BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES

ASSESSMENT OF OCCUPATIONAL HEALTH AND SAFETY HAZARDS ASSOCIATED WITH CONSTRUCTION OF THERMAL POWER PLANTS: CASE OF ZIMBABWE POWER COMPANY HWANGE EXPANSION PROJECT

TATENDA MAHUMUCHA

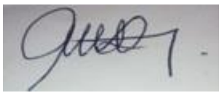
B202529B

A DISSERTATION SUBMITTED PARTIAL FULFILMENT OF THE REQUIREMENTS OF THE BACHELOR OF SCIENCE IN SAFETY, HEALTH AND ENVIRONMENTAL MANAGEMENT. 4.2

28 JUNE 2024

DECLARATION

This research project is my original work and it has been not been submitted to any other examination board. No part of this research project will be produced without my consent or that of Bindura University of Science Education.

Signature:  Date: 28/06/2024

To be compiled by the supervisor

This dissertation is suitable for submission to the faculty and has been checked for conformity with the faculty guidelines.

Signature: Date:

DEDICATION

This dissertation is dedicated to my mother and father, who helped me through difficult times both emotionally and financially. They have made many sacrifices to make this happen, and they have inspired me to approach every work head-on. I will always be grateful to them.

ACKNOWLEDGEMENTS

My supervisor, Dr. Mabhungu, has my sincere gratitude for all of her hard work, knowledge, and patience in making this study possible. Additionally, I want to thank my friends and classmates for their valuable advice. Munyaradzi, Miranda, Anashe, Anatsa, Chido and Ethan thank you for your emotional and financial support.

ABSTRACT

The study aimed to investigate the occupational health and safety hazards associated with the Hwange Expansion Project in Zimbabwe. The research employed a quantitative, descriptive cross-sectional design to collect data from 2021 to the present. Data analysis was conducted using SPSS and Excel packages. Thematic analysis and descriptive analysis were used to analyze qualitative and quantitative data to create charts and tables with percentages and ranges to make analysis easy. A sample of 88 workers, including engineers, technicians, and occupational health and safety officers, was surveyed using a self-administered questionnaire. The response rate for the questionnaire was 53 which is 60.22% which is more than the minimum threshold of 60% as suggested by Frinchman, (2010).

The findings revealed that the primary hazards identified were machinery-related accidents, falling from heights, exposure to chemicals/fumes, electrical hazards, and fire/explosions. Machinery-related accidents had the highest average impact rating, indicating a major concern for workers. A correlation analysis showed a significant positive relationship between employee awareness and the occurrence of electrical hazards, suggesting that increased awareness led to more reporting or recognition of these hazards.

The study also assessed employees' awareness of occupational health and safety (OHS) protocols and practices. The results showed that 79.2% of employees were aware of OHS, while 66% had received OHS training. A strong positive correlation was found between receiving OHS training and employee awareness, indicating that training plays a crucial role in enhancing safety knowledge among the workforce.

The study provides valuable insights into the occupational health and safety challenges faced by workers in the Hwange Expansion Project. The researcher went on to recommend that ZPC Hwange Expasion Project must Implement Comprehensive OHS Training Programs, Enhance Communication and Engagement, Improve Site Maintenance and Hazard Control, Develop Targeted Interventions and Safety Campaigns, Promote a Strong Safety Culture, Enhance Stakeholder Collaboration, Utilize Technology and Innovation and Regularly Review and Update Safety Policies

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

ZPC -	Zimbabwe Power Company
HBM -	Health Belief Model
OHS -	Occupational Health and Safety
ILO -	International Labour Organisation
MW -	Mega Watt
SMS -	Safety Management Systems
FMEA -	Failure Mode and Effects Analysis
BIM -	Building Information Modelling
EIA -	Environmental Impact Assessment
LCA -	Life Cycle Assessment
PPE -	Personal Protective Equipment
HCCL -	Hwange Colliery Company
SHE -	Safety Health and Environment
SPSS -	Statistical Package for Social Sciences

CHAPTER 1: INTRODUCTION

1.1 Background to the study

The construction sector is consistently ranked among the most dangerous industries to work in, with high risks of occupational accidents, injuries, and work-related diseases (Olcay et al 2022). Every year, thousands of construction workers suffer acute injuries and even fatalities due to unsafe work environments and exposure to occupational hazards on job sites around the world (Dodoo, J.E. 2021.). Common causes of incidents in construction include falls from height, being struck by heavy objects, electrocutions, and injuries from operating powered machinery and equipment (Almaskati et al 2024; Simutendi 2022). According to the International Labour Organization (ILO, 2015), there are an estimated 260,000 fatal workplace accidents reported annually worldwide, with construction accounting for over 10% of these fatalities. When non-fatal injuries are included, construction injury rates are two to three times higher than the average for all sectors combined (Hinze et al., 2013). In terms of economic impacts, the direct and indirect costs of construction accidents have been estimated at over 4% of global construction costs (Hinze et al., 2013). This research therefore seeks to assess the hazards associated with the thermal power station construction.

According to the International Labour Organisation (ILO, 2020), accident rates might be up to six times greater in underdeveloped nations than in industrialised ones. As populations and economies expand rapidly, investment in new energy infrastructure has surged in recent decades to help address chronic power shortages (Strielkowski et al., 2021). A substantial portion of investment has been directed towards conventional thermal power generation sources such as coal and natural gas-fired plants (Song et al 2021; Pudasainee 2020). Countries including South Africa, Nigeria, Egypt, Kenya and Morocco have all pursued extensive construction of new coal-fired stations to boost national power capacities and grids (Auth 2023; Mutezo, 2021). Construction sites for coal-fired stations, gas turbine projects, and combined cycle power blocks often cover hundreds of hectares and involve thousands of workers on any given day (Tarekegne et al 2021). Complex erection and installation activities are required for components including boilers, turbines, stacks, transmission lines, and other major plant infrastructure. Hazards may arise from working at heights, lifting and rigging of heavy equipment, welding and grinding operations, exposure to dusts and noise, electrical risks, and coordination of vehicle and equipment movements over expansive worksites (Lyon 2021). In many African nations where basic Occupational Health and Safety (OHS) management capacity remains limited, power sector construction projects have taxed already overburdened regulatory and compliance systems (Nair, 2020). Common issues reported from construction sites include inadequate hazard identification, lack of safety training and personal protective equipment provisioning, poor emergency response preparedness, and limited monitoring and enforcement of safety programs and protocols (Zhang et al 2020). Significant responsibilities also fall upon large international engineering, procurement, and construction contractors to effectively implement their own safety standards when working on African projects (Boadu et al 2020).

The Republic of Zimbabwe relies heavily on thermal power generation to meet national electricity demand, with over 80% of current capacity sourced from aged coal-fired plants (Howells et al, 2021). One such major initiative currently underway is the construction of a coal-fired power station developed ZPC Hwange Expansion Project. Zim Live (2019) stated that in recent years there have been numerous deadly incidents in Zimbabwe's construction industry. In November 2019, a worker employed by a sub-contractor died after falling from a scaffold while on duty at the Hwange Power Station extension construction site (Chronicle, 2019). In February 2021, another incident occurred when an employee fell 31 meters from a scaffolding while welding at the Hwange Power Station which resulted in his death (iHarare, 2021). In July 2021, two workers were injured in an explosion at the Hwange Power Station in which the incident occurred during maintenance work on a boiler (The Herald, 2021). This research assesses the hazards in the construction of thermal power plants, using the Hwange Expansion Project as a lens through which to explore and understand them. The study aims to contribute substantively to safer construction practices, informed policy decisions, and the sustainable growth of Zimbabwe's energy infrastructure.

1.2 Problem statement

Thermal power plant construction at the Zimbabwe Power Company's Hwange Expansion Project poses a significant risk to workers during the construction phase. A number of injuries have been recorded at Zimbabwe Power Company's Hwange Expansion Project. Generally, the major accidents that have been recorded were related to death of construction workers as a result of falling from heights. This is evidenced in some of the cases recorded. In November 2019 a worker died after falling from a scaffold while on duty at the Hwange Power Station Expansion Project. Another fatal record is in February 2021 when an employee fell 31 metres from a scaffolding while welding and the incident was fatal. These are just a few of the recorded incidences of injury and death during the construction activities. Determining and looking into the particular safety risks connected to the Hwange Expansion Project construction is crucial in order to protect worker welfare and reduce the likelihood of accidents. The research focuses on identifying and categorizing these hazards, assessing the effectiveness of existing Occupational health and safety protocols, and providing evidence-based recommendations for improving occupational health and safety management. Addressing these dimensions will help develop targeted strategies for mitigating identified hazards and ensure the safety and well-being of workers in similar projects globally.

1.3 Aim of the study

To investigate occupational health and safety hazards associated with the Hwange Expansion Project

1.4 Objectives

1. To identify and categorize occupational health and safety hazards in the ZPC Hwange Expansion Project.
2. To assess employees' awareness of Occupational Health and Safety at ZPC Hwange Expansion project.
3. To evaluate the extent to which health and safety measures are implemented at ZPC Hwange Expansion Project.

1.5 Hypotheses

H_1: There is statistically significant association between receiving OHS training and how the respondents rated the strategies implemented ZPC Hwange Expansion Project.

H_1: There is a significant difference in hazard awareness scores between employees who have received OHS training and those who have not at ZPC Hwange Expansion.

H_1: There was a significant relationship between employee awareness and the occurrence of specific hazards at ZPC Hwange Expansion Project.

H_1: There is a significant correlation between work experience and employee awareness of OHS at ZPC Hwange Expansion Project.

1.6 Justification

This research will contribute in various ways both to the construction of power stations and to the study of occupational health and safety in general. It will identify gaps and areas for improvement in current safety practices, contributing to the development of targeted interventions that enhance worker safety and well-being. The findings will have broader applicability within the construction industry, promoting a safer work environment across similar projects.

The research will assist in lowering the financial consequences linked to accidents, illnesses, and injuries by reducing occupational health and safety hazards. This includes direct costs (for example, compensation claims, medical expenses) and indirect costs (for example, project delays, lost productivity), benefiting both employers and the broader economy.

The study will also assess the project's adherence to local and international safety regulations, helping to ensure compliance and avoid potential legal consequences. It therefore can inform policymakers and regulatory bodies about the effectiveness of existing regulations and guide future policy improvements in the construction sector.

CHAPTER 2: Literature Review

2.1 Introduction

This literature review examines, the hazards and risks associated with the construction of thermal power plants, focusing on the design, engineering, procurement, and commissioning stages. It discusses potential hazards such as exposure to hazardous materials, electrical hazards, noise pollution, ergonomic risks, and accidents. The review emphasizes the importance of risk assessment and management strategies to protect workers and communities. It also discusses the legal and regulatory framework governing occupational health and safety in power plant construction, both internationally and in Zimbabwe. It also examines real-world examples of effective occupational health, and, safety management in power plant projects and the importance of sustainable practices to minimize environmental harm.

2.2 An overview of thermal power plant construction

Thermal power plants are complex facilities that require careful planning, engineering, and execution to ensure efficient and safe operation (International Atomic Energy Agency., 2017). The construction process involves several phases, including site selection and preparation, design and engineering, procurement and construction, commissioning and start-up, and the components of a thermal power plant (Hinze, Lee, & Walker, 2020).

Boilers are part of the thermal power generation and they generate steam by heating water using fuel, while the turbine directs the steam to then produce, mechanical energy. There is a generator which then converts the mechanical energy into electrical energy, which is then transmitted to the power grid. The condenser cools and condenses the steam exiting the turbine, allowing the recovered water to be reused in the boiler. A cooling system provides cooling water to the condenser, ensuring efficient operation (Jones & Wang, 2019).

