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Assessment of workers' perception of occupational hazards at Nampundwe Mine in Zambia

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Abstract

Mine accidents remain a significant concern despite ongoing investments in health and safety training. This study explores mineworkers' perceptions of workplace hazards to better understand accident prevention and the protection of health, life, and property. A total of 205 workers from Nampundwe Mine participated in the study, including managers, supervisors, machine operators, general miners, and contractors. A mixed-methods approach was employed, incorporating semi-structured interviews, focus group discussions, and document reviews. The findings revealed that occupational health hazards significantly affect contractors' monthly income. Workers have good to fair knowledge of occupational hazards, with supervisors having the highest level of awareness and contractors the lowest. Despite receiving training in emergency response and awareness of health and safety measures, workers rarely followed standard operating procedures. The major causes of accidents identified were violation of safety rules, falls from heights, and incidents involving trackless vehicles. These findings highlight the need for improved adherence to safety protocols to prevent accidents. Targeted interventions are necessary to enhance workplace safety and reduce accidents in the mining industry. Our study provides valuable insights into the perceptions of mineworkers and identifies areas for improvement. By addressing these gaps, mining companies can create a safer working environment and protect the health and well-being of their workers.

Keywords: Occupational hazards; Mineworkers; Safety training; Workplace safety; Health risks

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1. Introduction

Globally, about 15% of the world's working population lives with disabilities. Many of these cases are found in less developed nations. Disabilities can have a significant impact on individuals and communities. According to the World Health Organization, disability is a complex phenomenon that reflects the interaction between a person's physical condition and the social environment in which they live (World Health Organization, 2022). Research has shown that people with disabilities face various

challenges, including limited access to education and employment opportunities (Centers for Disease Control and Prevention, 2022). A study by the National Institute on Disability, Independent Living, and Rehabilitation Research found that individuals with disabilities are more likely to experience poverty and social isolation (National Institute on Disability, Independent Living, and Rehabilitation Research, 2020). Furthermore, mining activities can significantly affect the health and well-being of individuals with disabilities, particularly those living in communities surrounding mining operations (Phiri, 2021). It is therefore essential to consider their needs and develop strategies to support their health and well-being.

Approximately half of these disabilities result from direct injuries in the mining industry, as opposed to the manufacturing industry (World Health Organization, 2011). Despite the large investments in occupational health and safety measures, mining is still considered a high-risk industry. Studies have shown that the introduction of advanced technologies has reduced mining injuries by 30%. However, mining continues to be perceived as more hazardous than other industries (World Health Organization, 2011). For instance, Zambia has witnessed some of the worst mining accidents in history: in 1970, the Muffler disaster claimed 89 lives due to flooding, and in 2005, an explosion at the Chambishi Mine killed 50 workers (Besa & Bunda, 2018). In addition, 46 miners were killed when a blast tore through an explosives factory at the same mine, destroying the plant (Besa & Bunda, 2018).

Globally, more than 600,000 mine workers have been injured at their workplaces, and over 500,000 have developed new illnesses attributed to mining conditions. According to the Construction Design and Management Regulations (2015), in 2006, a total of 3,021 non-fatal injuries were recorded among coal miners, translating to a rate of 3.3 injuries/100 full-time employees. Employee fatigue, as reported by the Bureau of Labor Statistics (2007), has further increased the risk of accidents in mining settings. In many workplaces, safety protocols are either not followed or not clearly communicated to workers, contributing to the occurrence of accidents.

In Zambia, the mining industry employs 15% of formal workers, contributes about 8% to the national gross domestic product, and accounts for 84% of export earnings (Burgess-Limerick & Steiner, 2006). A study conducted in Africa revealed higher rates of mining-related injuries compared to developed nations (Miller & Swain, 2006). These findings underscore the urgent need to improve understanding of health and safety hazards in the mining industry. This study aims to address that need by exploring mineworkers' perceptions of occupational hazards. Such insight can lead to improved health and safety records; increased productivity; and a reduction in accidents, disability, and deaths.

The purpose of this study was to evaluate mineworkers' knowledge of occupational hazards, risks, and safety protocols. It also sought to determine areas where workers lack understanding or awareness, thereby informing the development of targeted training and education programs. The findings of this study are also intended to guide the development of effective safety training, policies, and procedures to enhance workers' knowledge and behavior.

