lessin (2000) is such that workers are often rewarded for performing tasks in an at-risk manner because doing so is typically faster, easier more comfortable, and more efficient or convenient than following the safe procedures.

Ninety-four percent of accidents due to human factors can be blamed on inadequate supervision or management of safety issues (NSSA, 2012). In other instances, employees are aware of the hazards associated with their type of work but generally decide not pay attention to them and rather use their experience. This is manifested when employees ignore safety procedures or regulation putting themselves at great risk of being involved in accidents. Causal attitudes about safety can result in a casualty (Sixin, 2016). The effects of such irresponsible behaviour are detrimental. As such from this background it is critical that behavioural change interventions be introduced in a way that will have a positive impact on the overall safety culture at the workplace. This greatly assists in minimising accidents as most accidents in the workplace are being attributed to human behaviour.

Working for long hours is also another cause of accidents. The number of hours of work and the way those hours are organized can significantly affect the day to day life of the worker. It is essential that he worker have free time to rest and leisure in a working day of eight hours (ILO,1982). Long working hours cause fatigue and exhaustion. The injuries due to fatigued workers has intensified the risk of accidents (Holcium,2010)

2.3 Classification of accidents

Mining accidents are classified according to their severity, first aid cases, minor (non-lost time), major (lost time) and fatality (death) (SI 68:1990). According to the Taiwan Labor Safety and Health Act as quoted by Cheng *et al*, (2012) a major accident is an accident that causes injuries to three or more persons or causes death of at least one person at the time it occurs. Hamalainen (2006), postulated that there are two types of accidents and these are: individual and organizational accidents. Individual accidents are the ones where the individual is both the agent of the accident and the victim. Organizational accidents are very rare though they are more catastrophic. These are the events which have multiple causes and they occur within complex modern technologies.

2.4 Trends on occurrence of mining accidents

Historically mining has been seen as a risky industry when comparing to other industries globally. Many studies have been carried out showing the causes of accidents and also the trend and frequency of the occurrence of accidents. A research was done by a group of fundi's in China showing the trend in occurrence of mining accidents and mortality rate in mines from January 2001 to December 2008(Wang et al, 2009) as shown in Fig 2.1. In China, there appears to have been a decrease both in mining accidents and deaths since 2006. This decline can be attributed to efforts by the Chinese government to improve the country's mining safety.

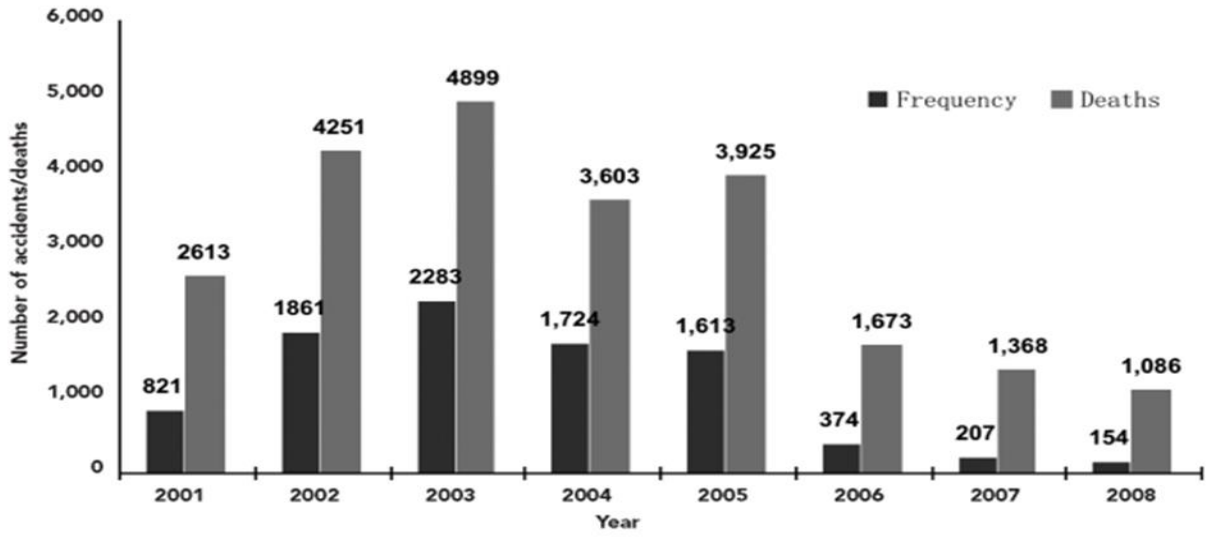


Figure 2. 1 Number of mining accidents and deaths in China 2001-2008
Source: Public Health Report, China (2009)

According to NSSA on Guard publication of June 2013, close to twenty-one workers are injured in every eight hour shift and almost two workers are killed on the job in Zimbabwe. The Chamber of Mines of Zimbabwe (2013) shows that 51.4% of the mining accidents are caused by the fall of ground and the rest by some other factors such as gassing, explosives, shaft among others. In Zimbabwe the mining sector contributes a significant number of occupational injuries. The injury rate among mining workers significantly increased from 131/1000 workers in 1998 to 789/1000 workers in 2008 and the proportion of severe occupational injuries in the sector increased from 18% in 2008 to 37% in 2009 (Chimamise et al, 2013). Table 2.2 shows the distribution of fatalities in Zimbabwe for the past decade.

Table 2.2 Frequency distribution of Zimbabwe mining fatalities

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Fatalities	14	14	10	7	11	8	18	7	21	20

Source: NSSA Annual Statistics Report (2006-2015)

2.5 Accident Investigation

Zakaria et al (2012), postulated that to understand why and how an accident happens is the first step in finding the solution. According to Alexander (2017) the purpose of accident or incident investigation is to identify causes and prevent reoccurrence and also to evaluate the causal factors of the incident or accident a number of researches have shown that accidents do not just happen on their own but they are caused by a number of factors, chiefly being the human error (Domino theory). Hamalainen (2010), asserted that gone is the era when accidents were thought to as being from the gods and connected to the nature.

The accident or incident investigation process consist of a wide range of activities. The investigation process is divided into three phases: collection of evidence and facts, analysis of these facts, and development of conclusions and development of judgements of need to write the report (Strauch, 2017). In order to assess the risks, and take any corrective steps necessary the employer, in cooperation with workers and their representatives, should investigate accidents and

incidents as soon as possible, based on the nature of incident or accident and in accordance with the requirements of the competent authority on occupational accidents (ILO, 2003). Accident investigation is done to ascertain the causes of accidents through the application of different techniques such as the root cause analysis, the tripod amongst other techniques. Appropriate corrective action should be taken to prevent recurrence and to assess and monitor the effectiveness of action taken. Corrective actions should be implemented in all areas of the workplace where there is a similar of accidents occurring (ILO, 2003)

2.6 Adverse impacts of accidents

Occurrence of an accident causes untold suffering to both the casualty and the company in many aspects. Pillay (2014) stated that the consequences of an accident to the casualty's social life include: lack of concentration, changes in decision making, depression, isolation and also changes in family life. More so, the impacts of accidents to families and organisations are devastating ranging from staggering costs in terms of loss of life, pain and suffering, lost wages for the injured worker, damage to production facilities and equipment to loss of production opportunity as according to Pillay (2014). Hughes and Ferret (2010) argued that accidents effects follow the Iceberg Theory which talks of direct and indirect costs. According to the theory, direct costs are those costs which are directly related to the accident. For example, absence of employees, damage to equipment, production loss and medical costs. Indirect costs are those which may not be directly attributable to the accident but may result from a series of accidents. These include recruitment of new employees, legal expenses, investigation time.