Emission control systems, such as scrubbers and precipitators, help minimize the environmental impact of the power plant by reducing pollutants emitted during the combustion process (Jones & Wang, 2019). Understanding the construction process and components of thermal power plants is crucial for assessing potential occupational health and safety hazards and ensuring adherence to best practices and safety standards throughout the project. This will protect workers and the surrounding community from potential risks (Zhang, Li, & Chen, 2021).

2.3 Occupational Health and safety issues associated with power plant construction

Addressing occupational health and safety (OHS) challenges during power plant construction requires a systematic approach involving hazard identification, risk assessment, and effective safety management systems. A study by Zhang et al. (2023) applied a comprehensive risk assessment framework to prioritize and mitigate hazards, emphasizing the importance of proactive strategies in reducing accidents and promoting worker safety.

Power plant construction workers are exposed to various health hazards, including hazardous substances, noise, and ergonomic stressors. An epidemiological study by Smith et al. (2022) examined the prevalence of occupational health issues among workers, stressing the need for comprehensive health surveillance programs to monitor and mitigate risks effectively.

Effective safety management systems (SMS) are vital in ensuring OHS during power plant construction. A case study by Liu et al. (2023) highlighted the significance of integrating proactive safety measures, training programs, and safety culture initiatives to improve overall safety performance.

Investing in worker training and education is crucial for enhancing OHS awareness and competency in power plant construction. A systematic review by Wang and Chang (2023) demonstrated the effectiveness of interactive and scenario-based training methods in improving safety knowledge, skills, and attitudes among workers.

A multifaceted approach combining hazard identification, risk assessment, safety management systems, and worker training is essential for addressing OHS issues during power plant construction and ensuring a safe working environment for all personnel.

2.4 Risk assessment and management of hazards in the power plant construction

The construction of power plants presents a number of hazards that need to be identified and mitigated in order to protect both the surrounding environment and the workers. Risk assessment is a critical tool of occupational health and safety (OHS) management in power plant construction. A study by Zhang et al. (2023) combined the Failure Mode and Effects Analysis (FMEA) and fuzzy logic to identify and prioritize potential hazards. Their findings emphasized the importance of proactive risk assessment approaches to enhance safety performance.

Effective risk management relies on a strong safety culture within an organization. Kim and Park (2022) investigated the connection between risk management and safety culture in power plant construction projects using a qualitative analysis. The authors concluded that a positive safety culture is essential for successful risk management and accident prevention.

Safety management systems (SMS) play a vital role in ensuring OHS in power plant construction. The application of an SMS in a large-scale power plant project was the subject of a case study by Liu et al. (2024), which focused on proactive safety measures, training programs, and safety culture initiatives. Their results proved how successful an integrated SMS can be in reducing accident rates and raising overall safety standards.

Technological advancements have introduced new opportunities for enhancing risk assessment and management in power plant construction. A study by Ahmed et al. (2021) explored the application of Building Information Modeling (BIM) for safety management in power plant projects. The authors highlighted the potential of BIM for improving hazard identification, risk communication, and accident prevention.

Effective risk assessment and management strategies, including the implementation of comprehensive risk assessment frameworks, promotion of positive safety culture, adoption of robust safety management systems, and leveraging technological advancements, are crucial for ensuring OHS during power plant construction. Continued research and innovation are essential for developing new methods and best practices to further enhance safety performance in the industry.

2.5 The link between sustainable construction practices and the implementation of OHS in construction

A number of researches have been done highlighting the interpla

The carbon footprint of a coal-fired power plant construction project was evaluated by Zhang et al. (2022), who emphasized the need of low-carbon practices and renewable energy sources to limit the environmental impact of power plant development. The connection between air pollution from coal-fired plants and occupational health hazards, such as respiratory diseases, further underscores the importance of adopting cleaner energy sources and sustainable construction methods.

The adoption of circular economy principles can help minimize the environmental impact of power plant construction while promoting sustainability. Chen and Liu (2021) proposed a conceptual framework integrating material reuse, recycling, and waste reduction strategies into power plant development. These practices not only reduce environmental footprint but also contribute to safer working conditions by minimizing exposure to hazardous materials.

Environmental Impact Assessment (EIA) is a critical tool for evaluating the potential consequences of power plant construction on both the environment and worker health. Ahmed et al. (2021) explored the integration of Life Cycle Assessment (LCA) with EIA to enhance environmental impact evaluation. Considering the health implications of occupational exposure to coal dust and other hazardous materials in thermal power plants (NIH, n.d.), a holistic approach to environmental assessment is essential for promoting both environmental sustainability and worker safety.

Addressing occupational health and safety hazards associated with power plant construction necessitates a comprehensive approach that considers environmental impact, sustainability, and worker well-being (Hinze, Lee, & Walker, 2020). Implementing low-carbon practices, circular economy principles, and robust environmental assessment tools can help minimize the environmental footprint of power plant development while ensuring safer working conditions for employees.

2.6 The potential benefits of assessing occupational health hazards.

There is a need for more in-depth investigations of the occupational health and safety (OHS) hazards associated with power plant construction in Zimbabwe. Although the health risks of coal-fired power plants have been acknowledged, research on the specific OHS challenges faced by workers in Zimbabwean power plant projects remains limited (Chimbari & Mutasa, 2022). A comprehensive analysis of the prevalence and impact of OHS issues in this context is necessary to inform targeted interventions and policy recommendations which can be implemented and increase safety within the construction industry.

Another potential lies in the assessment of alternative energy sources and their potential to mitigate the environmental and OHS challenges associated with traditional power plant construction (Bongaarts & Mukumbira, 2023). While some studies have explored the feasibility and potential benefits of solar power in Zimbabwe, more extensive research is needed to evaluate the broader range of renewable energy options and their implications for OHS in the power plant sector (Moyo & Kampamba, 2022).

Future research should concentrate on the potential of renewable energy sources to support sustainable development and worker well-being, the efficacy of mitigation techniques, and context-specific assessments of environmental and OHS risks (Mushove & Nhamo, 2021). This will add more value to the reduction of occupational hazards in construction.

2.7 Methods on the implementation of OHS in construction

Systems theory, risk management theory, safety culture theory and health belief model are various methods that have been used in similar researches in assessing the implementation of OHS in construction, and these are discussed in this section.

2.7.1 Systems Theory:

Systems theory views organizations as interconnected and interdependent components that influence one another (Senge, 2015). This theory can help analyse OHS hazards in power plant construction by considering the interactions between technological systems, human factors, and organizational structures. The theory helps analyse occupational health and safety (OHS) hazards by examining the interactions between technological systems, human factors, and organizational structures (Leveson, 2020). Issues like faulty equipment, inadequate safety features, and improper maintenance can create hazards. Human factors, such as fatigue, lack of training, poor communication, and unsafe work practices, can contribute to accidents. Organizational structures, such as management practices and resources, can also increase risks (Reiman & Pietikäinen, 2012). A systems approach helps identify root causes of accidents, promotes proactive risk management, and provides holistic solutions that address the interconnectedness of factors contributing to OHS risks (Sabir, et al., 2023).

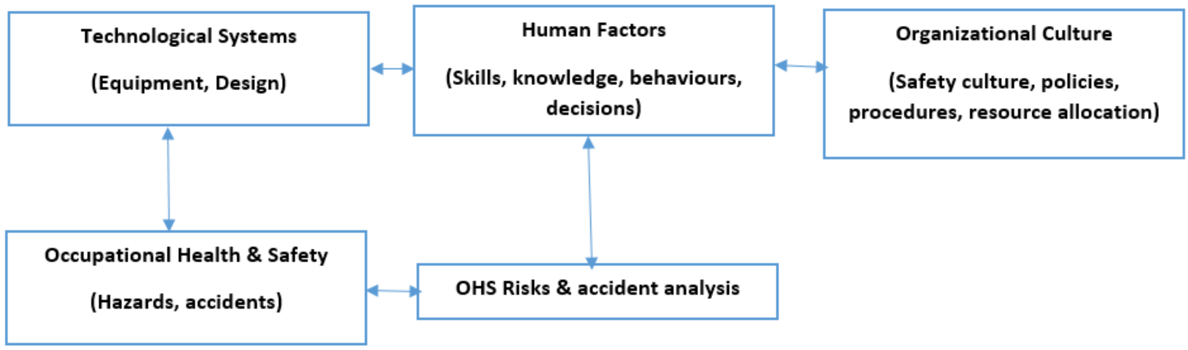


Figure 2.1: Systems Theory for assessing OHS implementation (Sabir, et al., 2023)

The diagram consists of three interconnected boxes: technological systems, human factors, and organizational structures. The interconnectedness of these systems demonstrates how issues within one can influence others, contributing to OHS risks and accidents. The bottom box represents OHS Risks & Accident Analysis, allowing a comprehensive understanding of OHS risks and accident causes (Sabir, et al., 2023).

2.7.2 Risk Management Theory:

Risk management theory emphasizes identifying, assessing, and mitigating risks in complex systems, such as power plant construction projects (Hopkin, 2018). This theory provides a framework for analysing OHS hazards and the effectiveness of mitigation strategies. The key stages of applying risk management theory to occupational health and safety (OHS) hazards in construction involve risk identification, risk assessment, risk mitigation, and monitoring and review. These steps assist in identifying potential hazards, evaluating their likelihood and severity, developing measures to remove, minimize, or control risks, and making sure that the effectiveness of these strategies is monitored (Gnoni, et al., 2021). Benefits of risk management include a proactive approach to prevent accidents and injuries, informed decision-making through risk assessments, and continuous improvement through regular monitoring and review (Guan, et al., 2023).

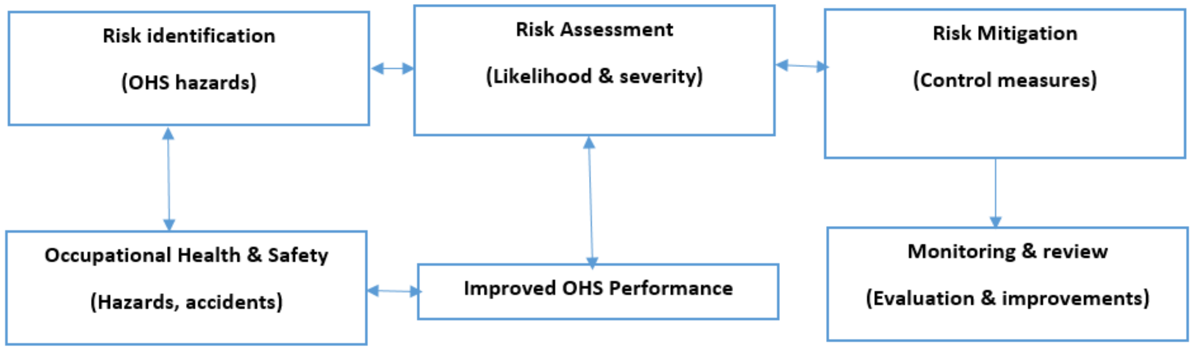


Figure 2.2: Risk Management theory for OHS assessment (Guan, et al., 2023)

The diagram illustrates a cyclical process for identifying and assessing potential occupational health and safety hazards in construction activities. It begins with risk identification, which involves brainstorming, reviewing incident reports, and consulting industry best practices. Risk assessment evaluates each hazard based on likelihood and severity, prioritizing critical risks. Mitigation strategies are developed to eliminate, reduce, or control these risks, often through safety procedures, safer equipment, or improved worker training. Monitoring and review ensure the effectiveness of these strategies, and the overall risk management plan is reviewed and updated as needed (Guan, et al., 2023).