2. Method

2.1. Study site

Nampundwe Mine is located in the Central Province of Lusaka in the Sibuyunji district (5.4999° S, 27.9308° E). It lies in the western part of Lusaka, about 48 km from the Lusaka Central Business District. The mine began operations in 1913 under the name "King Edwards Mine" (Feyer *et al*., 2001). It is currently an underground pyrite mine owned by Konkola Copper Mine (KCM) Plc. It was previously owned by Anglo-American Cooperation, which also operated Change Mine in Chingola and Konkola Mine in Chililabombwe (Feyer *et al*., 2001).

In 2004, the Zambian government and Vedanta Resources Limited concluded negotiations for the sale of a 51% stake in KCM. Majority shares in KCM were eventually taken by Vedanta Resources Limited following an international bidding process led by Standard Bank and supported by the World Bank (Geological Society of London, 2005). The Nampundwe pyrite deposit lies on the Western flank of a synformal basin, with the orebody hosted within the Cheta Formation, comprising massive dolomites and impure limestones, steeply dipping to the northeast. The pyrite mineralization occurs as disseminated grains as well as continuous pyrite bands up to 2 m thick (Geological Society of London, 2005).

2.2. Research design

According to Kothari (Oxfam International Annual Report, 2001), a research design guides decisions in a study and determines the arrangement of conditions for data collection and analysis to ensure relevance to the research objectives. This study employed a mixed-methods approach, integrating both quantitative and qualitative methods. Quantitative data were analyzed using the Statistical Package for the Social Sciences. Analysis of variance was used to assess differences between groups of workers, while ordinal regression was employed to categorize levels of knowledge (excellent, good, fair, or poor). For qualitative data, audio recordings from focus

group discussions were transcribed into text files. After multiple readings, the narratives were transferred to NVivo 12 software for coding and analysis.

2.3. Sample selection

Both qualitative and quantitative data were obtained from 205 mineworkers at Nampundwe Mine. The participants included 8 managers, 18 supervisors, 24 machine operators, 80 general miners, and 75 contractors.

These key informants were purposively chosen based on their expertise and knowledge of the research topic. An interview guide was used to collect data from key informants. Purposeful sampling, widely used in qualitative research, enables the identification and selection of information-rich cases for effective use of limited resources (Oxfam International Annual Report, 2001).

2.4. Ethical considerations

Throughout the research process, social scientists have a strong moral and professional duty to act ethically (Kothari, 2004). Ethical approval for this study was obtained from the University of Zambia's Research Ethics Committee. The participants were told about the nature of the study and their rights, which included the right to personal privacy, the right to withdraw from the research at any time without providing a reason, and the right to review or withhold interview content—all following the principles of informed consent and voluntary participation. Furthermore, there was no physical or emotional damage inflicted on participants. Informed consent was obtained from all participants, ensuring they understood the study's purpose, risks, and benefits (Beauchamp & Childress, 2001). Participants' confidentiality and anonymity were maintained throughout the research process (British Sociological Association, 2017). The study also adhered to the ethical principles of respect for persons, beneficence, non-maleficence, and justice (Beauchamp & Childress, 2001). To protect confidentiality, raw data were safely stored, with access limited to the researcher and academic supervisors. Pseudonyms were used in documenting the results to protect the identities of participants and organizations (Patton, 2002).

2.5. Study validity and limitations

Validity refers to the extent to which an instrument accurately measures the concept it is intended to assess (Neuman, 2012). To ensure validity, participants were surveyed in their actual work setting at Nampundwe Mine. The researcher collaborated closely with supervisors to ensure that the research instrument was valid and relevant (Creswell, 2014). The questionnaire was constructed after an extensive review of relevant literature and instruments from similar studies (Babbie, 2013). Validity was also ensured by aligning the flow of questions with the study's objectives (Fowler, 2014). The instrument was revised based on feedback and tested through a pilot study at Munali Nickel Mine (Devellis, 2017). To obtain empirical data, respondents were requested to provide specific indicators and supporting evidence for their responses (Yin, 2018).