2.7 Knowledge and its effects in accidents

Multiple causation theory which is an outgrowth of the domino theory advances that lack of knowledge on occupational safety and health among workers is a contributing factor to occurrence of accidents (Raouf, 2011). Bluff (2011) defines knowledge as all that a person knows or believes to be true that is the individual's personal stock of information belief, skills, experiences and memories. Procedural knowledge is practical knowledge which helps employees to perform their tasks according to the requirements of the organisation. Safety and health training and awareness educate the workers on the benefits of practicing good workplace behaviours. Workers may not always recognize the importance of safety training and awareness

or think of it as unnecessary because they have been doing it for years. But an important benefit of periodic safety training and awareness is the reminder that a danger can exist and that no one is immune to accidents (Thomson 2015). Safety and health awareness and training is part of a direct assault on the causes and frequency of injury and illnesses (Kinn, 2000; Ericson, 2015).

2.8 Research gap

Previous studies on the causes of accidents in the mining industry have greatly contributed to the pool of knowledge available. Many studies have been carried out in the United States of America, European Union and Australia identifying the causes of accidents, how accidents occur at different mines and how these accidents can be reduced as a way to save lives. This can be evidenced by case studies done by researchers like Sanmiquel et al (2010) analysed work related accidents in the Spanish mining sector and Lenne et al, (2012) carried out a study on understanding and supervisory failures that cause mining accidents in Australia. The researcher therefore noticed the gap in the information and knowledge available in Zimbabwe specifically in the gold mining sector on the cause of accidents. The safety culture in Zimbabwe has not yet matured, for example, aspects like providing PPE to employees are still a major problem in the country. Different industries and workplaces present different hazards and different causes of accidents therefore different prescriptions should be given accordingly but first there is need to know what is happening on the ground so that recommendations can be drawn from that. Therefore, the study aims to bridge the gap between developed countries and Zimbabwean gold mining industry on the causes of accidents.

CHAPTER THREE: RESEARCH METHODOLOGY

3. 1 Research Design

Cresswell (2013) defines a research design as a model or any action plan upon which the entire study is built; it dictates the manner in which a study is conducted and provides the road map of the study in terms of sample, data collection instruments and analysis procedure. A descriptive research design was used in this research. According to Cresswell and Poth (2017) a descriptive research design is a way to describe systematically and accurately facts and characteristics of a given population or any area of interest. The research design was essential in that it allowed for an in-depth description of the causes of accidents at Dalny mine. A descriptive research design provides answer to the questions where, when and what in relation to a particular research problem, in this case, the causes of accidents at RioZim Dalny mine in Chakari

Descriptive research design allows the integration of both qualitative and quantitative approaches and this was applied in the study. Qualitative approach gives an in depth portrayal of the components under study, for example, work experiences, attitudes, and behaviour (Denzin and Lincoln, 1994; Mackey and Gass 2015). The qualitative approach was used by the researcher for an in depth analysis of comments that the respondents gave. The quantitative paradigm was used in this research because it improved data collected from qualitative research as it reduced the data to numerical values, for instance it facilitated tabulation and graphical representation. The researcher used various primary and secondary data collection procedures and instruments including questionnaires, interview, field observations and Health, Safety and Environment (HSE) documents such as accident registers, HSE annual and monthly reports.

3.2 Target population

The aim of research is to draw conclusion and make generalization about the entire population. Population is the entire collection of objects under consideration hence there is need for a targeted population. Gray (2004) and Mpofu (2016) defined target population as the totality of people, organisations, objects or occurrences from which a sample for a study is withdrawn. The target population of this study was the totality of Dalny mine employees excluding the technical service department as it a new department at the organisation and no accident has been recorded

from the department. The target group was subdivided into strata's thus according to sections. The different strata include engineering, assay laboratory, grizzly, crushing, milling, elution and slimes dam. This sub division was done so that all the employees had an equal chance of being selected in each strata. The research concentrated on 184 employees. The other group that was of great importance were the mine management team which included HSE Officer, Plant Superintendent, resident engineer and plant operators whom the researcher interviewed. Altogether the target population had 189 employees.

3.3 Sampling procedure

A sample refers to any portion of a population selected for the study and on whom information needed for the study is obtained (Awoniyi et al, 2011). Therefore, a sample is a subset of the population. It can be emphasized that to study the entire population can be cumbersome, time consuming and of course very costly hence, a sample takes a fair portion as representative of the entire population. The sample of the study was taken from the targeted population. Maher et al (2014) postulates that there are different types of sampling designs and these are based on representation and element selection. The representation basis can further be divided into two that is probability and non-probability sampling.

As noted above the study population was divided into several subdivisions. Stratified sampling was used thus dividing the population in different strata and then random sampling was carried out in each stratum. The advantage of this sampling design is that all the employees had an equal chance of being selected in each stratum. This sampling design was meant for those to whom questionnaires were administered. For the interviews the researcher used purposive sampling because the employees were chosen based on the knowledge they possessed and their professional judgement.

In order to make inferences about the characteristics of the population to gather information of the phenomenon under study from the targeted population the researcher considered 50% of the 184 employees so as to produce reliable results from the findings. The total number for each section was used to calculate the ratios for each section's contribution to the sample size as illustrated in table 3.1. This was intended to promote equal representation according to the

section's number of employees. This allowed the researcher to have more time with the targeted population to acquire more information of underlying issues or problems under study.

Table 3. 1 Sample size determination

Department	Total population	Sample size
Grizzly	21	11
Crushing	27	13
Milling	34	17
Elution	20	10
Slimes dam	28	14
Engineering	47	24
Assay Laboratory	7	4
Total	184	92

3.4 Primary data

Primary data has been defined as that data which has been collected afresh for the first time hence it is original in character (Kothari, 2004; Morse,2016). Kothari (2004) also adds that primary data materials contain direct evidence, first hand testimony, or an eye witness account to the topic or event under investigation. Primary data was collected from Dalny Mine employees using research instruments such as questionnaires, interviews, field observation and photographs.