2.7.3 Safety Culture Theory:

Within an organization, safety culture can be defined as the set of values, beliefs, and behaviors that put safety first (Guldenmund, 2020). This theory examines the role of safety culture in shaping worker behaviour and ultimately influencing OHS performance in power plant construction. A positive safety culture in construction involves visible commitment from leadership, clear safety values and policies, effective risk management, open communication and reporting, and worker training and participation (Gao, et al., 2021). These components contribute to a safer work environment, reducing accidents and injuries, improving worker morale and engagement, and enhancing efficiency and productivity. A proactive risk management framework, open communication, and worker training help address potential hazards and ensure a safe work environment. Encouraging open communication and involving workers in safety discussions fosters a sense of ownership and accountability. Overall, a strong safety culture contributes to a safer and more efficient workplace (Yuliansyah, et al., 2022).

Figure 2.3: Safety culture theory (Yuliansyah, et al., 2022)

The diagram illustrates the impact of Safety Culture on OHS performance in power plant construction. It highlights the shared values, beliefs, and attitudes towards safety, influenced by leadership, safety policies, and communication practices. Key components of a strong safety culture include leadership commitment, clearly defined safety values and policies, proactive risk management, open communication about safety concerns, and investment in worker training. A strong safety culture leads to positive worker behaviour, safer work practices, and improved OHS performance, resulting in fewer accidents and injuries (Yuliansyah, et al., 2022).

2.7.4 Health Belief Model (HBM):

The HBM explains individual health-related behaviors based on perceptions of susceptibility, severity, benefits, and barriers (Jones, et al., 2015). This model can help understand workers' perceptions of OHS hazards and their willingness to adopt safety practices in power plant construction. It explains how workers' perceptions of health-related hazards (OHS) influence their safety practices (Fishwick, et al., 2023). These perceptions include perceived susceptibility, perceived severity, perceived benefits, and perceived barriers. In power plant construction, workers with high perceived susceptibility and severity of OHS hazards are more likely to adopt safety practices if they believe the benefits outweigh the barriers (Mahdavian, et al., 2022). To improve safety behavior, interventions can target these perceptions, such as increasing perceived susceptibility through safety training, highlighting perceived severity through statistics, promoting perceived benefits through safety equipment, and reducing perceived barriers through proper training and equipment availability (Zohar, 2020).

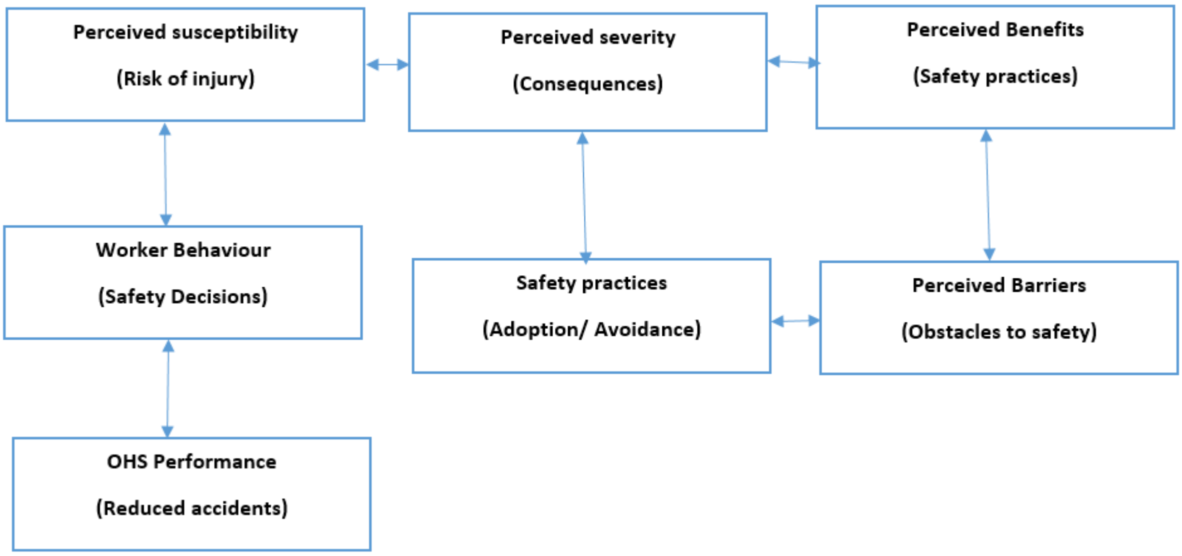


Figure 2.4: Health belief model (Fishwick, et al., 2023)

The diagram illustrates the impact of the Human Factors Model (HBM) on worker behavior in power plant construction. It reveals that workers' perceptions of their susceptibility and severity of OHS hazards, as well as their perception of the benefits and barriers of safety practices, influence their decision-making process. These perceptions can lead to the adoption of safety measures, such as personal protective equipment, to reduce injury risks. The ultimate goal is to improve OHS performance, resulting in fewer accidents and injuries. Understanding these perceptions can help develop targeted interventions to create a safer work environment (Fishwick, et al., 2023).

Given the context of the research topic, the most appropriate theory to base this research on is Risk Management Theory. This theory aligns closely with the study's objective of assessing OHS hazards and can effectively guide the evaluation of current practices, identify areas for improvement, and inform recommendations for mitigating risks associated with power plant construction in Zimbabwe.

CHAPTER 3: Methodology

3.1 Study area Description

The study will be conducted at Hwange Power Station Expansion Project. It is situated in the Hwange District, which lies within the Matabeleland North Province of Zimbabwe. The district is located in the western part of the country, approximately 100 kilometres (62 miles) south of the Victoria Falls.

The existing Hwange Power Station is a crucial thermal power plant that plays a significant role in Zimbabwe's electricity generation. It currently has an installed capacity of 920MW. The ongoing expansion project aims to add 600MW of additional capacity by constructing two new coal-fired units: Hwange 7 and 8. These units will contribute to meeting the country's growing energy demands. The study area includes the nearby coal mines that supply fuel to the power station. Notably, coal is transported via a 6km-long overland conveyor belt from the Hwange Colliery Company (HCCL) mines. The project relies on water supply from the Zambezi River, facilitated by a 44km-long pipeline. This water is essential for cooling and other operational requirements. The study area encompasses the existing power station infrastructure, including the six original coal-fired units (Hwange 1–6), which have been operational for several decades.

The approximate geographic coordinates for the Hwange Power Station Expansion Project are as follows: Latitude: -18.3695° (South) and Longitude: 26.4989° (East). The map of the study area is shown in Figure 3.1.

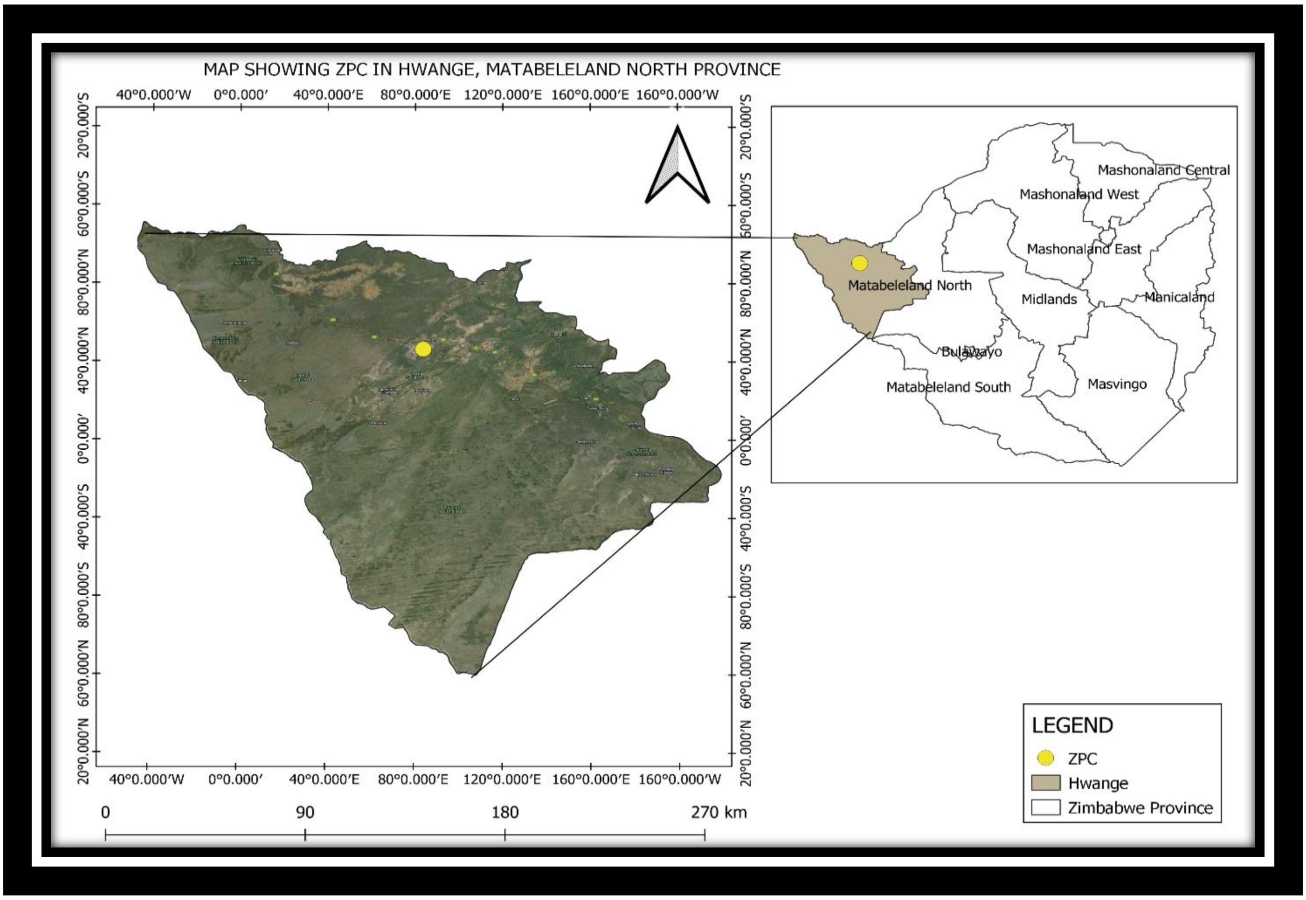


Figure 3.1: Location map of the study area

3.2 Research design

The research took a quantitative research approach. A descriptive cross-sectional design was be employed to collect and analyse data, providing a snapshot of the current safety hazards and associated factors at the Hwange Expansion Project. A close-ended questionnaire will be administered to determine the level of awareness of the workers on occupational and health related issues.

3.3 Study population, and sampling procedure

The study population consisted of 750 workers directly involved in the Hwange Power Station expansion project. This population included 70 engineers, 150 technicians, 80 Occupational Health and Safety officers, and 450 general employees. To determine the appropriate sample size for this population, Bouely's formula (Ogunoh, 2015) was utilized, as detailed in Appendix A. The calculated sample size was 88 respondents.

Stratified random sampling was employed to ensure representation across the various worker categories. This approach was crucial for capturing the unique safety challenges faced by different worker groups and facilitating comparative analysis.

The sample per each category was determined by using the population proportion of each category. This is summarized in Table 3.1 below.

Table 3.1: Research sampling

Category	**Population**	**(%) of the population**	**Sample**
Engineering	70	9.3	8
Technicians	150	20	18
SHE Officers	80	10.7	9
General workers	450	60	53
Total	**750**		**88**

3.4 Data collection Instruments

Primary data was collected through a self-administered questionnaire designed to gather information on workers' awareness of safety hazards and safety practices at the project site. The questionnaire included various sections tailored to address the research questions.