Limitations refer to potential weaknesses in a study that is usually beyond the researcher's control (Simon & Goes, 2013). In this study, management at Nampundwe Mine could not avail sensitive data, such as accident reports and financial records (Kumar, 2011). The attainment and selection of study respondents were also challenging due to workers' concerns about time consumption (Bryman & Bell, 2015). Despite targeting six focus group discussions, only four were successfully conducted, with some yielding repetitive information (Morgan, 1997). The researcher visited the mine twice but faced difficulties in collecting data from all departments (Creswell, 2014).

3. Results

3.1. Demographic characteristics

Table 1 shows that male respondents constituted the majority at Nampundwe Mine, accounting for close to 88.91%, while female respondents made up 11.09%. The sample distribution across all five respondent categories was as follows: managers (4.03%), supervisors (8.07%), machine operators (20.00%), general miners (50.84%), and contractors (17.06%). Furthermore, the mean age, educational background, monthly salary, and mean years of service are presented in Table 1.

3.2. Mineworkers' knowledge of occupational health and safety at Nampundwe Mine

As shown in Table 2, workers at Nampundwe Mine have good to fair knowledge of occupational hazards. Supervisors appeared to have the highest levels of awareness, with 38.97% categorized as having fair knowledge and 54.61% as having good knowledge. The contractors had the lowest levels of awareness, with 37, 05% ranked as fair and only 18.65% as good.

3.3. Mineworkers' attitude toward the use of personal protective equipment (PPE)

Figure 1 illustrates that 100% of managers and supervisors reported positive attitudes toward wearing PPE. Among other groups, 78% of machine operators (160/205), 72% of general miners (147/205), and 61% of contractors (125/205) were reported to have a favorable attitude toward PPE use.

Table 1. Demographic characteristics of respondents (*n*=205)

Variables	Value (%)
Age (mean)	35 years
Gender	
Male	88.91
Female	11.09
Position	
Manager	4.03
Supervisor	8.07
Machine operator	20.00
General miner	50.84
Mine contractors	17.06
Level of education	
Primary	15.84
Secondary	31.66
College	35.22
University	9.58
Postgraduate	7.7
Monthly salary	
Contractor employee	K2,500 and above
Company employee	K6,500 and above
Years on the job (mean)	33 years

Table 2. Awareness levels of mineworkers on health and safety hazards

Awareness (%)	Manager	Supervisor	Machine operator	General miner	Contractor
Excellent	0.29	4.37	3.00	2.33	2.00
Good	42.86	54.61	41.00	25.69	18.65
Fair	56.85	38.97	56.00	43.06	37.05
Poor	0.00	2.05	0.00	28.92	42.30

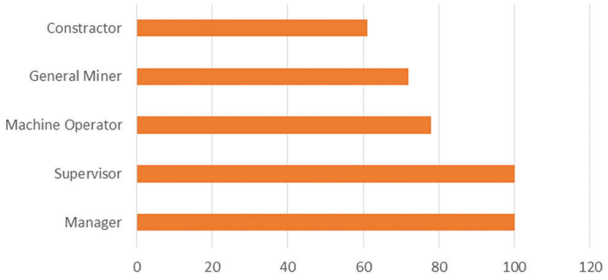

Figure 1. Mineworkers' attitude toward the use of personal protective equipment

3.4. Causes of accidents at Nampundwe Mine

As presented in Table 3, the major causes of accidents are contravention of safety rules (38.11%) falling from heights (37.52%), incidents involving trackless vehicles (8%), rock falling (5.4%), morning shift-related fatigue (4.01%), and electricity shocks (6.91%).

3.5. Effectiveness of existing health and safety measures at Nampundwe Mine

As shown in Table 4, the majority of the respondents indicated that they had adopted the safety and health measures developed by Nampundwe Mine.

4. Discussion

4.1. Demographic characteristics

4.1.1. Age

Our findings revealed that the average age of respondents was about 35 years, suggesting that Nampundwe Mine employs a predominantly youthful workforce. The majority of workers were machine operators (20%) and miners (50.84%). As shown in Table 1, most of the younger workers are employed in underground roles, which are physically demanding and require endurance and physical strength—qualities typically associated with younger individuals (Pransky, 2005). These roles are also high-risk and require an understanding of safety procedures to prevent accidents.