3.5 Research instruments

3.5.1 Questionnaires

According to Burns and Bush (2010), a questionnaire is a research instrument consisting of series of questions and the other prompts for the purpose of gathering information from

respondents. McGuirk and O'Neil (2016) explain that questionnaires answer the what, where, when how and why questions in fact finding. The researcher used questionnaires to collect the appropriate data, to make comparable and amenable to analysis, to minimise bias and formulating and asking questions, and make questions engaging and varied. The questionnaires were self-administered so as to achieve high rate of cooperation. Ninety-two questionnaires were administered to the employees by the researcher.

The questionnaire had some closed and open-ended questions and these were used to entreat information from the employees at Dalny Mine. The closed questions helped the researcher to easily analyse and tabulate the data because the responses were structured. The closed questions were asked to provide definite answer choice and the answers only fit in categories that which have been decided by the researcher, for example, asking the employees the length of the shift whether it was 8-hour shift or 12-hour shift. On the other hand, open-ended questions which enabled the respondents to air out their views and respond in their own words giving detail to their answers. Such questions were used to get information on the causes of accidents at the workplace.

3.5.2 Interviews

Watson (2017) define an interview as a purposeful conversation in which one person asks prepared questions (interviewer) and another answers the questions (interviewee). This was done to gain information on the research questions. Face to face interviews were done so as to ensure 100% response rate and his therefore, allowed the researcher to capture data from verbal communication. Interviews were used in this case as they allowed the interviewee to talk over their perceptions regarding the situation under study and express their views thereby allowing the researcher to gain relevant information for the research topic. Appointments with the interviewees were made so as to avoid inconveniences and surprise visits by the researcher. The interview guide comprised of logically organized questions which directed the interviewer not to lose focus of the data intended to be obtained from the interviewees as guided by the specific objectives. The questions on the guide acquired data like the causes of the accidents in the plant and management involvement in the plant. The target population for the interviews included the HSE Officer, Plant Superintendent, Resident Engineer and Plant Operators. Table 3.2 below shows the key informants who were purposively selected to assist in conducting this research.

Table 3. 2: Key interviewees and why they were interviewed

Interviewee	Justification
HSE Officer	➢ Governs and enforces all mine OHS procedures and keeps all the mine OHS records. ➢ Has information on mine's environmental accidents and their causes. ➢ Is responsible for training and giving awareness to employees on safety, health and environment issues ➢ Carries out daily plant inspections and they know hazardous areas and areas prone to accidents.
Plant Superintendent	➢ Has information on plant processes and the accidents that normally occur in the plant
Plant Operator	➢ Responsible for on-the-job training and induction of employees in different sections
Resident Engineer	➢ Has information on property/ equipment damage accidents

3.5.3 Observation

Meriam et al (2015) define observation as a way of assembling data by watching behaviour, events or noting physical characteristics in their natural setting. Observations are characterized

into two that is direct observation and indirect observation (Merriam et al 2015). Direct observation is a method of collecting evaluative information in which the researcher watches the subject within their usual context without altering the environment and this was employed in the study. An observation checklist was compiled by the researcher. Employees were observed whilst they were carrying out their tasks. The observation checklist was used in the different sections. More so, the checklist was used to evaluate the response of the employees to Safety, Health and Environment measures as a way to prevent occupational accidents at the workplace as well as operation of the machinery, provision of PPE and noting if risk assessments were being done.

3.6 Secondary data

Johnston (2017) define secondary data as shelf information gathered at some time earlier for other purposes but which can shed light on the subject under study. Secondary data was collected from the RioZim's HSE department as the department kept all records of all accidents statistics, investigations, monthly and annual HSE reports and accidents statements from eye witnesses or the injured person. To develop a stealth comprehensive study, data was collected from sources like HSE documents such as accident registers, HSE annual and monthly report, accidents statements and accident report forms. Secondary data was employed to give meaning to primary data collected during the research. Secondary data was used because it is less expensive to acquire and is less time consuming to collect, compile and analyse and it is readily available. The monthly and annual reports records provide the total number of accident that occurred during a particular time. The accident register provides information about each and every accident that occurred at the mine, the type of accident (property damage, lost time injury, fatal), the immediate and root causes of the accident, findings and recommendations from the accident report. The accident register was of great importance as it helped the researcher to establish an in-depth understanding of the trends of accidents for the past three years.

3.7 Data analysis and presentation

Data analysis involve examining and organizing data collected from the field into meaningful information which provides answers to research questions. Salaga and Leeedham (2017) define data presentation as a way of displaying results obtained from the research and making

interpretations on certain variables. In this study both primary and secondary data were being analysed to provide meaningful information which goes hand in hand with the research objectives. Data analysis consists of processes such as examining, categorizing, tabulating or otherwise recombining the evidence to address the initial proposition of the study (Hayat et al, 2013). Data from the research was analysed using the Social Packages for Social Sciences (SPSS version 20.0). This package was used in creating graphs and other charts. In addition, Microsoft excel was also used in analyzing data to draw meaningful conclusions from the findings. Furthermore, the grounded theory whereby data is grouped into meaningful descriptive discussion was also used in analyzing qualitative data from interviews and observations. The Chi-Square was used in testing the hypothesis of the study. The results were then presented through tables, bar graphs and charts.

3.8 Ethical considerations

Ethics is defined as what people have to do, or their doctrines of proper conduct (Becker and Becker 2013). Ethical principles in research include humans' subject protection, honesty, objectivity, carefulness, confidentiality and responsible publication amongst other factors. Firstly, the researcher sought permission from the RioZim's Dalny Mine Human Resources department to conduct the research to ensure that no boundaries other the aims of the research were crossed.

Data collection techniques were employed in such a way that no physical or emotional harm would be caused to the respondents. Furthermore, before the collecting data the respondents were informed about the research, voluntary participation, anonymity and confidentiality were honoured throughout the research. It was reiterated to them that that their responses would be kept private and confidential.

The research took special precautions with the respondents by respecting their dignity and upholding autonomy. It also minimised any risk or harm and ensured that more benefits were derived from the information thus embracing the humans' subject protection principle. Their interviews and information filled in questionnaires are strictly confidential and would not be used for any other purpose except to come up with a comprehensive study. In analyzing data,

fabrication, ignoring and filtering results that do not fit the researchers expected end was considered unethical therefore, was avoided at all costs.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Questionnaire distribution and response rate across the strata

The researcher distributed 92 questionnaires and a total of 74 were returned giving a response rate of 80%. This can be attributed to the fact that the employees were busy with their tasks as the researcher went for data collection during month end when employees were working hard to meet monthly targets. This can be illustrated by in table 4.1 below

Table 4.1 Frequency distribution of questionnaires across the strata

Stratum	Number of questionnaires distributed	Number of questionnaires collected	Response rate at each stratum
Grizzly	4	3	75%
Crushing	11	10	91%
Milling	13	11	76%
Elution	17	13	76%
Slimes dam	10	10	100%
Assay lab	14	10	71%
Engineering	24	18	75%
Total	92	74	80%

Source: Field data (2016)

4.2 Background information of employees

4.2.1 Distribution by gender

Questionnaire responses indicated that 86.5% of the respondents were males whilst 13.5% were females. The findings illustrate that males dominates the labour force of Dalny and this can be attributed to the intensive labour requirements of the mining industry as most of the activities are done manually and require too much man power.