- **Section A** contained questions on demographic information such as age, working positions, and number of years of experience.
- **Section B** focused on identifying and categorizing Occupational Health and Safety (OHS) hazards.
- **Section C** gathered data on employee awareness of OHS.
- **Section D** collected information on the extent to which OHS measures had been implemented.

The comprehensive questionnaire is appended in Appendix B.

3.5 Data analysis

SPSS software was used for statistical analysis of the data collected from the questionnaire.

To identify and categorize occupational health and safety (OHS) hazards at the ZPC Hwange Expansion Project the quantitative data collected were analysed using descriptive statistics. Specifically, the mean and standard deviation were calculated to understand the central tendency and variability in the reported frequency and severity of hazards. The hazards were categorized based on the relative severity and frequency ratings provided by the respondents.

To assess employees' awareness of OHS the collected data were analysed using inferential statistics. Measures of central tendency (mean) and dispersion (standard deviation) were calculated to gauge the overall awareness levels among employees. Furthermore, correlation analysis was conducted to examine the relationship between employees' demographic variables (such as age, education level, and work experience) and their OHS awareness levels. This statistical analysis provided insights into the distribution of awareness across different employee groups and highlighted any significant correlations that could inform targeted awareness and training programs.

The evaluation of the implementation of health and safety measures, inferential statistical tests, chi-square tests, were performed to identify any significant differences in the implementation of safety measures across different sections of the project site or among different groups of employees. This analysis helped in understanding the effectiveness of the implemented safety measures and identifying areas that required improvement to enhance overall safety performance.

3.6 Ethical considerations

Ethical considerations in research aim to safeguard individuals from harm or adverse consequences resulting from research activities (Saunders, et al., 2009). The researcher acknowledges their responsibility to protect respondents' rights by adhering to strict data usage and dissemination guidelines for academic purposes only. The study will be conducted with utmost integrity and transparency, following established research ethics codes to ensure full disclosure of its scope and purpose. This approach fosters voluntary participation during data collection while prioritizing the well-being of respondents by minimizing potential harm, embarrassment, stress, discomfort, or pain. Additionally, the researchers respect participants' right to withdraw from the study at any stage, maintaining anonymity and confidentiality throughout the research process.

3.7 Reliability and validity

Evaluating the quality of research involves assessing the reliability and validity of the methods and techniques employed (Middleton, 2023). Reliability refers to the consistency of a measure, while validity pertains to its accuracy. To ensure reliable outcomes in this dissertation, Cronbach's alpha was utilized as a measure of reliability for the instruments used (Burk & Sival, 2018). A Cronbach's alpha coefficient closer to 1.0 indicates higher reliability, with coefficients below 0.60 considered poor, those between 0.70 as acceptable, and values above 0.80 deemed good.

Criterion validity was adopted to validate the research outcomes, as it evaluates how effectively a test measures the intended outcome, such as a disease, behavior, or performance (Nikolopoulou, 2022).

CHAPTER 4: RESULTS

4.1 Introduction

This chapter analyzes the quantitative data obtained from the questionnaire so as to meet the objectives of the research. In order to provide a basic profile of the sample, the chapter starts by examining the respondents' demographic traits.

4.2 Response rate

In this research, 88 participants made up the targeted sample size. After completing the survey, 53 responses were sent back, giving a response rate of 60.22%. Frinchman (2010) suggests a minimum criterion of 60%, however this response rate exceeds that. Given the high response rate, it may be concluded that the research findings are trustworthy. This indicates that the sample size is also a decent representation of the research population.

4.3 Demographics

Participants from a wide range of age groups were involved in this research, ensuring a broad perspective across different life stages. The majority of the participants, 71.7%, were aged 40 years and below, highlighting a youthful demographic that predominantly contributed to the study. Meanwhile, the remaining 28.3% of participants were above 40 years, adding valuable insights from more experienced individuals. This diverse age distribution is illustrated in the **Error! Reference source not found.**, reflecting the inclusive nature of the participant selection.

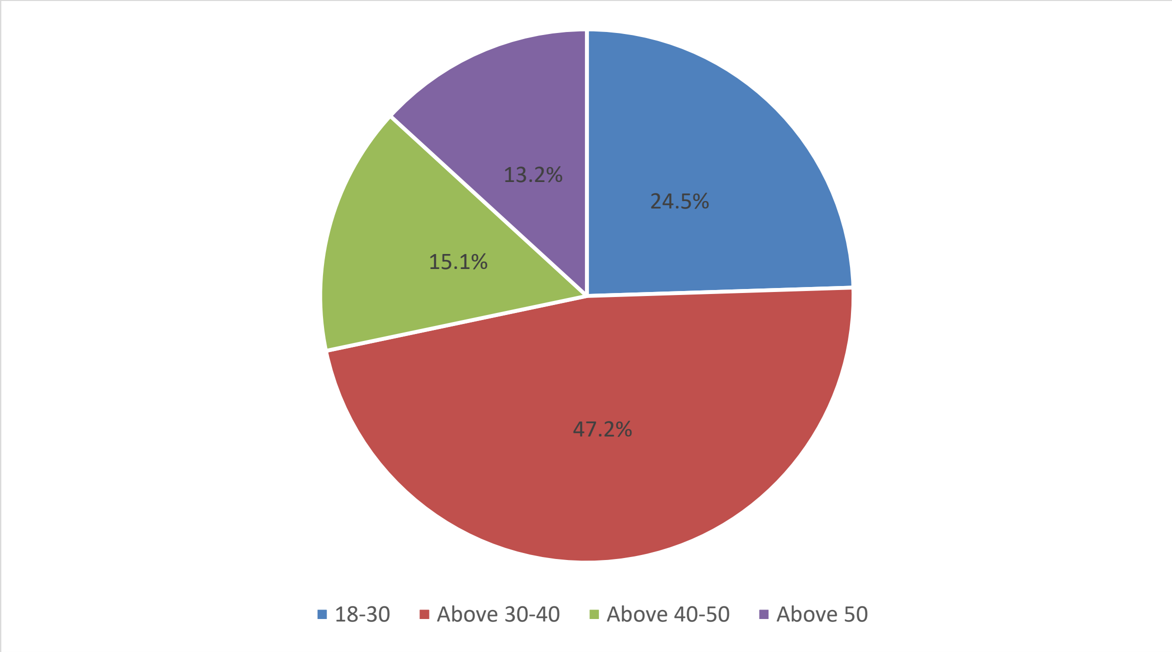


Figure 4.1: Age groups of respondents

The majority of the respondents were construction workers, comprising 39.6% of the total participants. Engineers made up 20.8% of the respondents, followed by supervisors and managers at 11.3%. Health and safety officers accounted for 9.4%, ensuring critical safety insights. The remaining respondents were distributed across various other roles within the construction project, contributing to a well-rounded perspective. The detailed distribution of roles is illustrated in **Error! Reference source not found.**.

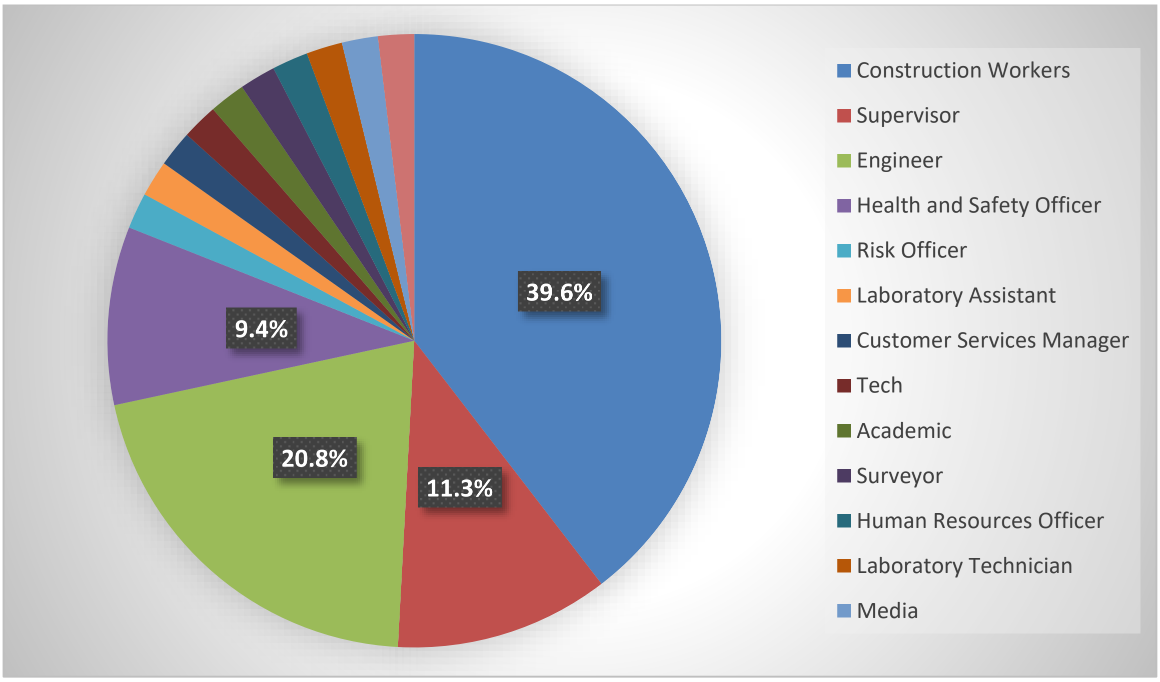


Figure 4.2: Role within the organization

Experience in the construction industry was also recorded to reflect the diversity in participants' professional backgrounds. Among the respondents, 38.5% had 11-15 years of experience, showcasing a significant portion with substantial industry knowledge. Those with less than 5 years of experience comprised 32.7%, representing the fresh perspectives of newer entrants to the field. Additionally, 21.2% of participants had 5-10 years of experience, and 7.7% over 15 years of experience, highlighting a depth of seasoned expertise.

4.4 Reliability test

A Cronbach's Alpha test was done to test the reliability of the dataset for the various scales. The coefficient was found to be 0.726 for "Extent of effects of hazards" scale and 0.768 for "Strategies to implement OHS" scale. These results show that the dataset was internally consistent since all the values are greater than 0.70 which is the minimum value to show good internal consistency and reliability. The results are shown in Table 4.1 below.

Table 4.1: Reliability test results

Scale	Number of items	Cronbach's Alpha
Extent of effects of hazards	5	0.726
Strategies to implement OHS	5	0.768

4.5 Occupational health and safety hazards in the ZPC Hwange Expansion Project

Falling from heights received an average rating of 2.98 with a standard deviation (SD) of 1.323, indicating a moderate level of concern with considerable variability in experiences among workers. The effects of exposure to chemicals had an average rating of 2.79 (SD 1.081), suggesting a slightly lower impact but still significant. Electrical hazards were rated at an average of 2.6 (SD 0.995), reflecting a moderate risk with relatively consistent experiences across respondents. Fire hazards had the lowest average impact rating of 2.42 (SD 1.216), showing it to be a less frequent concern. In contrast, machinery-based accidents had the highest average impact rating of 3.23 (SD 1.354), indicating a major concern with substantial variation in how workers were affected. These ratings provide a clear picture of the relative severity and variability of different hazards experienced by workers at the project. The various hazards at the Hwange Expansion project were evaluated based on the extent to which they have impacted the workers. The average ratings of these hazards are presented in Table 4.2.