A youthful workforce is expected to be more agile, with quicker reflexes, which can contribute to accident prevention (Ilmarinen, 2001). In addition, younger workers may be more adaptable to new technologies and updated safety measures, which can help reduce the likelihood of workplace incidents. They may also be more easily reassigned to other departments after an injury, reducing disruptions to overall operations. However, accident prevention depends not only on age but also on workers' knowledge of and adherence to the safety rules and regulations. The injuries, if not properly managed, may have negative effects on individual productivity and the company's overall performance (Hackshaw, 2008).

4.1.2. Gender

As shown in Table 1, males represented 88.91% of the workforce, while females represented 11.09%. The findings are consistent with the World Bank report, stating that mining companies rarely employ women as the mining jobs are typically reserved for men because of the physical demands involved (Ilmarinen, 2001).

4.1.3. Position

The majority of the workforce falls under the machine operator and general miner categories, indicating that a substantial proportion of workers is directly involved in day-to-day operations within the mine.

4.1.4. Level of education

The study revealed that more than half of the respondents (52.5%) had tertiary education. The remaining had secondary education (31.64%) or primary education (15.84%). These figures suggest that most workers have formal education, which likely enhances their ability to comprehend occupational hazards and safety procedures. The presence of an educated workforce is advantageous for hazard awareness and compliance with safety protocols, as formal education provides foundational knowledge that supports workplace learning and training.

4.1.5. Monthly salary

The findings indicate that contractor employees at Nampundwe Mine typically earn a monthly salary starting from K2, 500, while company-employed workers earn from K6, 500 and above. This income disparity has contributed to a lack of motivation among contractors, which may, in turn, affect compliance with safety rules and regulations. Table 1 highlights this contrast, suggesting that lower-income earners are less likely to adhere strictly to safety protocols compared to their higher-paid counterparts. This concern was reflected in the qualitative data as well.

One contractor stated:

> *"To be honest, we contractors are very much demotivated, hence we cannot follow the morning briefings on the so-called standard operational procedures which would not benefit us but would benefit more to the company… How do you expect a contractor employee who is getting K2, 500—compared to a full-time employee who is earning K6, 500 but performing the same job—to follow the heavily imposed operational procedures?"*

Table 3. Causes of accidents at Nampundwe mine

Cause of accident	Frequency	%
Contravening safety rules	12	38.11
Morning shift-related fatigue	4	4.06
Falling from heights	16	37.52
Electricity shocks	9	6.91
Trackless vehicle incidents	10	8.00
Rock falls	33	5.40

4.1.6. Number of years on the job

The study finding shows that the mean work experience among mineworkers was approximately 3 years (Table 1). Workers with this level of experience were typically exposed to health and safety training and were more likely to avoid accidents. Insights from the focused group discussion also support this observation:

> *"Mineworkers with more than 2 years of work experience are highly aware of mine hazards. This is because they have attended a number of trainings and a series of refresher training. However, there has been a violation of following safety rules and regulations."*

These findings suggest that work experience contributes positively to hazard awareness and risk prevention. With an average of 3 years of experience, mineworkers are expected to be familiar with basic safety procedures. Moreover, personal experiences with accidents may enhance safety consciousness and encourage preventive behavior. As noted by Eftimie *et al*. (2009), individuals who have previously encountered workplace accidents tend to act more cautiously to avoid recurrence.

The overall results of this study indicate that workers at Nampundwe Mine have fair to good knowledge of occupational hazards. These results are corroborated in Manuele's International Labor Organization (2012) study, which reported that workers in the mining industry had reasonable knowledge of occupational hazards. Similarly, Bahn's (2013) study of Australian mineworkers also reported that the workers had good knowledge of occupational hazards.

4.2. Mineworkers' knowledge of occupational health and safety at Nampundwe Mine

The findings revealed that mine managers had a lower level of knowledge about mine hazards, compared to supervisors. This gap is particularly concerning as mine managers have the overall responsibility to directly coordinate all the duties of supervisors and general

Table 4. Types of health and safety measures employed at Nampundwe Mine

Measure (%)	Manager	Supervisor	Machine operator	General miner	Contractor
Safe use of workplace tools, machinery, and equipment	100.00	100.00	98.00	97.56	96.00
Fire safety and emergency procedures	80.00	76.78	77.80	76.00	55.00
First aid	60.10	76.10	80.00	80.20	79.00
Accident reporting procedure	97.00	100.00	97.00	88.91	59.00
Risk assessments	66.10	60.00	57.10	55.00	61.00

mineworkers. Their limited hazard awareness entails that they may be less likely to take preventive action or respond effectively to hazard reports submitted by supervisors.