4.2.2 Distribution by age

Most of the questionnaire respondents (77%) belonged to the age category 18-44years and just a few belonged to the age group of 45 to 65years and above. This indicates that the organisation is dominated by economically active population.

4.2.3 Distribution by level of education attained by the respondents

18% of the respondents attained tertiary education, 55% attained secondary school, 16% attained high school and 10% attained primary school (Fig 4.1). This shows that generally employees are educated as many have attained tertiary education and these employees have skills as compared to the rest who are unskilled workers. Workers with national certificates, diplomas and degrees are involved in the production sector mostly and partly the engineering section.

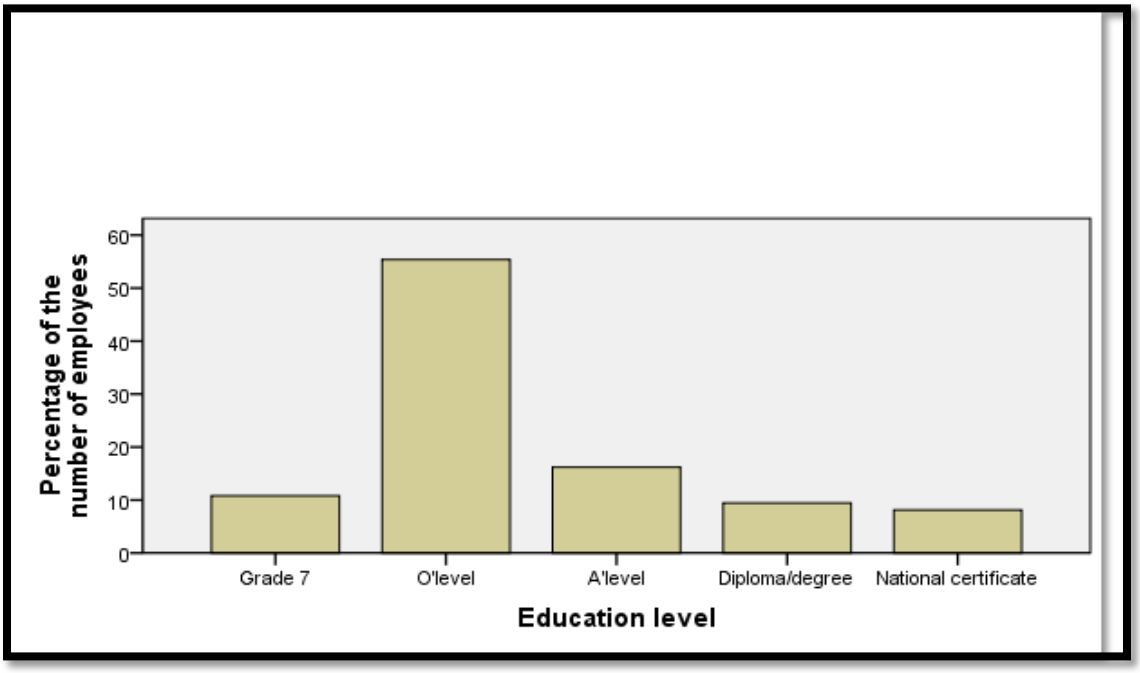


Figure 4. 1 Respondents level of education
Source: Field data (2017)

4.2.4 Distribution by working experience of respondents

70% of the respondents have been working in the organisation for many years. Most of the employees are former Falcon Gold mine employees, they have been in the system for years. However, some of the employees were retrenched from the (Empress Nickle Refinery) ENR and they started working at Dalny mine since its re-opening. The other 29% had been working at the organisation for the past months meaning there has been a recruitment due to the need of more labour force as eluded by the SHE Officer in an interview. The other 1% had worked at the organisation for only a few weeks.

4.3 Causes of accidents at Dalny Mine

For easy analysis the researcher classified the factors contributing to accidents at the organisation as unsafe acts and unsafe conditions. The HSE Officer alluded that classification of accident causation helps on the risk analysis and easily highlights the major contributors of the accident at the organisation. Respondents showed that 60% of the major contributors of the accidents at Dalny were unsafe conditions and unsafe acts contributed about 40% (Fig 4.2)

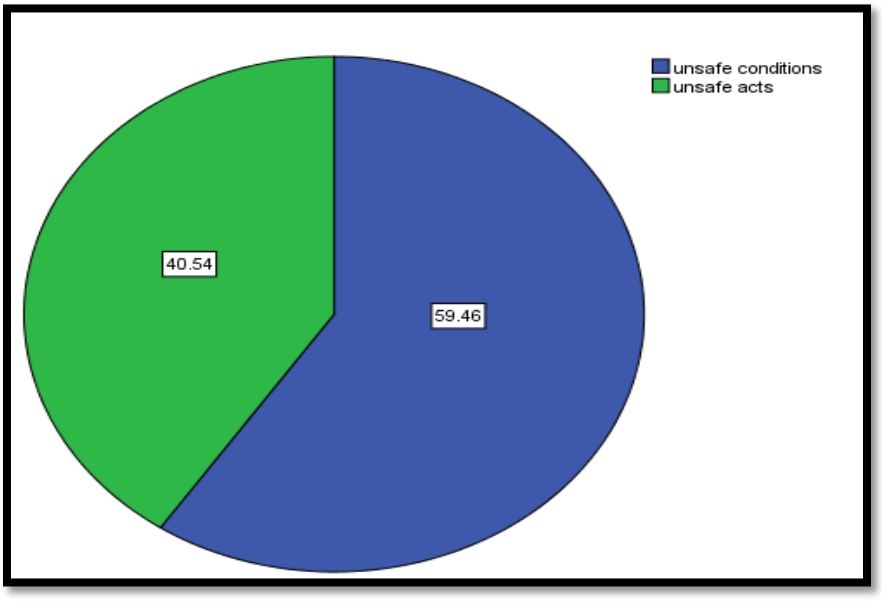


Figure 4. 2 Percentage of unsafe conditions and unsafe acts leading to accidents at Dalny Mine
Source: Field data (2017)

4.3.1 Unsafe conditions causing accidents

Lagrandeur (2013) defines an unsafe condition in the workplace as a condition that is likely to cause property damage or any injury.

4.3.1.1 Dangerous equipment

From the crushing, milling and grizzly section one of the unsafe conditions that was identified was that the conveyor belts do not have guards. The risk associated with conveyors that do not have guards is entanglement and entrapment of hands or any other body part. From the engineering section most of the accidents were caused by poor maintenance of the equipment. The workers work with intricate machines and these machines breakdown a lot which forces the plant to run in the breakdown maintenance mode. The workers are forced to improvise in order for production to carry on hence the machinery can dismantle at any time causing the risk of an accident. The poorly maintained equipment tend to pose hazards like oil leaks which leads to falls.