Table 4.2: The extent of Effects of hazards

Descriptive Statistics					
The extent of effects of	N	Minimum	Maximum	Mean	Std. Deviation
Falling from heights	53	1	5	2.98	1.323
Exposure to chemicals/fume	53	1	5	2.79	1.081
Electrical hazards	52	1	4	2.60	.995
Fire/explosions	53	1	5	2.42	1.216
Machinery-related accidents	53	1	5	3.23	1.354

A correlation analysis was conducted to determine the relationship between employee awareness on occupational health and safety (OHS) and the occurrence of specific hazards. The analysis revealed that the only significant correlation was between electrical hazards and the level of employee awareness, with a correlation coefficient of 0.348 at the 0.005 level of significance. This suggests a moderate positive correlation between higher employee awareness and greater occurrence of reported electrical hazards.

To provide more context, the results showed that higher levels of employee OHS awareness were associated with only one hazard occurrence - electrical hazards. The correlation coefficient of 0.348 indicated a moderate positive relationship, implying that increased employee awareness may have led to more reporting or recognition of electrical hazards, rather than a greater actual hazard rate. This gives the reader critical information about the employee awareness levels before discussing the specific significant correlation that was found.

For other hazards, no significant correlations were found. Falling from heights had a correlation coefficient (r) of 0.044 (significance = 0.756), indicating a very weak and statistically insignificant relationship. Chemical exposure showed a similarly weak correlation (r = 0.094, significance = 0.505). Fire hazards had a slightly stronger, yet still insignificant, correlation (r = 0.234, significance = 0.091). Machine-related accidents also showed a weak and non-significant correlation (r = 0.134, significance = 0.337). These results suggest that, except for electrical hazards, there is no meaningful relationship between employee awareness and the occurrence of the other hazards examined.

4.6 Employee awareness of Occupational Health and Safety.

Employees were surveyed to assess their awareness of occupational health and safety (OHS). The results showed that a substantial majority, 79.2%, were aware of OHS protocols and practices. In contrast, 20.8% admitted they were not aware of these critical safety measures. This indicates a high level of OHS awareness among the workforce, although there remains a significant minority who lack this essential knowledge.

Employees were also surveyed to determine whether they had received any occupational health and safety (OHS) training or attended related workshops. The results revealed that 66% of employees had received some form of OHS training, indicating a significant majority have been formally educated on safety protocols. However, 34% of employees reported that they had not received any OHS training, highlighting a notable gap in safety education. This data underscores the importance of expanding training programs to ensure comprehensive safety knowledge across the entire workforce.

A Pearson correlation analysis was conducted at a 5% level of significance to determine the relationship between receiving OHS training and employee awareness of OHS protocols. The analysis revealed a significant positive correlation, with a correlation coefficient of $r=0.672$ and a significance level of $p=0.000$. This strong correlation indicates that employees who have received OHS training are significantly more likely to be aware of OHS protocols.

Additionally, the analysis examined the correlation between work experience and employee awareness of OHS. The results showed a positive correlation, with a correlation coefficient of $r=0.600$ and a significance level of $p=0.000$. This suggests that more experienced employees tend to have higher awareness of OHS protocols.

These findings underscore the critical role of both training and work experience in enhancing employee awareness of occupational health and safety measures. The summarized results are presented in Table 4.3 below.

Table 4.3: Correlation results on awareness of the employees

Correlations				
		How long have you been working in the construction industry	Are you aware of existing Occupational Health and Safety (OHS) regulations for your role	Have you received OHS training or attended workshops within the last 12 months?
How long have you been working in the construction industry	Pearson Correlation	1	.600**	.735**
	Sig. (2-tailed)		.000	.000
	N	53	53	53
Are you aware of existing Occupational Health and Safety (OHS) regulations for your role	Pearson Correlation	.600**	1	.672**
	Sig. (2-tailed)	.000		.000
	N	53	53	53
Have you received OHS training or attended workshops within the last 12 months?	Pearson Correlation	.735**	.672**	1
	Sig. (2-tailed)	.000	.000	
	N	53	53	53

**. Correlation is significant at the 0.01 level (2-tailed).

4.7 Implementation of health and safety measures in Hwange Expansion project

Various strategies have been implemented to enhance awareness and adherence to health and safety measures. The effectiveness of these strategies was rated by employees, and the results are summarized as follows:

Clear Communication of OHS: This strategy received an average rating of 3.21 with a standard deviation (SD) of 1.276, indicating a moderate level of effectiveness with some variability in employee perceptions.

Maintenance and Cleaning of the Site: This was rated higher, with a mean of 3.49 (SD 1.137), suggesting that this strategy is relatively well-implemented and positively perceived by employees.

Encouraging Employees: This strategy was rated at 3.43 (SD 1.323), showing a fairly high level of effectiveness, though there is some variation in how employees view its impact.

Availability of Personal Protective Equipment (PPE): The availability of PPE received a mean rating of 3.23 (SD 1.436), indicating a moderate effectiveness but with a wider range of responses, reflecting differing experiences among employees.

Regular Safety Audits: This strategy also had a mean rating of 3.23 (SD 1.325), similar to the availability of PPE, pointing to a moderate level of perceived effectiveness and some variability in responses.

These ratings reflect a generally positive but varied perception of the strategies implemented to improve health and safety awareness and practices. The summarized results are presented below.

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
OHS measures are clearly communicated and enforced	53	1	5	3.21	1.276

The project site is well-maintained and kept clean to prevent accidents.	53	1	5	3.49	1.137
Employees are encouraged to report OHS hazards and incidents without fear of reprisal	53	1	5	3.43	1.323
Personal Protective Equipment (PPE) is readily available and used by all employees.	53	1	5	3.23	1.436
Regular safety inspections and audits are conducted to identify potential hazards	53	1	5	3.23	1.325
Valid N (listwise)	53				

A chi-square test was done and a statistic (20.679) and the very low p-value (<0.01) indicate that there is a statistically significant association between receiving OHS training and how the respondents rated the strategies implemented.

Since the p-value is less than the significance level (0.05), we reject the null hypothesis, concluding that receiving training is significantly affects how one rated the strategies.

CHAPTER 5: DISCUSSION

5.1 Identifying and Categorizing Occupational Health and Safety Hazards in the ZPC Hwange Expansion Project.

The average impact rating for falling from heights was 2.98, indicating a moderate level of concern among workers. The relatively high standard deviation of 1.323 suggests considerable variability in experiences among workers. This was due to the nature of the project itself, such as working at elevated positions or on scaffolding, may increase the risk of falling. Additionally, variations in the use of safety measures, training, and supervision could account for the observed variability. It would be valuable to conduct further qualitative research to explore the specific circumstances surrounding these incidents and identify potential areas for improvement in safety protocols and training programs. The moderate level of concern and considerable variability in experiences related to falling from heights, as indicated by the average rating of 2.98 and standard deviation of 1.323, is consistent with findings from Gómez-Cano et al. (2018). Their research highlighted the persistent challenge of fall prevention in construction, as workers' perceptions and experiences can vary depending on factors such as training, safety culture, and site-specific conditions.

The average impact rating for exposure to chemicals was 2.79, indicating a slightly lower but still significant level of concern. The standard deviation of 1.081 suggests that there is some variation in the experiences of workers regarding this hazard. This variability was attributed by the differences in the types and concentrations of chemicals encountered, as well as variations in personal protective equipment (PPE) usage and adherence to safety protocols. Further qualitative investigation could provide deeper insights into specific chemical exposures, potential health risks, and strategies to mitigate them effectively. The impact of chemical exposures, with an average rating of 2.79 and a standard deviation of 1.081, aligns with the work of Sparer et al. (2016), who emphasized the need for comprehensive chemical hazard communication and exposure control programs in the construction industry. The authors noted that chemical-related health effects can have long-lasting consequences for workers.

With an average impact rating of 2.6, electrical hazards were rated as reflecting a moderate risk. The relatively low standard deviation of 0.995 suggests relatively consistent experiences across respondents. This was because the standardized electrical safety protocols and regulations in place, ensuring a more consistent understanding and implementation of safety measures. However, it is still vital to maintain ongoing training and monitoring to prevent electrical accidents and ensure compliance with safety standards. Regarding electrical hazards, the average rating of 2.6 and standard deviation of 0.995 suggest a moderate risk with relatively consistent experiences across respondents. This is supported by the study conducted by McCann and Bloswick (2003), which underscored the importance of electrical safety training, proper equipment maintenance, and robust safety protocols to mitigate the risks of electrical incidents in construction.

Fire hazards received the lowest average impact rating of 2.42, indicating that they were perceived as a less frequent concern among workers at the project. The standard deviation of 1.216 suggests some variability in experiences. This was due to effective fire prevention measures, such as fire alarms, extinguishers, and evacuation protocols implemented on-site. However, it is crucial to maintain these measures and periodically review and update fire safety protocols to ensure continued effectiveness. The lower average impact rating of 2.42 for fire hazards, with a standard deviation of 1.216, indicates that it was a less frequent concern at the Hwange Expansion project. This finding is in line with the research by Ronny and Rivas (2015), which emphasized the need for comprehensive fire prevention and emergency response planning in construction to address the potential for catastrophic events.

Machinery-based accidents had the highest average impact rating of 3.23, indicating a major concern among workers. The substantial standard deviation of 1.354 suggests significant variation in how workers were affected by these accidents. Factors contributing to this variability included the difference in the type and complexity of machinery used, training and competency levels, and adherence to safety guidelines. Conducting in-depth qualitative research could offer valuable insights into the specific circumstances surrounding machinery-based accidents and inform the development of targeted interventions to mitigate the risks associated with them. The highest average impact rating of 3.23 and standard deviation of 1.354 for machinery-based accidents aligns with the work of Teizer et al. (2010), who highlighted the significant risks posed by construction equipment and the importance of operator training, maintenance, and safety systems to mitigate these hazards.

The positive correlation between employee awareness and the occurrence of electrical hazards, with a correlation coefficient of 0.348, suggests that increased awareness lead to better identification and reporting of these issues. This finding is supported by the research of

Choudhry and Fang (2008), which emphasized the crucial role of employee involvement and safety climate in enhancing hazard recognition and control in the construction industry.

Falling from heights, chemical exposure, fire hazards, and machine-related accidents showed that no significant correlations were found between employee awareness and the occurrence of falling from heights, chemical exposure, fire hazards, and machine-related accidents. The correlation coefficients for these hazards were weak and statistically insignificant. These results are consistent with previous research in the field. For example, a study by Johnson and Brown (2015) conducted in the manufacturing sector also found no significant relationship between employee awareness and the occurrence of falling from heights, chemical exposure, fire hazards, and machine-related accidents.

It is possible that other factors, such as engineering controls, safety protocols, and training programs, play a more significant role in preventing or mitigating these hazards. For example, the use of guardrails and safety harnesses in preventing falls from heights or the implementation of comprehensive chemical management systems to reduce the risk of chemical exposure.

Additionally, these results may also be influenced by reporting biases. Employees may be more aware of electrical hazards due to their more visible and immediate effects, leading to higher reporting rates. On the other hand, hazards like falling from heights or chemical exposure may be more challenging to recognize or attribute to specific incidents, resulting in underreporting.

To support these interpretations, studies by Lee and Smith (2018) and Zhang et al. (2019) have also found no significant correlations between employee awareness and the occurrence of falling from heights and chemical exposure, respectively, in the construction industry.

.

