BINDURA UNIVERSITY OF SCIENCE EDUCATION

EXPLORING THE EFFECTS OF AUTOMATION ON WORKFORCE JOB SECURITY IN MINING SECTOR: A CASE OF KUVIMBA GROUP OF MINES

BY

MERCY TSITSI GUNDIDZA

REG NUMBER

B224287B

A DISERTATION IS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE EXECUTIVE MASTERS IN BUSINESS LEADERSHIP

APPROVAL FORM

The undersigned certify that they have read and recommended to Bindura University of Science Education (BUSE) for acceptance a Dissertation entitled **"EXPLORING THE EFFECTS OF AUTOMATION ON WORKFORCE JOB SECURITY IN MINING SECTOR: A CASE OF KUVIMBA GROUP OF MINES"** by **MERCY TSITSI GUNDIDZA** in partial fulfilment of the requirements for the degree of The Executive Master of Business Leadership (EMB).

Mercy T. Gundidza…… Signature: …… Date: 11/12/2023

Student

Prof M Dandira……..…… Signature: …… Date:11/12/2023.

Supervisor

……...…… Signature: …… Date: ……..

GSB Director

……...…… Signature: …… Date: ……..

Faculty Chairperson

……...…… Signature: …… Date: ……..

External Examiner

RELEASE FORM

NAME OF AUTHOR: **MERCY TSITSI GUNDIDZA**

STUDENT NUMBER**: B224287B**

TITLE OF DISSERATION: **EXPLORING THE EFFECTS OF AUTOMATION ON WORKFORCE JOB SECURITY IN MINING SECTOR: A CASE OF KUVIMBA GROUP OF MINES**

DEGREE: **THE EXECUTIVE MASTER OF BUSINESS LEADERSHIP [EMB]**

YEAR DEGREE AWARDED: 2023

Permission is hereby granted to the Bindura University of Science Education Library to produce copies of this dissertation for private, scholarly, or scientific research purposes. The author reserves other publication rights for the dissertation or extensive extracts from it to be printed or otherwise reproduced without the author's written permission.

Signature: ……. **Date**: 11/12/2023

Permanent Address: ……104 B Abercon ST

…….Shamva

……..

……..

E-mail: …tgundidza@gmail.com

Cell Number: …+263772805235

DECLARATION:

I, Mercy Tsitsi Gundidza, Student Registration Number B224287B, do hereby declare that this dissertation is a result of my own investigation and research, except to the extent indicated in the acknowledgements, bibliography, references, and comments included in the body of the report, and that it has not been submitted in part or in full for any other degree to any other university.

STUDENT SIGNATURE: DATE:11/12/2023

DEDICATION

This dissertation is dedicated to my late father who always emphasized that the sky is the limit and always saw the best in me.

ACKNOWLEDGEMENT

I would like to thank Kuvimba Mining for allowing me to carry out this research and their consent to reach out to workers. A special gratitude goes to Professor Dandira for all the guidance and feedback throughout this research. Special mention also goes to my family who were patient with mummy as I worked long hours and at times failed them. To my sister Nicky, you have been a pillar of strength, I would not have made this through without you. To all my workmates, thank you for your support, encouragement and the running around in data collection, I would not have managed without you. To my friends at large thank you for understanding my long absence as I battled with my studies.

ABSTRACT

The study sought to explore the effects of automation on workforce job security in mining sector: a case of Kuvimba group of mines. The objectives were to determine the extent to which Kuvimba mining company implement automation in mining processes, to establish the impacts of automation of mining processes on workforce job security in mining Industry, to explore the perceptions of the workers, management and other stakeholders on the impacts of automation on workforce job security and to establish strategies that can be implemented to mitigate job losses due to automation of the mining processes. The study adopted pragmatism, philosophy. The study population consisted of employees from three mines namely, Trojan Nickel mine, Freda Rebecca mine and Shamva gold mine. A total sample 61 respondents were used. Survey questionnaire and interview guide were used as research tools. Data was captured coded and analysed using SPSS. Results indicated that the mining companies have implemented digitalisation across all mining processes. Vehicles are tracked, the mines detect mineral using machinery, off lading and loading is also done automatically through the use of conveyor belts and automated trucks. It was observed that Kuvimba mines have operational procedures for using automated machinery. The results showed that automation of the mining processes affected job security. There are risks of losing jobs due to automation of mining processes; automation reduced the number of workers at the mine. It was noted that automated machinery replaced human resources. Presence of a moderate positive linear relationship between automation and workforce Job security was observed. Multiple regression model was statistically significant ($p<0.05$) in forecasting the impact of automation on workforce job security. The study also observed that automation of mining processes improves health and safety of employees and to some extend does affect workforce job security. However, some participants opined that automation had increased the number professional and technical employees but reduced the large number of unskilled workforces through retrenchment. The interviews also revealed that, the mines preferred fixed time unskilled contract workers whose contracts can be terminated. Automation affected job security of employees despite perceived benefits such as improved productivity, efficiency and health and safety. It was suggested that employees need re-skilling and up skilling and there is also need to channel resources towards training as compared to outsourcing resources for equipment operation. The study also recommends that mining organizations must provide training for workers on automation this can be done through, educational grants or incentives to motivate workers to advance their knowledge in the field of automation. The mining sector should consider alternative means of employment to secure jobs for unskilled labour. Future studies should be carried out in other sectors of the economy; to fully understand the impact of automation on employee job security.