Plate 4. 1 Unguarded machinery at the flocculent tanks
Source: Field data (2017)

4.3.1.2 Poor standard working procedures

From the questionnaire respondents 53.2% said they did not have adequate standard work procedures in place and they were not taught about the procedures. The plant foreman also alluded that the organisation did not have clear standard working procedures. Some of the tasks did not have standard working procedures. Observation revealed that the engineering and laboratory sections had standard working procedures in place. Work procedures were meant to diminish safety and health glitches that can emanate as a result of improper following of operational codes of practices. The production section which are at high risk areas in the organisation do not have working procedure which explains the high prevalence of accidents in these sections.

4.3.1.3 Pressure of meeting targets

When a breakdown occurs the workers are given unrealistic targets which at times forces them to take shortcuts thus leading to an unsafe action. Unrealistic targets are mainly experienced by the production and engineering workers who are responsible for the upkeep of equipment at the organisation. This pressure also causes fatigue and exhaustion of workers thus leading to lack of concentration causing accidents. In one of the accident that occurred at the company, the worker hurriedly used the wrong tool to do the task which led into an incident as the supervisor told him to do the task immediately so that they meet the daily target. In most cases accidents occur during month end as workers will be working under pressure to meet the monthly target of gold.

4.3.1.4 Work overload

From the respondents the effects of work overload are causing accidents, fatigue and exhaustion. When a person is exhausted, they become more prone to incidents and accidents. Most tasks in the industry require a person to be on his/ her toes all the time. 58% of the respondents showed that the work overload was high at the organisation, 39% revealed that it was on average scale, 2% indicated that the work overload was excessive and the other 1% revealed that the workload was low.

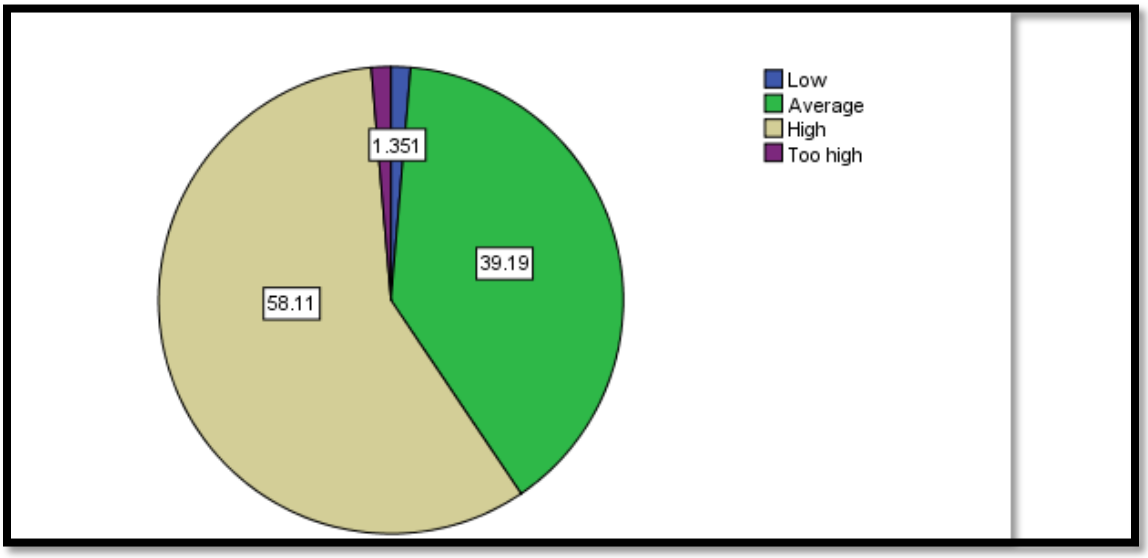


Figure 4.3 Percentage work overload on workers
Source: Field data (2017)

4.3.1.5 Poor management commitment

Lack of management control permits the existence of certain accidents and lower the operation of the HSE department. The HSE department is responsible for all the HSE issues in the whole organisation and that's burdensome. There is need to educate the supervisors and managers concerning the need for them to be on the forefront in the running of safety issues in their respective sections thus promoting a safety environment for the workers. Williams (2008) postulates that managers may inadvertently encourage at risk behaviour through failure to enforce safe behaviour. On one condition one of the managers told the workers to do their work without doing their pre-task risk assessment thus showing the management is not creating a safe environment for the workers. In addition, lack of supervision is another cause of accident identified. Poor management commitment also leads to accidents.

4.3.1.6 Lack of adequate PPE

Another unsafe condition that was identified by employees was that the employer was not providing adequate PPE. It is the duty of the employer to provide the necessary PPE for the job as stated in the SI 68:1990. Information from the mine's safety and health complaints book

revealed that the employees do not have adequate PPE. Employees complained that they were working at times without gloves, leg guards and dust masks. Even from the questionnaire the respondents also indicated that at times they would work with inadequate PPE.

4.3.1.7 Lack of adequate training

Lack of adequate training from the supervisor, management and HSE practitioners is also leading to high prevalence of accidents at the organisation. Questionnaires results showed that employees went through the HSE induction prior to the commencement of work. 70% of the respondents were not trained on the causes of accidents, only 30% were trained. This shows that the employees have little knowledge on the causes of accidents. On the HSE induction they are just trained on the general safety skills. Workers need to be trained by external trainers like NSSA officials who are well versed in HSE issues. The HSE Officer revealed that they sometimes do refresher courses when need arises but at times nothing is done on training the employees on refresher courses. Some of the employees do not even know the procedures due to inadequate training.

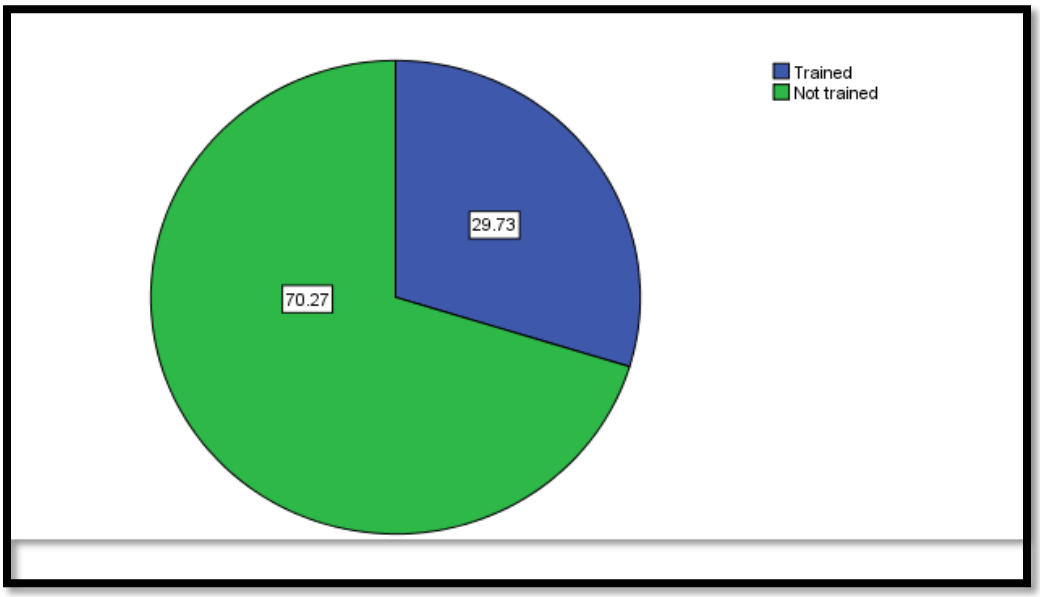


Figure 4. 4 Percentage of knowledge on the causes of accidents
Source: Field data (2017)