Mineworkers with good or excellent awareness of mine hazards are more likely to act proactively to prevent accidents. In this study, supervisors showed higher levels of awareness, followed by machine operators and general miners. The regular interactions between supervisors and mineworkers may explain their hazard awareness. In addition, their prior work experience may also account for their deeper perception of hazards.

The low level of hazard awareness among contractors can be attributed to several factors. A major contributing factor appears to be the lack of motivation, stemming from significantly lower income levels. Table 1 illustrates that lower-income workers were more likely to disregard health and safety regulations. The results indicate a significant association between income and the impact of occupational health hazards among contractors ($p<0.001$, odds ratio = 0.99, confidence interval = 0.997–0.998). Specifically, for every 0.99 decrease in the odds of monthly income, the negative impact of demotivation and accidents increased. This suggests that income reduction is directly associated with increased accident risks due to low morale and diminished compliance with safety protocols (Table 5).

The study also revealed a statistically significant relationship ($p<0.001$, Table 5) between occupational health hazards and monthly income among contractors. These findings are similar to Chipere (2008), who conducted a study on stress management in the copper mines in Zambia. The study identified excess workload, low monthly income, long working hours, and unreasonable performance demands as key contributors to stress and the neglect of safety rules.

The high proportion of workers with poor awareness (73.27%; Table 2) can also be attributed to low educational attainment. Approximately 15.84% of workers had only primary-level education, limiting their ability to understand and follow written safety instructions. Bahn (2013) and Weichbrodt (2015) argue that workers who do not understand the implications of safety rules are less likely to comply. The ability to read safety instructions is important for avoiding injuries, and a lack of literacy increases the likelihood of accidents. Another contributing factor to poor awareness is insufficient training and lack of refresher courses. Regular and adequate training can significantly enhance hazard recognition and compliance. Well-trained workers are more likely to take all necessary precautions, including the consistent use of protective gear such as boots, helmets, and safety clothing. They are also more likely to report safety breaches and proactively maintain a safe working environment. Conversely, the lack of knowledge and training exposes workers to risks that could lead to serious injuries or long-term disabilities, as noted by Golovina *et al*. (2015). In addition, workers who strictly adhere to safety measures but still experience uncontrollable accidents—such as landslides—may become disillusioned with the entire safety system. As Manuele (2010) suggests, such experiences can lead to the abandonment of personal protective practices due to a perceived lack of efficacy.

Table 5. The impact of occupational health hazards on income levels at Nampundwe Mine

Position	Odds ratio	Confidence intervals	*p*
Contractor	0.99	0.99–0.99	0.00
General miners	2.08	0.95–4.74	0.07
Machine operator	1.32	0.43–4.01	0.61
Manager	1.24	0.14–7.69	0.82

Notes: Ordinal logistic regression was used. The confidence intervals are indicated at 95% and $P<0.05$ indicates statistical significance.

4.3. Mineworkers' attitude toward the use of PPEs

As shown in Figure 1, the study revealed that all managers and supervisors reported a positive attitude toward the wearing of PPE, stating that PPE helps to prevent mine accidents. This finding aligns with Mavhunga (2020), who reported that PPEs are useful to mineworkers and serve as a protection against mine hazards. However, the findings also showed a reduced attitude toward the use of PPE among 78% of machine operators, 72% of general miners, and 61% of contractors. This supports Manuele (2010), who reported that some mineworkers demonstrated a negative attitude toward PPE, citing it as "frequently uncomfortable, rarely fully protective, and sometimes hazardous to the health of workers when worn for long periods of time." The excellent attitude among Managers and Supervisors may be attributed to their role in enforcing health and safety measures at the mine. Conversely, the negative attitude among some machine operators (22%), general miners (28%), and contractors (39%) is reportedly linked to resistance against wearing PPE for long durations. This contrasts with ILO (2012) guidelines emphasizing the importance of PPE in preventing accidents. Working without PPE regularly exposes mineworkers to avoidable accidents, which may result in injuries, disabilities, or even fatalities.