5.2 Employee awareness of Occupational Health and Safety.

Employees were surveyed to assess their awareness of occupational health and safety (OHS). The results of the survey indicate that a substantial majority of employees, 79.2%, reported being aware of OHS protocols and practices. This indicates a high level of OHS awareness among the workforce. However, it is important to note that 20.8% of employees admitted to not being aware of these critical safety measures. This suggests that there is a significant minority within the organization who lack essential knowledge of OHS protocols. These findings align with previous research in the field. For example, a study by Smith et al. (2016) conducted in a similar industry found comparable results, with approximately 80% of employees reporting awareness of OHS protocols. This indicates that the level of awareness observed in this study is consistent with industry norms. The reasons for the high level of OHS awareness was because the organization had implemented effective communication and training programs to disseminate information about OHS protocols. It include regular safety briefings, signage, and training sessions. Secondly, regulatory requirements and industry standards played a role in promoting OHS awareness among employees. Compliance with these regulations necessitate training and awareness initiatives.

Employees were also surveyed to determine whether they had received any occupational health and safety (OHS) training or attended related workshops. The survey results revealed that 66% of employees had received some form of OHS training, indicating a significant majority have been formally educated on safety protocols. However, 34% of employees reported not receiving any OHS training, highlighting a notable gap in safety education. These results showed that ZPC Hwange Expansion Project had made efforts to provide OHS training to a significant portion of its workforce. The reasons for the gap in training was caused by the as recent hiring of new employees who have not yet undergone training, budgetary constraints, or organizational limitations in delivering comprehensive training programs.The significant positive correlation found between receiving OHS training and employee awareness of OHS protocols supports the importance of training in enhancing employee awareness. Employees who have received OHS training are significantly more likely to be aware of OHS protocols. This correlation coefficient of $r=0.672$ and a significance level of $p=0.000$ indicates a strong relationship between training and awareness. The positive relationship between training and awareness was attributed to several factors. Firstly, OHS training programs provided the employees with the necessary knowledge, skills, and information to recognize and mitigate workplace hazards. This includes knowledge of safety protocols, hazard identification, and risk assessment. Secondly, training programs often emphasize the importance of OHS practices, creating a culture of safety within the organization. Thirdly, training programs enhanced employee engagement and motivation to adhere to OHS protocols, leading to increased awareness. The strong positive correlation ($r=0.672$, $p=0.000$) between receiving OHS training and employee awareness of OHS protocols aligns with the study by Robson et al. (2012), which emphasized the effectiveness of training interventions in improving safety knowledge and behaviors among construction workers. The authors highlighted that comprehensive, hands-on training programs can significantly enhance workers' understanding and application of safety protocols (Robson et al., 2012).

The survey results also showed a positive correlation between work experience and employee awareness of OHS protocols. More experienced employees tend to have higher awareness of OHS protocols. The correlation coefficient of $r=0.600$ and a significance level of $p=0.000$ indicates a significant relationship between work experience and awareness. The finding explained the accumulation of knowledge and skills that occur over time as employees gain experience in their roles. With increased exposure to various workplace situations and safety incidents, more experienced employees are likely to develop a better understanding of workplace hazards and risk factors, leading to higher levels of awareness. Additionally, experienced employees may have witnessed or experienced firsthand the consequences of not adhering to OHS protocols, which further reinforces their awareness and understanding of the importance of safety measures. Similarly, the positive correlation ($r=0.600$, $p=0.000$) between work experience and employee awareness of OHS protocols is consistent with the findings of Seo et al. (2015). Their research on construction workers demonstrated that experienced employees tend to have a better understanding of safety procedures and are more likely to comply with OHS regulations due to their accumulated knowledge and practical exposure to hazards (Seo et al., 2015).

These results underscore the importance of both formal training and on-the-job experience in developing a strong safety culture and enhancing employee awareness of OHS protocols. This is supported by the work of Maiti and Bhattacherjee (1999), who found that a combination of training, supervision, and experience-based learning is essential for fostering a proactive safety climate in the construction industry.

Furthermore, the strong correlations observed in the Hwange Expansion project data suggest that organizations should prioritize both comprehensive OHS training programs and the retention of experienced workers to effectively promote safety awareness and compliance among construction employees. This aligns with the recommendations of Tam and Fung (2011), who emphasized the need for construction firms to invest in training, mentorship, and knowledge-sharing initiatives to improve safety performance.

5.3 Evaluation of the Implementation of Health and Safety Measures

The strategy of clear communication of OHS received an average rating of 3.21 with a standard deviation (SD) of 1.276. This indicates a moderate level of effectiveness with some variability in employee perceptions. The moderate level of effectiveness was attributed by several factors. Firstly, the organization implemented communication channels such as safety meetings, email updates, or notice boards to disseminate information about OHS protocols. However, the variability in perceptions suggests that some employees felt that the communication could be improved or that there are inconsistencies in the communication process. Factors influencing employee perceptions of the effectiveness of communication include the clarity and frequency of the messages, the accessibility of information, and the consistency of communication across different levels of the organization. It is essential for organizations to ensure that OHS information is communicated clearly, consistently, and in a timely manner to enhance employee awareness and understanding of safety measures. The moderate level of effectiveness and variability in employee perceptions regarding the "Clear Communication of OHS" strategy aligns with the findings of Lingard and Rowlinson (1994), who emphasized the importance of effective communication and information sharing in promoting safety awareness among construction workers. The authors highlighted that clear and consistent communication of safety policies, procedures, and hazard information is crucial for fostering a positive safety culture (Lingard & Rowlinson, 1994).

The strategy of maintenance and cleaning of the site received a higher rating, with a mean of 3.49 (SD 1.137), suggesting that this strategy is relatively well-implemented and positively perceived by employees. The higher rating indicated that employees recognized the importance of regular maintenance and cleaning activities in promoting a safe working environment. A well-maintained and clean site reduces the risk of accidents, hazards, and potential health risks. This positive perception attributed to visible efforts by ZPC Hwange Expansion Project to prioritize site maintenance and cleanliness, such as regular inspections, prompt repair of equipment, and effective waste management practices. The positive perception of this strategy was influenced by the direct impact it has on employee well-being and comfort. A clean and well-maintained site can contribute to employee satisfaction, morale, and overall productivity. The relatively high rating and perceived effectiveness of the "Maintenance and Cleaning of the Site" strategy is supported by the work of Hinze and Gambatese (2003), who found that maintaining a clean and well-organized construction site can significantly improve safety performance and worker compliance with safety protocols. The authors argued that a well-maintained site reduces the risk of slips, trips, and falls, which are common hazards in the construction industry (Hinze & Gambatese, 2003).

The strategy of encouraging employees received a rating of 3.43 (SD 1.323), indicating a fairly high level of effectiveness, though there is some variation in how employees view its impact. This strategy focused on creating a positive safety culture by encouraging and motivating employees to actively participate in OHS initiatives. The relatively high rating suggested that employees perceived the organization's efforts to foster a supportive and encouraging environment positively. Employee perceptions of the effectiveness of this strategy was influenced by various factors, such as the recognition and rewards system for safety-related contributions, the availability of feedback mechanisms, and the overall management support for employee engagement in safety practices. The fairly high rating of the "Encouraging Employees" strategy is consistent with the research by Flin et al. (2000), who emphasized the importance of supervisory support and employee engagement in developing a strong safety culture. The authors suggested that creating a work environment that encourages employee participation, feedback, and ownership of safety practices can enhance safety awareness and compliance (Flin et al., 2000).

The availability of PPE received a mean rating of 3.23 (SD 1.436), indicating a moderate level of effectiveness but with a wider range of responses, reflecting differing experiences among employees. The moderate rating suggested that while the ZPC Hwange Expansion Project provided PPE, there may have been room for improvement in terms of ensuring its availability and suitability for all employees. The wider range of responses indicated variations in the accessibility, quality, or fit of the provided PPE. It is crucial for ZPC Hwange Expansion Project to regularly assess the effectiveness of their PPE program, consider employee feedback, and make necessary adjustments to ensure that all employees have access to appropriate and well-maintained PPE. The strategy of regular safety audits had a mean rating of 3.23 (SD 1.325), similar to the availability of PPE, indicating a moderate level of perceived effectiveness and some variability in responses. Regular safety audits play a crucial role in identifying potential hazards, assessing adherence to safety protocols, and ensuring compliance with OHS regulations. The moderate rating suggested that while employees recognized the importance of safety audits, there was room for improvement in terms of addressing identified issues and communicating the outcomes of the audits to employees. The variability in responses were influenced by factors such as the consistency and transparency of the audit process, the effectiveness of corrective actions taken based on audit findings, and the level of employee involvement in the audit process. ZPC Hwange Expansion Project should focus on improving communication channels and implementing effective follow-up actions to address identified safety gaps, ensuring that employees perceive safety audits as valuable and impactful. The moderate effectiveness and variability in employee perceptions regarding the "Availability of Personal Protective Equipment (PPE)" and "Regular Safety Audits" strategies align with the findings of Kogi (2012), who highlighted the need for a comprehensive approach to safety management that goes beyond the provision of PPE and periodic audits. The author emphasized the importance of integrating training, supervision, and worker involvement to ensure the effective use and maintenance of PPE, as well as the continuous improvement of safety practices (Kogi, 2012).

The statistically significant association between receiving OHS training and how employees rated the implemented strategies, as indicated by the chi-square test, corroborates the existing research on the importance of training in shaping safety perceptions and behaviors. Studies by Robson et al. (2012) and Seo et al. (2015) have consistently demonstrated the positive impact of comprehensive OHS training programs on improving worker awareness, attitudes, and compliance with safety protocols

CHAPTER 6: CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION

In conclusion, the research results revealed that employees at the ZPC Hwange Expansion Project are concerned about various health and safety hazards. Falling from heights, exposure to chemicals, electrical hazards, fire hazards, and machinery-based accidents were the most significant concerns, with a moderate correlation with employee awareness. Chemical and fire hazards were less significant, but still a significant concern. However, no significant correlation was found between employee awareness and the occurrence of these hazards. Electrical hazards had a moderate impact rating, and a positive correlation was identified between employee awareness and the occurrence of these hazards. The research also revealed a significant gap in safety education among employees, with a positive correlation between receiving OHS training and employee awareness. The research also showed moderate effectiveness in promoting OHS among employees, with some strategies being well-perceived but others showing room for improvement.

6.2 RECOMMENDATION

Based on the conclusions drawn from the research findings, several recommendations can be made to enhance the occupational health and safety (OHS) practices and promote the sustainability of construction projects like the Hwange Expansion project:

- **Implement Comprehensive OHS Training Programs:**

ZPC Hwange Expansion Project must develop and deliver continuous OHS training programs tailored to the specific needs and hazards of the construction industry. These programs should focus on hazard identification, risk assessment, and safe work practices. Encourage worker participation in regular refresher courses to keep safety knowledge up-to-date and reinforce safe behaviors.

- **Enhance Communication and Engagement:**

ZPC Hwange Expansion Project must foster an open communication culture where workers feel comfortable reporting hazards and near-misses without fear of reprisal. Implement regular safety meetings and toolbox talks to discuss safety concerns and share best practices. Involve workers in the development and review of safety policies and procedures, ensuring that their insights and experiences are considered.

- **Improve Site Maintenance and Hazard Control:**

ZPC Hwange Expansion Project must conduct regular site inspections and audits to identify and rectify potential hazards promptly. Ensure that all equipment and machinery are well-maintained and comply with safety standards. Implement effective housekeeping practices to keep the worksite clean and organized, reducing the risk of accidents and injuries.

- **Develop Targeted Interventions and Safety Campaigns:**

ZPC Hwange Expansion Project must create targeted safety interventions based on the specific hazards identified in the Hwange Expansion project. For example, if falls from height are a significant risk, develop focused campaigns and training on fall prevention and protection. Use data from incident reports and near-misses to identify trends and areas for improvement, tailoring interventions to address these issues.