4.3.2Unsafe acts

4.3.2.1 Drinking alcohol whilst working

One of the unsafe acts that was identified was being drinking alcohol whilst working. Employees drink alcohol whilst they are on duty meaning that they are not concerned with their safety at the workplace because if one gets drunk whilst on duty their chances of being involved in an accident are very high. In most cases truck drivers are drink while on duty and this has led to accidents. In one of the investigation it was noted that the driver was drunk although they couldn't prove out because there was no breathalyzer. Operating machinery whilst under the influence of alcohol affect judgement and visibility of workers which lead to accidents.

4.3.2.2 Ignoring safety procedures/ regulations

Employees are ignoring safety procedure/ regulations. This includes not conducting pre-task risk assessments before work commences as well as isolating machinery. Pre-task risk assessment assists in identifying hazards that lead to accidents and establishing ways to minimise them. In most of the reports the pre-task risk assessment was inadequately done by the employees. Some of the employees just sign in that they have been involved in the assessment but they do not know the identified hazards

4.3.2.3 Working without adequate PPE

At times the employees do not have adequate PPE but at times they are not putting on the provided PPE, for instance, most of the engineering workers do not wear their gloves putting themselves of risk of sustaining cuts and bruises as they give a reason that the gloves are not comfortable and you can't handle other equipment. More so employees from the Grizzly section do not put on their hard hats those working at the milling section do not put on their ear plugs although these are available.

4.3.2.4 Sleeping on duty

Some of the workers are sleeping on duty due to exhaustion, fatigue, high temperatures and also long working hours. Most of the employees work 12 hour shifts and they leave work late as the bus delays to get them from work. The employees rest for a few hours hence they will be

exhausted causing them to sleep on duty. One of the plant foreman in the interview alluded that long working hours are causing exhaustion and fatigue and this leads to the occurrence of accidents because employees are not getting enough time to rest.

4.3.2.5 Ignorance to HSE issues/ Inertia

Most of the workers due to the fact that they have been working for a long time in the organisation do not wear their dust masks because they claim they have been going for medical checkups for the past years and they have never been diagnosed with pneumoconiosis this shows that the workers are resistant and ignorant. They think that safety rules and regulations are only applicable on paper rather than in reality.

4.3.2.6 Poor housekeeping

Poor housekeeping is also another cause of accident that was identified by the respondents. The researcher also picked poor housekeeping from direct observations. The walkways were full of disorder posing high risk of falls and trips. Debris from falling ore was left on the walkways, tools and equipment were left in the working area instead of the items being returned to storage places, spills and oil leaks were everywhere in the plant section posing the risk of slipping.

Plate 4. 2 Poor housekeeping at the crushing section shed
Source: Field data (2017)

4.4 Hypotheses Testing

4.4.1 Relationship between level of education and knowledge on the causes of accidents.

In order to establish whether there is any significant relationship between level of education and knowledge on the causes of accidents, a Chi-Square test was administered and he results are shown in the table below. The following hypotheses were tested:

H_0 There significant relationship between level of education and knowledge on the causes of accidents

H_1 There is a significant relationship between level of education and knowledge on the causes of accidents

Table 4. 2 Chi-square tests for the level of education and knowledge on causes of accidents

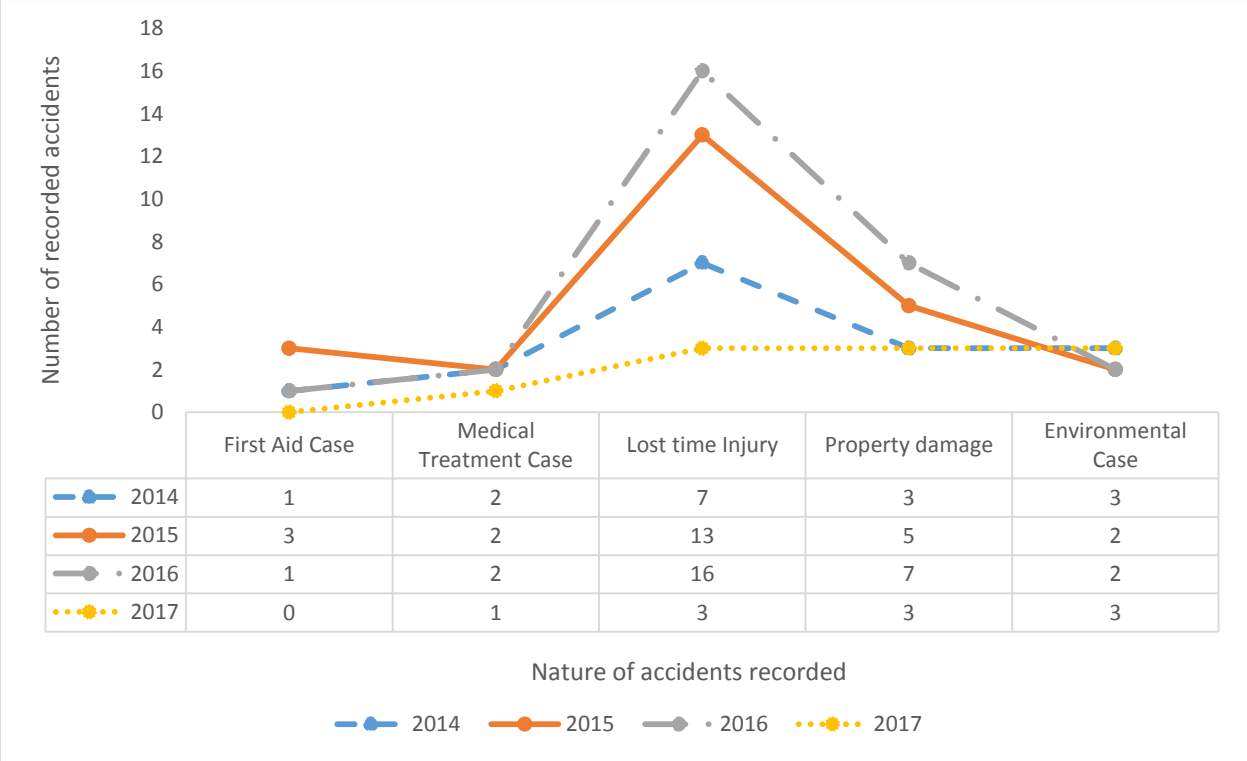
	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.839	4	.211
Likelihood Ratio	5.432[a]	4	.246
N of Valid Cases	74		

6 cells (60.0%) have expected count less than 5. The minimum expected count is 1.78.