4.4. Causes of accidents at Nampundwe Mine

The finding shows that at Nampundwe Mine, the most frequent cause of accidents was the contravention of safety rules (38.11%; Table 3). This finding aligns with study conducted by Frippo's (1984) in America, which revealed

that human error was the primary cause of accidents, outnumbering technical causes four to one. According to Flippo, human-related causes are often linked to individual deficiencies, including improper attitudes, carelessness, recklessness, incompetence, daydreaming, alcoholism, and substance abuse on the job. These findings are also supported by Musonda (1990), who studied lost-time accidents at Nampundwe Mine and cited lack of supervision, failure to exchange warning whistles, and reporting to work under the influence of alcohol as common causes. The second most frequent cause was falling from heights (37.52%), attributed to slippery or unstable environments within the mine. A focus group discussion among mineworkers revealed:

> *"There are a number of hazardous environments in our mine—some are slippery and some environments are not all that stable…You would find that whilst you are drilling, an heavy rock and mine soil would fall on you."*

(Mine worker; 07).

Third, the findings reported that Trackless vehicles accounted for 8% of reported accidents, often due to poorly maintained roadways. Most of the underground working places are poorly illuminated, which always results in poor driving conditions and a lack of visibility. These findings are similar to those of Fowler (2014), who analyzed mine safety in South African mines and identified similar hazards—poor roadways, poor illumination, and the use of heavy plant and machinery. One mine manager in this study stated that trackless vehicle accidents occurred due to human error resulting from alcohol consumption, with drivers reportedly concealing and consuming small sachets of alcohol during work hours.

Rockfalls accounted for 5.4% of accidents. These occur due to the instability of high, erosion-resistant outcrops and are influenced by several factors, including rock hardness, weathering, slope steepness, and bedding characteristics. Stacey (2004) also identified rockfalls as a major cause of fatalities in the mining industry. The morning shift accounted for 4.01% of accidents. This may be due to pressure to increase production and profits, which can lead to errors and unsafe practices.

Finally, electrical shocks were responsible for 6.91% of accidents, often occurring during drilling and maintenance. These findings are supported by Cawley (2003), who reported that most electrical accidents and fatalities in mining occurred during electrical maintenance and mineral extraction activities.

4.5. Effectiveness of existing health and safety measures at Nampundwe Mine

As shown in Table 4, various health and safety measures have been employed at Nampundwe Mine, including training on basic health and safety rules, hazard identification, and control. The findings indicate that all employees are trained to respond to an emergency. For example, when an emergency alarm is triggered, workers are expected to rush to the emergency assembly point, allowing the fire or rescue team to act accordingly. These results are similar to the findings of McLaughlin (2006), who stated that employee training in basic health and safety rules minimizes accident occurrences.

However, not all mineworkers follow the rules and regulations. One possible explanation is the relatively low literacy levels among some workers. As shown in Table 1, 15.84% of the respondents had only attained primary school education. These workers may prefer hands-on training approaches over written instructions. Poplin (2007) noted that participation in orientation and health and safety training before commencing work indicates a greater likelihood of workers adapting well to their roles and avoiding severe injuries that may result in long-term disabilities.

5. Conclusion

The findings of this study revealed that mineworkers have good to fair knowledge of occupational hazards. However, mine managers demonstrated comparatively lower levels of hazard awareness than supervisors. Given their role in directly coordinating the duties of supervisors, it is critical that managers maintain a high level of hazard awareness. In contrast, supervisors demonstrated higher awareness. These results indicate variability in hazard awareness across different job categories, underscoring the need for tailored safety training and reinforcement of safety protocols throughout the workforce.

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Conflict of interest

The authors declare that they have no competing interests.

Author contributions

Conceptualization: Maxwell Phiri, James Manchisi
Formal analysis: Maxwell Phiri
Investigation: Anthony Phiri, Wezi Nyirenda, Enos Phiri
Methodology: Anthony Phiri
Writing–original draft: Anthony Phiri
Writing–review & editing: Maxwell Phiri, James Manchisi

Ethics approval and consent to participate

Ethical approval was obtained from the University of Zambia's Research Ethics Committee (Approval No.: NASREC: 2021-2021- MAY -008). Written informed consent was obtained from the relevant authorities and participants at Nampundwe Mine, ensuring confidentiality and anonymity.