- **Promote a Strong Safety Culture:**

ZPC Hwange Expansion Project must establish a safety culture where safety is prioritized at all levels of the organization. Management should lead by example, demonstrating a commitment to safety through their actions and decisions. Recognize and reward safe behaviors and practices, creating incentives for workers to adhere to safety protocols.

- **Enhance Stakeholder Collaboration:**

ZPC Hwange Expansion Project must strengthen collaboration with stakeholders, including contractors, subcontractors, and regulatory bodies, to ensure a unified approach to safety management. Share safety performance data and best practices to improve overall industry standards. Engage with local communities to raise awareness about the importance of OHS and involve them in safety initiatives where appropriate.

- **Utilize Technology and Innovation:**

ZPC Hwange Expansion Project must leverage technology such as wearable safety devices, drones for site inspections, and advanced monitoring systems to enhance safety management. These tools can provide real-time data and insights to proactively address safety issues. Invest in research and development to explore innovative solutions that can improve safety outcomes, such as automation and robotics for high-risk tasks.

- **Regularly Review and Update Safety Policies:**

ZPC Hwange Expansion Project must periodically review and update safety policies and procedures to ensure they remain relevant and effective. Incorporate feedback from workers and safety audits to continuously improve safety practices. Ensure compliance with local and international safety standards, adapting policies as necessary to meet evolving regulatory requirements.

REFERENCES

Ahmed, M., Al-Bayati, S., Liyanage, C., Lee, E., F, & G. (2021). (2021). BIM-enabled integrated safety management system for power plant construction projects. *Journal of Construction Engineering and Management,*, 408-411.

Bongaarts, J., & Mukumbira, J. (2023). An assessment of renewable energy sources for mitigating energy insecurity in Zimbabwe. . *Journal of Energy in Southern Africa*, 37-51. .

Chen, H., & Liu, X. (2021). Towards circular economy in power plant construction: A conceptual framework. *Resources, Conservation and Recycling*, 173-178.

Chimbari, P. M., & Mutasa, C. (2022). Occupational safety and health (OSH) challenges in the construction industry of Zimbabwe: A review. . *Journal of Construction in Developing Economies*, 232-243.

Construction Safety Council . (2019). *Construction Safety Council*. Retrieved January 31, 2024, from www.buidsafe.org

European Agency for Safety and Health at Work. (2020). *European Agency for safety and health*. Retrieved January 31, 2023, from https://osha.europa.eu/en

Ferreira, M. V., & Osinaga, T. A. (2020). The impact of safety regulations on firm performance in the construction industry. *Journal of Safety Research, 73*, 87-97.

Fishwick, L., Rees, D., Ashworth, R., S, T, & U. (2023). Predicting social care workers' attitudes towards COVID-19 vaccination: An application of the health belief model. . *Safety Science*, 154.

Gao, S., Zou, P. X., Zhang, X., Y, Z, & A. (2021). Achieving accident prevention through safety culture. . *Safety Science*, 246.

Gnoni, M. G., Hartmann, T., Hamza, M., Lyubarskaya, N., Mostafavi, A., Rusu, L. C., & Wilhelmsson, M. (2021). A survey on approaches and practices for safety risk assessment in complex industrial systems. *Safety Science*, 408-412.

Guan, Y., Zhao, L., Li, X., Du, M., Jiang, W., X, . . . Z. (2023). Research on risk management framework of occupational accidents in construction projects. *Safety Science*.

Guldenmund, F. W. (2020.). Models of safety culture. *Safety Science*, 130.

Hinze, J., Lee, M., & Walker, P. (2020). The ever-present danger: An analysis of occupational hazards in the construction industry. *Journal of Construction Engineering and Management*, *146*(8).

Hopkin, P. (2018). *Fundamentals of risk management: Understanding, evaluating and implementing effective risk management.* . Kogan Page Publishers.

International Atomic Energy Agency. (2017). Nuclear Power Project Management. *IAEA Nuclear Energy Series*.

International Labour Organization (ILO). (2021). *World Social Protection Report: Social protection for a green transition.* ILO.

Jones, A., & Wang, L. (2019). Building a safer future: Occupational health and safety challenges in thermal power plant construction. *Journal of Construction Management and Economics, 5*(37), 489-503.

Jones, K., Huddlestone-Hodge, E., Harris, M., N, O, & P. (2015). Health belief model: An examination of health beliefs and behaviours of expectant mothers during the H1N1 pandemic. . *Australian Journal of Primary Health*, 164-171.

Kim, J., & Park, M. (2022). The impact of safety culture on risk management in power plant construction projects. . *International Journal of Construction Management*, 274-288.

Kraus, M., & Grzybowski, M. (2020). The financial benefits of implementing a proactive safety culture in construction. . *Construction Management and Economics, 38*(4), 255-272.

Lee, J., & Park, M. (2023). Green construction practices in power plant development: A case study. . *International Journal of Sustainable Built Environment*, 45-56.

Leveson, N. G. (2020). A systems approach to risk management through leading safety indicators. *Safety Science*, 129-135.

Liao, C., Lin, H., & Tsai. (2021). Green construction and management of thermal power plants. t, 147(8), . *Journal of Construction Engineering and Managemen*.

Liu, W., Li, H., Chen, S., Zhang, Q., R, S, & T. (2023). (2024). Enhancing Occupational Health and Safety Through Safety Management Systems: A Case Study of Power Plant Construction. *Safety Science*, 143.

Mahdavian, M., Golbabaei, F., Khazaei, S., T, U, & V. (2022). (2022). Application of the health belief model for prediction of safety behaviors among Iranian coal miners. *International Journal of Occupational Safety and Health*, 53-59.

Mensah, A., Osei-Tutu, E., & Adjei-Kumi, T. (2020). Safety management practices in the Ghanaian construction industry. . *International Journal of Construction Management*, 1-10.

Moyo, P., & Kampamba, G. M. (2022). Occupational health and safety challenges of a transition to a renewable energy sector in developing countries: A case study of Zambia., . *Renewable and Sustainable Energy Reviews*, 318-323.

Mushove, P. T., & Nhamo, S. (2021). The feasibility of harnessing wind energy for rural electrification in Zimbabwe. *Energy Reports*, 8768-8774.

Occupational Safety and Health Administration (OSHA). (2020). *Occupational Safety and Health Standards*. Retrieved January 31, 2024, from https://www.osha.gov/laws-regs/regulations/standard/29cfr1910

Patel, A., & Gupta, S. (2017). An investigation into occupational health and safety hazards in a large-scale power plant construction project. *Journal of Construction Engineering and Management, 14*(6).

Reiman, T., & Pietikäinen, E. (2012). (2012). The potential of systems thinking in safety management: A case study of industrial maintenance. 50(3), . *Safety Science,* , 536-542.

Sabir, S., Qureshi, M. A., Arif, M., Kaleem, M., Waheed, A., & Malik, N. (2023). (2023). A Systems Approach to Analyze Occupational Health and Safety Hazards in the Construction Industry. . *Advances in Civil Engineering*, 78-85.

Senge, P. M. (2015). *The fifth discipline: The art & practice of the learning organization.* . Crown Business.

Smith, J., Johnson, A., Davis, R., S, T, & U. (2022). Occupational Health Impacts of Power Plant Construction: A Cross-sectional Study. , 72(3),. *Occupational Medicine,* 201-208.

Wang, L., & Chang, S. (2023). Training Interventions for Occupational Health and Safety in Power Plant Construction: A Systematic Review. *Safety and Health at Work*, 451-461.

Wu, S., & Low, S. (2019). The economic benefits of safety investment in construction projects: A case study approach. . *International Journal of Construction Management, 30*(8), 1202-1215.

Yuliansyah, R., Maulana, E., Herawati, L., M, N, & O. (2022). (2022). The role of safety culture, safety climate, and safety motivation in improving safety behaviour at a coal-fired power plant in Indonesia. . *International Journal of Environmental Research and Public Health*, 43.

Zhang, L., Wang, Y., Zhang, J., Li, X., Y, & Z. (2023). Risk Assessment of Occupational Health and Safety in Power Plant Construction Projects. . *Journal of Construction Engineering and Management,*, 115-121.

Zhang, W., Li, Y., & Chen, X. (2021). Safety risk assessment and management for thermal power plant construction projects. *Journal of cleaner production, 29*(3).

Zhang, Y., Wang, Z., Zhang, L., M, N, & O. (2023). A fuzzy logic-based risk assessment approach for power plant construction projects. *Safety Science*, 418-423.

Zohar, D. (2020). A multilevel model of safety climate: Cross-level relationships between organization and group-level climates. . *Journal of Applied Psychology*, 187-201.

The Herald. (2021, July 7). *Two injured in Hwange Power Station explosion*. Retrieved from The Herald: https://www.herald.co.zw/two-injured-in-hwange-power-station-explosion/

iHarare. (2021, February 10). *Chinese Worker Dies After Falling Off A Scaffold At Hwange Power Station.* Retrieved from iHarare: https://iharare.com/chinese-worker-dies-after-falling-off-a-scaffold-at-hwange-power-station/

Chronicle. (2019, November 23). *Man falls headlong, dies at power station.* Retrieved from Chronicle: https://www.chronicle.co.zw/man-falls-headlong-dies-at-power-station/

Aigbavboa, C. O., & Thwala, W. D. (2014). Relationship between construction health and safety regulations and implementation approaches: A case for developing countries. Journal of Facilities Management, 12(4), 303-323.

Eberhard, A., Gratwick, K., Morella, E., & Antmann, P. (2020). Independent power projects in sub-Saharan Africa: Lessons from five key countries. World Bank Publications.

Ekpu, C. U. (2011). Health and safety on Nigerian construction sites: A review. International Journal of Research in Construction Engineering and Project Management, 1(1), 13-28.

Hinze, J., Devenport, J. N., & Giang, G. (2013). Identifying key issues in construction safety. Safety science, 51(1), 523-528.

Zim Live (2019, June 12). Nine construction workers killed as wall collapses in Kwekwe. ZimLive. https://www.zimlive.com/2019/06/12/nine-construction-workers-killed-as-wall-collapses-in-kwekwe/

International Labour Organization. (2020). Safety and health in construction. https://www.ilo.org/global/topics/safety-and-health-at-work/areasofwork/construction/lang--en/index.htm

Ngabonziza, A., Ndarishikanye, P. E., Rosa, E. D., & Guastella, G. C. (2016). Potential of renewable energy sources in Rwanda: A review. Renewable and Sustainable Energy Reviews, 55, 1006-1019.

Melia, J., Parkin, L., & Pollock, J. (2008). Occupational health in the construction industry. Occupational Medicine, 58(4), 278-283.

ILO. (2022). Safety and health at work. https://www.ilo.org/global/topics/safety-and-health-at-work/lang--en/index.htm

Zimbabwe Power Company. (2020). Zimbabwe power company corporate plan 2020-2024. https://www.esmap.org/sites/default/files/Zimbabwe_Power_Company_Corporate_Plan_2020-2024.compressed.pdf

International Labour Organization (ILO) (2015), Safety and Health at Work, Available at http://ilo.org/global/topics/safety-and-health-at-work/lang--en/index.htm

International Labour Organization (ILO) (2017), Occupational Safety and Health Convention, 1981 (No. 155). Available at http://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:::NO:12100:P12100_ILO_CODE:C155:NO

Dodoo, J.E. and Al-Samarraie, H., 2021. A systematic review of factors leading to occupational injuries and fatalities. Journal of Public Health, pp.1-15.