The Chi Square figure of 0.211 is greater than 0.05 therefore we reject H_1 and accept H_0 which says that there is no significant relationship between level of education and knowledge on the causes of accidents. This means that the employees who had the knowledge on the causes of accidents could have been trained at the workplace.

4.5 Trends on the occurrence of accidents at Dalny mine

The lost time injury frequency rate for Dalny mine is above the expected from NSSA acceptable standard of 0.7 and below. The HSE Officer alluded that every month an accident occurs at the mine and a times two or three accidents occur during the same month. Questionnaire responses however show that 76% of the workers indicated that they experience accidents monthly, this could be because the workers are only notified of serious or near fatal accidents. The HSE officer also revealed that at most they experience an average of 2 accidents every month. 17% of the workers showed that accidents occur once per fortnight which shows variance of the number of accidents. 4% of the workers mentioned that accidents occur weekly which indicates that not all accidents which occur at the organisation are reported.



	First Aid Case	Medical Treatment Case	Lost time Injury	Property damage	Environmental Case
2014	1	2	7	3	3
2015	3	2	13	5	2
2016	1	2	16	7	2
2017	0	1	3	3	3

Figure 4. 5 Trends of accidents at Dalny Mine
Source: Field data (2017)

Secondary data from Dalny Mine accident register report showed that since the reopening of Dalny Mine in 2014 to date the organisation has recorded total number of 79 accidents. Of the 79 accidents 10 were environmental cases, 18 were property damage, 7 were medical aid cases, 4 were first aid cases and 39 were lost time injuries. The accident trends at the mine showed that the rate at which accidents were occurring was higher in 2016 as illustrated in fig 4.8. This is

largely because the organisation had a crisis in terms of money hence workers worked under a lot of pressure most of the time so that they meet the production targets although in some cases they couldn't make the targets.

First aid cases radically increased in 2015 and this could be a result of the nature of jobs the employees were being exposed to. Dalny Mine started to fully operate in 2015. Most of the workers recruited came from Empress Nickel Refinery, one of the organisations RioZim owns. These employees were not qualified to work in gold processing and had little knowledge on gold processing. In 2016 the numbers of first aid cases were low due to the fact that the employees could have adopted a safety culture. First aid cases result from falls, minor injuries, exposure to excessive heat etc.

A lost-time injury is an accident that results in a fatality, permanent disability or time lost from work. It could be as little as one day or shift (Ebrahim et al 2016). Dalny mine has recorded 39 lost time injuries since the reopening of the organisation and lost time injuries have the highest number and occurrence rate. From the opening there has been an increase in the number of lost time injuries as 7 were recorded in 2014, 13 in 2016 and 16 in 2016 and the period from January to February 2017 3 have been recorded already. These lost time injuries were as a result of poor policy enforcement, working under pressure to meet production targets and not fully identifying the hazards that are associated with one's task.

Medical treatment cases are severe cases where the casualty or the wounded person seeks treatment from a specialized medical doctor or nurse (International Association of Geophysical Contractor et al, 2000). The organisation has recoded 4 medical treatment cases since the reopening in 2014 up to date. In 2015 there was a gradual increase of the medical treatment cases recorded and this could be alluded to the fact that the employees were working under a lot of pressure to meet their monthly target as the manager had promised that if they did not meet their target the plant will close.

18 property damages accidents were recorded from 2014 to date and this is the second highest type of accident recorded after lost time injuries. From the record one can note that there has been an increase in terms of the recorded property damages. The reason why the number of property damages are still increasing is that some of the employees at Dalny are poorly trained or do not have the necessary skills of operating the equipment. They just have been working on the

equipment for years so they think they know everything about the equipment. Most of the operators were not trained internally due to the fact that there was no trainer to do that. Other factors that result in property damages are personal factors like stress, fatigue and drinking alcohol whilst on duty. In the plant section property damage cause work to stop, for instance, when one of the ball mills gear box exploded the whole plant stopped operating as the gear box was completely destroyed meaning production went down. A lot of money is lost on damaged equipment says the engineer in an interview, as most of the equipment is not insured like in the case of the gearbox, $US12 000 was lost owing to the damaged equipment.

4.6 Level of awareness of the employees on causes of accidents

All the employees went through the HSE induction whereby they are taught about general safety issues. 70% of the questionnaire respondents revealed that they were not trained on the causes of accidents only 30% were trained on the causes of accidents. This therefore, shows that there has been inadequate training on the causes of accidents as the majority of the respondents confessed that they were not trained although they have the know-how. It is the duty of the HSE team to give training and awareness to employees on safety issues but they have not played their part in training hence the employees are not fully aware of the causes of accidents.

The researcher also noted that employees could identify the hazards associated with their tasks. From the observation, the researcher had time to look at the pre-task risk assessments that they displayed at their working area which they would have performed before work commences. However, it was noted that they did not identify all the hazards, for instance, heat, tools and machinery (jack hammer). They only identified hazards like dust, noise and fumes.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

The study has shown that the major causes of accidents at Dalny mine were as a result of both unsafe conditions and unsafe acts. With unsafe conditions contributing to 60% of the accidents while unsafe acts constituted 40% of the accidents. Some of the major causes of accidents were lack of adequate training, negligence by the management or failure by employers to invest in occupational safety and health and adopt a systems approach to ensuring the safety and health of employees. The risk assessment system was found to be weak as employees failed to identify some the hazards associated with their task hence the high prevalence of accidents at the mine.

Accidents at the organisation are occurring at an alarming rate and from the trend analysis the researcher noted that the accident occurrence rate was increasing since the re-opening of the mine. Year 2016 recorded the highest number of accidents with a total number of 28 accidents compared to previous years. Of the 79 accidents 10 were environmental cases, 18 were property damage, 7 were medical aid cases, 4 were first aid cases and 39 were lost time injuries.

Employees at Dalny Mine have little knowledge on the causes of accidents. This shows why accidents are occurring at an alarming rate. The findings show that although the employees know the reporting procedure almost, every week an accident occurs but the employees are not reporting all the accidents due to fear of being retrenched. The HSE team is not playing its role of training and giving awareness to the employees on causal factors of accidents.