Consent for publication

The participants gave consent to publish their data in this article.

Availability of data

Data are available from the corresponding author upon reasonable request.

Further disclosure

The paper has been uploaded to or deposited in a preprint server (doi: 10.1101/2024.11.26.24317988).

References

Babbie, E.R. (2013). The Practice of Social Research. 13th ed. United States: Cengage Learning. Available from: https://www.scirp.org/reference/referencespapers?referenceid=3882001 [Last accessed on 2022 Oct 28].

Bahn, S. (2013). Workplace hazard identification and management: The case of an underground mining operation. *Safety Science*, 57:129-137.

https://doi.org/10.1016/j.ssci.2013.01.010

Beauchamp, T.L., & Childress, J.F. (2001). Principles of Biomedical Ethics. Oxford: Oxford University Press.

Besa, B., & Bunda, V. (2018). Analysis and Management of Safety Issues on the Copper Belt Mines, SSTEP Project, African Development Bank, Ministry of Higher Education (MoHE), Report 001.

British Sociological Association. (2017). Statement of Ethical Practice. Durham: British Sociological Association.

Bryman, A., & Bell, E. (2015). Busiess Research Methods. Oxford: Oxford University Press.

Bureau of Labor Statistics. (2007). Available from: https://www.bls.gov/opub/mlr/2007/ [Last accessed on 2022 Jun 19].

Burgess-Limerick, R., & Steiner, L. (2006). Injuries associated with continuous miners, shuttle cars, load-haul-dump and personnel transport in New South Wales underground coal mines. *Mining Technology IMM Transactions*, 115(4):160-168.

https://doi.org/10.1179/174328606X151033

Cawley, J.C. (2003). Electrical accidents in the mining industry, 1990-1999. *IEEE Transactions on Industry Applications*, 39(6):1570-1577.

https://doi.org/10.1109/IAS.2001.955710

Centers for Disease Control and Prevention (CDC). (2023). Available from: https://www.ebsco.com/research-starters/public-health/centers-disease-control-and-prevention-cdc [Last accessed on 2024 Nov 12]

Chipere, G. (2008). Reduction of the Job Accidents through Stress Management: A Case Study for Mopani and Konkola Copper Mines. [MSc Dissertation]; University of, Zambia.

Creswell, J.W. (2014). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. London: Sage Publications.

Devellis, R.F. (2017). Scale Development: Theory and Applications. London: Sage Publications.

Eftimie, A., Heller, K., & Strongman, J. (2009). Gender Dimensions of the Extractive Industries: Mining for Equity. Washington, DC: World Bank.

Feyer, A.M., Williamson, A.M., Stout, N., Driscoll, T, Usher, H., & Langley, J.D. (2001). Comparison of work related fatal injuries in the United States, Australia, and New Zealand: Method and overall findings. *Injury Prevention*, 7(1):22-28.

https://doi.org/10.1136/ip.7.1.22

Fowler, F.J. (2014). Survey Research Methods. London: Sage Publications.

Frippo, E.B. (1984). Personnel Management. 6th ed. Toronto: Me Graw Hill International Editions.

Geological Society of London Report. (2005). Available from: https://www.lyellcollection.org/loi/sp/group/c2000.d2000.y2005 [Last accessed on 2022 Jun 18].

Golovina, O., Teizer, J., & Pradhananga, N. (2015). Heat map generation for predictive safety planning: Preventing struck-by and near miss interactions between workers-on-foot and construction equipment. *Automation in Construction*, 71(1):99-115.

https://doi.org/10.1016/j.autcon.2021.10.03:03

Hackshaw, A. (2008). Small studies: Strengths and limitations. *European Respiratory Journal*, 8(32):1141-1143.

https://doi.org/10.1183/09031936.00136408

Ilmarinen, J.E. (2001). Aging workers. *Occupational and Environmental Medicine*, 58(8):546-552.

https://doi.org/10.1136/oem.58.8.546

International Labour Organization (ILO) (2003). Standards-

Related Activities in the Area of Occupational Safety and Health, Report VI, International Labor Conference, 91st Session. Available from: https://www.google.com/search? q=International+Labour+Organization [Last accessed on 2022 Feb 14].