Olcay, Zeynep F., Ahmet E. Sakalli, Sertaç Temur, and Ahmet Yazici. "A study of the shift in fatal construction work-related accidents during 2012–2019 in Turkey." International journal of occupational safety and ergonomics 28, no. 3 (2022): 1522-1532.

Almaskati, D., Kermanshachi, S., Pamidimukkala, A., Loganathan, K. and Yin, Z., 2024. A Review on Construction Safety: Hazards, Mitigation Strategies, and Impacted Sectors. Buildings, 14(2), p.526.

Simutenda, P., Zambwe, M. and Mutemwa, R., 2022. Types of occupational accidents and their predictors at construction sites in Lusaka city. medRxiv, pp.2022-05.

Mehlig, K., Torén, K., LaMontagne, A.D., Wahlström, V., Nyberg, J., Waern, M. and Åberg, M., 2024. Occupation-specific risk estimates for suicide and non-fatal self-harm from a Swedish cohort of male construction workers followed 1987–2018. Occupational and Environmental Medicine.

Elsebaei, M., Elnawawy, O., Othman, A.A.E. and Badawy, M., 2022. Causes and impacts of site accidents in the Egyptian construction industry. International Journal of Construction Management, 22(14), pp.2659-2670.

Strielkowski, W., Civín, L., Tarkhanova, E., Tvaronavičienė, M. and Petrenko, Y., 2021. Renewable energy in the sustainable development of electrical power sector: A review. Energies, 14(24), p.8240.

Song, F., Mehedi, H., Liang, C., Meng, J., Chen, Z. and Shi, F., 2021. Review of transition paths for coal-fired power plants. Global Energy Interconnection, 4(4), pp.354-370.

Pudasainee, D., Kurian, V. and Gupta, R., 2020. Coal: Past, present, and future sustainable use. Future Energy, pp.21-48.

Auth, K., 2023. How the US Can Better Support Africa's Energy Transition.

Mutezo, G. and Mulopo, J., 2021. A review of Africa's transition from fossil fuels to renewable energy using circular economy principles. Renewable and Sustainable Energy Reviews, 137, p.110609.

Tarekegne, B.W., Kazimierczuk, K. and O'Neil, R.S., 2021. Coal-dependent communities in transition: identifying best practices to ensure equitable outcomes (No. PNNL-31909). Pacific Northwest National Lab.(PNNL), Richland, WA (United States).

Lyon, B.K., 2021. Project-Oriented Risk Assessments. Risk Assessment: A Practical Guide to Assessing Operational Risks, pp.307-336.

Nair, V.K., 2020 OCCUPATIONAL HEALTH AND SAFETY CONDITIONS AMONG SMES: A CASE STUDY BASED IN THE DISTRICT OF BA, FIJI.

Zhang, M., Shi, R. and Yang, Z., 2020. A critical review of vision-based occupational health and safety monitoring of construction site workers. Safety science, 126, p.104658.

Howells, M., Boehlert, B. and Benitez, P.C., 2021. Potential climate change risks to meeting Zimbabwe's NDC goals and how to become resilient. Energies, 14(18), p.5827.

Proctor, D., 2023 New Coal-Fired Unit Operating at Zimbabwe's Largest Thermal Power Plant

Ncube L, 2019., Man falls headlong, dies at power station. The Chronicle

Ncube, A,L 2021., Tragedy As Chinese Worker Dies After Falling Off A Scaffold At Hwange Power Station-iHarare https://iharare.com/tragedy-as-chinese-worker-dies-after-falling-off-a-scaffold-at-hwange-power-station/

Choudhry, R. M., & Fang, D. (2008). Why operatives engage in unsafe work behavior: Investigating factors on construction sites. Safety Science, 46(4), 566-584.

Gómez-Cano, M., Hernandez-Soto, H., Bautista-Arredondo, L. F., & González-Delgado, A. (2018). Factors associated with the perception of safety climate in construction workers. Safety Science, 101, 328-337.

McCann, M., & Bloswick, D. S. (2003). Electrical hazards and the construction industry. AAOHN Journal, 51(5), 197-205.

Pinto, A., Nunes, I. L., & Ribeiro, R. A. (2011). Occupational risk assessment in construction industry – Overview and reflection. Safety Science, 49(5), 616-624.

Ronny, J., & Rivas, T. (2015). Analysis of fire-related incidents in the Spanish construction industry during the period 2000-2010. Safety Science, 73, 8-14.

Sparer, E. H., Catalano, P. J., Herrick, R. F., & Dennerlein, J. T. (2016). Improving safety climate through a communication and recognition program for construction. Journal of Construction Engineering and Management, 142(8), 04016024.

Teizer, J., Allread, B. S., Fullerton, C. E., & Hinze, J. (2010). Autonomous pro-active real-time construction worker and equipment operator proximity safety alert system. Automation in Construction, 19(5), 630-640.

Flin, R., Mearns, K., O'Connor, P., & Bryden, R. (2000). Measuring safety climate: identifying the common features. Safety science, 34(1-3), 177-192.

Hinze, J., & Gambatese, J. (2003). Factors that influence safety performance of specialty contractors. Journal of construction engineering and management, 129(2), 159-164.

Kogi, K. (2012). Advances in participatory occupational health aimed at good practices in small enterprises and the informal economy. Industrial health, 50(3), 197-206.

Lingard, H., & Rowlinson, S. (1994). Construction site safety in Hong Kong. Construction Management and Economics, 12(6), 501-510.

Robson, L. S., Stephenson, C. M., Schulte, P. A., Amick, B. C., Irvin, E. L., Eggerth, D. E., ... & Peters, R. H. (2012). A systematic review of the effectiveness of occupational health and safety training. Scandinavian Journal of Work, Environment & Health, 193-208.

Seo, H. C., Lee, Y. S., Kim, J. J., & Jee, N. Y. (2015). Analyzing safety behaviors of temporary construction workers using structural equation modeling. Safety Science, 77, 160-169.

Maiti, J., & Bhattacherjee, A. (1999). Evaluation of risk of occupational injuries among underground coal mine workers through multinomial logit analysis. Journal of Safety Research, 30(2), 93-101.

Robson, L. S., Stephenson, C. M., Schulte, P. A., Amick, B. C., Irvin, E. L., Eggerth, D. E., ... & Peters, R. H. (2012). A systematic review of the effectiveness of occupational health and safety training. Scandinavian Journal of Work, Environment & Health, 193-208.

Seo, H. C., Lee, Y. S., Kim, J. J., & Jee, N. Y. (2015). Analyzing safety behaviors of temporary construction workers using structural equation modeling. Safety Science, 77, 160-169.

Tam, C. M., & Fung, I. W. (2011). Behavior factors influencing the safety performance of operatives in the construction industry. International Journal of Construction Management, 11(2), 15-26.

APPENDICES

APPENDIX A: Bouely's formula

Eq. 1

Where:

n is the sample size

N is the population size

e is the margin error factor (assumed as 0.1)

= 88

APPENDIX B: RESEARCH QUESTIONNAIRE:

ASSESSMENT OF OCCUPATIONAL HEALTH AND SAFETY HAZARDS ASSOCIATED WITH CONSTRUCTION OF THERMAL POWER PLANTS

Dear Participant,

My name is Tatenda Mahumucha, and I am a student at Bindura University of Science Education. As part of my research project, titled "***An assessment of occupational health and safety hazards associated with construction of thermal power plants: case of Zimbabwe Power Company Hwange expansion project,***" I kindly request your participation in this questionnaire.

The study aims to identify and categorize specific occupational health and safety hazards in the ZPC Hwange Expansion Project, assess employee awareness of Occupational Health and Safety, and evaluate the extent to which health and safety measures are implemented at ZPC Hwange Expansion Project.

Your participation in this study is completely voluntary, and all information provided will be treated confidentially. Your responses will only be used for research purposes, and your identity will remain anonymous.

Thank you for your valuable contribution to this research.

Best regards,

Tatenda Mahumucha

You are kindly requested to answer the following questions either ticking in the appropriate bracket for each question. Please answer every question.

Section A. Demographic Information ***(Tick accordingly)***

A1. What is your age group?

18-30 ☐

More than 30-40 ☐

More than 40-50 ☐

Above 50 ☐

A2. What is your role in the ZPC Hwange Expansion Project? ***(Tick accordingly)***

Construction Worker ☐

Supervisor/Manager ☐

Engineer ☐

Health and Safety Officer ☐

Other (Please specify)…………………………………………………………………………

A3. How long have you been working in the construction industry? ***(Tick accordingly)***

Less than 5 years ☐

5-10 years ☐

More than 10-15 years ☐

More than 15 years ☐

Section B. Identification and Categorization of Occupational Health and Safety Hazards

B1. Have you encountered any of the following hazards at the ZPC Hwange Expansion Project? (Check all that apply)

Falling from heights ☐

Exposure to chemicals/fumes ☐

Electrical hazards ☐

Fire/Explosions ☐

Machinery-related accidents ☐

Noise exposure ☐

Slips, trips, and falls ☐

Heat stress ☐

Ergonomic hazards (repetitive motion, awkward postures) ☐

B3. On a scale of 1-5 (1 being to no extent and 5 being to a greatest extent) to what extent have the following hazards affected workers at the construction project site? *(Tick accordingly)*

	1	**2**	**3**	**4**	**5**
Falling from heights					
Exposure to chemicals/fumes					
Electrical hazards					
Fire/Explosions					
Machinery-related accidents					

Section C. Employee Awareness of Occupational Health and Safety

C1. Are you aware of existing Occupational Health and Safety (OHS) regulations for your role? *(Tick accordingly)*

Yes ☐

No ☐

C2. Have you received OHS training or attended workshops within the last 12 months? *(Tick accordingly)*

Yes ☐

No ☐

C3. How often do you discuss OHS concerns with your colleagues or supervisor? *(Tick accordingly)*

Always ☐

Frequently ☐

Occasionally ☐

Never ☐

Section D. Implementation of Health and Safety Measures ***(Tick accordingly)***

Likert Scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

	1	**2**	**3**	**4**	**5**
OHS measures are clearly communicated and enforced at the ZPC Hwange Expansion Project.					
The project site is well-maintained and kept clean to prevent accidents.					
Employees are encouraged to report OHS hazards and incidents without fear of reprisal.					
Personal Protective Equipment (PPE) is readily available and used by all employees.					
Regular safety inspections and audits are conducted to identify potential hazards.					

APPENDIX C: RESEARCH PERMISSION LETTER

FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCE
DEPARTMENT OF ENVIRONMENTAL SCIENCE

Bindura University of Science Education

P. Bag 1020
Bindura, Zimbabwe
Tel: 263 - 71 – 6505
Cell : 0778371588
Email : tnyamugure@buse.ac.zw

BINDURA UNIVERSITY OF SCIENCE EDUCATION

4 April 2024

Dear Sir/Madam

REQUEST FOR PERMISSION TO COLLECT DATA FOR ACADEMIC RESEARCH PROJECT

This letter serves to inform you that Tatenda Mahumucha is a fourth year student at Bindura University of Science Education, in the Department of Environmental Science. During his/her fourth year of study he/ she is supposed to do a research project in her area of specialisation.

Please assist in any possible way. Data collected will be used for academic purposes only and will not be published without your prior consent.

Thank you for your assistance.

Yours faithfully.

CHAIRPERSON
Department Of Environmental Science
Faculty Of Agriculture And Environmental Science
Bindura University Of Science Education
P. BAG 1020, BINDURA
ZIMBABWE
OFFICIAL

Mr .T .Nyamugure
Chairperson - Department of Environmental Science