5.2 Recommendations

In light of the findings obtained from the research the following recommendations were suggested:

- Dalny Mine should get certified with the safety management system OHSAS 18001 as it assists to improve compliance by providing a structure for establishing, monitoring and complying with all legal and regulatory requirements that relate to the operations of the

company. Getting certified not only improves workers health and safety but ensures quality and increases production and savings

- The organisation should review and update risk assessments and standard work procedures.
- Supervisor and top management should encourage employees to report accidents especially minor ones as workers do not report these accidents due fear of being retrenched.
- Management should also be committed to safety issues thus leading by example rather than leaving all safety issues to the HSE department
- Incentives should be given to departments or individuals for being conscious of safety to motivate workers to work safely.
- The HSE department should include issues like the causes of accidents in their induction and also conduct refresher inductions for all employees in order to sustain an accident free workplace.
- All the damaged equipment like conveyors, walkway gratings, ladders should be repaired as these cause accidents.
- The employer should provide adequate PPE to the employees to reduce injuries.
- The Plant Superintendent should enforce the need for plant foreman, shift foreman and supervisors in different departments to be solely responsible for ensuring that employees are working in a safe environment. Consequences should be set for supervisors who do not take responsibility of the safety of employees under their jurisdiction.
- Employees should be given the right at the workplace to refuse to work whenever the conditions are unsafe for them to do as this is already their legal right.

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APPENDIX 1

Dear respondent

I am a student at Midlands State University currently undertaking Honours Degree in Geography and Environmental Studies kindly requesting for your participation and assistance. I am carrying out a research project entitled "An assessment of the causes of accidents at RioZim's Dalny mine in Chakari, Zimbabwe". All the information that you disclose will be kept confidential and will not be used for any other purposes except for the academic research. For the study to be successful you are kindly requested to honestly and truthfully answer the following questions.

Introduction

- Please do not write your name on the questionnaire
- Tick the appropriate response or give a brief explanation in the spaces provided were applicable

Section A: Demographic data of respondents

1. Sex

Male	Female

2. Age

18-24yrs	25-34yrs	35-44yrs	45-54	55 and above

3. Level of education

Grade 7	O' Level	A' Level	Degree/ Diploma	National certificate

4. Which section do you work?

Grizzly	Crushing	Milling	Elution	Slimes Dam	Assay Lab	Engineering

5. How long have you been working in this section?

Weeks	Months	Years

Section B: Questionnaire data

Objective 1: To identify the causes of accidents

6. What is an accident?

.....

……

7. What causes accidents the most in your section

Unsafe conditions	Unsafe acts

8. Can you list some of the causes of accidents in your section?

……

……

……

……

……

……

9. When do you perform risk assessments?

Before work commences	During operation	Not carried out

10. What is the nature of work that is responsible for accidents? ……..

……

11. How would you rate the overall workload?

Very low	Low	Average	High	Too much

12. What effect does work over load has on employees? ……

……

13. What is the type of accident that arise from accidents in your section?

Burns	Road traffic	Skin cuts	Falls		Others specify

14. How many hours do you work per day?**.....**

15. Are workers in a position to refuse to work on hazardous environment?

Yes	No

16. If no explain why?.....
……

17. Does your employer provide adequate PPE?

Yes	No

Objective 2: To evaluate the trends on the occurrence of accidents at Dalny mine

18. How often do you experience accidents in your section?

Weekly	Fortnightly	Monthly

19. How often do people get injured? …….
20. Why is this so? …….
……..

21. Do you know the accident reporting procedure?

Yes	No

Objective 3: To determine the level of awareness of the causes of accidents of employees at the mine

22. Did you undergo the HSE induction session prior to employment?

Yes	No

23. Did you go under on-job induction by the supervisor?

Yes	No

24. Were you trained on accident causal factors?

Yes	No

25. a Do you change sections at times where you are working? ……
b. If yes where do you usually go to work? ……

26. Are you trained on the hazards that are associated with that area?

Yes	No

27. Do you think it's your responsibility to seek out opportunities to reduce accidents at your work place?

Yes	No

28. Explain why you say so? ……..
…….

THANK YOU FOR YOUR COOPERTAION……. GOD

APPENDIX 2
Interview questions for the HSE Officer

Objective 1: To identify the causes of accidents at Dalny Mine

What are the main causes of accidents at the mine?

Which section do normally experience most accidents?

Do you think the employees know the hazards that are associated with their tasks?

What are the type of accidents that you usually notice at the mine?

Do you go for hazardous inspections?

Do you inform your employees on the findings of the inspections?

Objective 2: To evaluate the trends on the occurrence of accidents at Dalny

What can you say about the trend of accidents since the re-opening of the mine?

How many accidents did you record since the re-opening of Dalny mine?

How frequent do these accidents occur?

Objective 3: To determine the levels of awareness of the causes of accidents at the mine

Are workers trained on the causes of accidents?

Are there any refresher courses carried out and they are carried after how long?

If an accident occurs do you inform other employees on the findings of the accident investigation, the causes and remedial actions?

APPENDIX 3
Interview questions for the Plant Superintendent and Plant Operators

Objective 1: To identify the causes of accidents at Dalny Mine

What are the main causes of accidents at the mine under your jurisdiction?

Which section in the plant do normally experience most accidents?

Do employees inform you when they see a hazard or accident at their work sections?

Objective 2: To evaluate the trends on the occurrence of accidents at Dalny

What can you say about the trend of accidents since the re-opening of the mine?

How many accidents did you record since the re-opening of Dalny mine?

How frequent do the employees report on accidents that occur in the plant?

What can you do as management to encourage workers to work safely?

Do you perform job hazard analysis as management?

Objective 3: To determine the levels of awareness of the causes of accidents at the mine

Were employees trained on the causes of accidents?

Do you take part in the training session with your employees?

Do you do accident recalls?

APPENDIX 4
Interview questions for the Resident Engineer

Objective 1: To identify the causes of accidents at Dalny Mine

What are the main causes of accidents at the mine under your jurisdiction?

What type of accidents do you experience in the Engineering section?

Do employees inform you when they see a hazard or accident at their work sections?

Objective 2: To evaluate the trends on the occurrence of accidents at Dalny

What can you say about the trend of accidents since the re-opening of the mine?

How many accidents did you record since the re-opening of Dalny mine?

How frequent do the employees report on accidents that occur in the plant?

What can you do as management to encourage workers to work safely?

Do you perform job hazard analysis as management?

Objective 3: To determine the levels of awareness of the causes of accidents at the mine

Were employees trained on the causes of accidents?

Do you take part in the training session with your employees?

Do you do accident recalls?

APPENDIX 5
Checklist

Sections visited	Observation	Yes	No	Comment
Grizzly Crushing Milling Elution Slimes Dam Assay Lab Engineering	Are works adhering to Standard working procedures and are they in place?			
	Are HSE complaints book being used?			
	Is the accident register accounting for all accidents that have occurred?			
	Are safety and health hazards being communicated to the employees?			
	Are there any unsafe acts that can be identified whilst employees are working?			
	Are employees cautioning each other when one is performing an unsafe act?			
	Are hazardous inspections being conducted?			
	Are risk assessments being conducted by employees?			
	Are job hazard analysis being done by management?			