International Labour Organization (ILO). (2012). Estimating the Economic Costs of Occupational Injuries and Illnesses in Developing Countries: Essential Information, for Decision Makers. Switzerland: Printed by the International Labour Office, p.16-17.

Kothari, C.R. (2004). Research Methodology: Methods and Techniques. 2nd ed. New Delhi: New Age International Publishers.

Kumar, N. (2011). Research Methodology: A Step-by-Step Guide for Beginners. London: Sage Publications.

Manuele, F.A. (2010). Risk Assessment, Acceptable Risk. Available from: https://aeasseincludes.assp.org/professionalsafety/pastissues/055/05/f1manuel_0510.pdf

Mavhunga, C. (2020). Poverty Pushes Zimbabwe Miners into Underground, Dangerous Work, Observers Say. Available from: https://www.voanews.com/a/africa_poverty/pushes/zimbabwe/miners-underground-dangerous-work-observers-say/6199319.html

McLaughlin, K. (2006). In China: Energy Needs v. Mine Safety, Christian Science Monitor, 26 January, p. 7.

Miller, D.P., & Swain, A.D. (2006). Human error and human reliability. In: Salvendy, G., editor. Handbook of Human Factors. New York: John Wiley & Sons.

Morgan, D.L. (1997). Focus Groups as Qualitative Research. London: Sage Publications.

Musonda, EM. (1990). Safety Management Course Practical Project, Losttime Accidents, Areas of Occurrence and their Costs Involving Falling of Ground at Draw and-Drilling Points Underground Personal Injuries 1985-1990 ZCCM. Zambia: ZCCM Investments Holdings.

Neuman, W.L. (2012). Basics of Social Research: Qualitative and Quantitative Approaches. United Kingdom: Pearson Education.

Neuman, W.L. (2012). Social Research Methods: Qualitative and Quantitative Approaches. United Kingdom: Pearson Education.

Patton, M.Q. (2002). Qualitative Research and Evaluation Methods. 3rd ed. Thousand Oaks, CA: Sage Publications.

Phiri, J. (2021). The effects of effective communication on organizational performance based on the systems. *Open Journal of Business and Management*, 9:659-671.

Poplin, G.S., Miller, H.B., Ranger-Moore, J., Bofinger, C.M., Kurzius-Spencer, M., Harris, R.B., *et al*. (2007). International evaluation of injury rates in coal mining, A comparison of risk and compliance-based regulatory approaches. *Safety Science*, 46(8):1196-1204.

https://doi.org/10.1016/j.ssci.2007.06.025

Pransky, G.S., Benjamin, K.L., Savageau, J.A., Currivan, D., & Fletcher, K. (2005). Outcomes of workrelated injuries, a comparison of older and younger workers. *American Journal of Industrial Medicine*, 47(2):104-112.

https://doi.org/10.1002/ajim.20122

Simon, M.K., & Goes, J. (2013). Dissertation and Scholarly Research: Recipes for Success. Seattle, WA: Dissertation Success.

Stacey, T.R. (2004). The link between the design process in rock engineering and thecode of practice to combat rock fall and rockburst accidents. *Journal of the Southern African Institute of Mining and Metallurgy*, 104(1):29-33.

The Construction (Design and Management) Regulations. (2015). Available from: https://www.google.com/search?q=andy+muranda&sca_esv=7cffce009da9068a&rlz=1c

Weichbrodt, J. (2015). Safety rules as instruments for organizational control, coordination and knowledge: Implications for rules management. *Safety Science*. 80:221-232.

https://doi.org/10.1016/j.ssci.2015.07.031

World Health Organization. (2011). Occupational Health Program of WHO Headquarters (Geneva, WHO) Workplace Injuries. Vol. 2. U.S. Bureau of Labor Statistics, January 2013). Available from: https://www.bls.gov/opub/btn/volume-2/injuries/illnesses-and-fatal-injuries-in-mining-in-2010.htm

World Health Organization. (2022). Disability. Available from: https://www.who.int/health-topics/disability#tab=tab_1

Yin, R.K. (2018). Case Study Research and Applications: Design and Methods. London: Sage Publications.