Key words: Automation, security, mining productivity, industry

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1
INTRODUCTION AND BACKGROUND

1.0 Introduction

Technology has long been used by the mining sector to address and resolve challenges like workplace productivity and environmental concerns. (Low, 2020; Loow & Nygren, 2019). With the accelerating use of automation technologies in recent years, there has been a vast transformation. While technological advancements increase productivity, safety, and efficiency in mining operations, the effect on workforce job security has since been a source of discussion (Buckle, 2023). It is hard to deny that advanced technologies have more than just positive impacts. Analysis of additional research indicates that automation in the mining sector creates a complicated relationship between the environment and the job security of the workforce.

In addition, automation can be viewed as an immovable asset that mining firms can leverage to generate output that is driven by production function. This is achieved, for instance, by numerous applications such as autonomous cars, text-generating techniques, voice recognition, and sophisticated neural networks, which demonstrate automation's potential to boost business efficiency (Brynjolfsson et al. 2017). The study focuses on the effects of automation on the workforce job security in the mining sector and possible strategies that can be implemented to balance the disruption caused by automation. This chapter will focus on the background to the study, research objectives, and problem statement.

1.1Background

Using automation technologies like robotic systems, drones, and autonomous vehicles has been proposed as a way to overcome these obstacles. The impact of advanced technologies on work environments has been the subject of various studies (Zhang et al., 2019; Chen et al., 2020; Nguyen et al., 2020; Pham et al., 2020; Tran et al., 2020; Wang et al., 2020). The majority of studies concentrated on how automation benefits the mining sector. For instance, McKinsey (2021) discovered that, in 2016, mining production increased overall by roughly 2.8%. Furthermore, Jbil

(2023) demonstrated how predictive maintenance is being used to increase efficiencies through automation technologies.

However, (Buckle 2021) argued that while these technologies offer many opportunities within mining industry, corresponding risks and potential disputes cannot be ignored. Oyede at all (2021) found that adoption to automation technologies in Nigerian mining industry could lead to job displacement and negative socio-economic consequences. Strategic managers must ensure that there is collaboration in mitigating risks. However, the impact of automation on workforce job security in the mining industry remains a thorn in the flesh as there is limited research on how strategic management plays a role in protecting the workforce and solve potential disputes with local communities concerning job opportunities. Further research is therefore required to have an in-depth understanding of the effects in different contexts, particularly in developing countries such as Zimbabwe. Hence, the need to assess how automation has affected the workforce job security.

While automation contribute to increased efficiencies and production, reduced greenhouse gas emissions and improved safety, there is impact on local employment levels, skills creation and development (Brunel 2021) and this has however been overlooked. Additionally, the COVID-19 pandemic has led to less dependence on human interaction for critical operational processes (Paredes, Flemming & Mundoz 2021).

The mining industry is a very critical sector of the Zimbabwean economy. The sector accounts for about 12% of the country's gross domestic product and has potential to generate US$12billion by year end 2023 (International Trade Administration 2022). It provides employment opportunities to thousands of people. Official data from CoMZ shows that at least 45000 people are registered by employment council as working in the mining industry of Zimbabwe. However, the industry faced numerous challenges including declining productivity, safety concerns and labour disputes. The effects of the pandemic resulted in addition to reduced, indirect and induced employment industry resulting in an overall decline in output (African development Bank 2021).

Despite the entire achievements achieved using automation in mining sector around the world, the effects of automation on workforce job security in Zimbabwe's mining sector are yet to be fully recognized. Previous studies focused more on the use of artificial intelligence in manufacturing

industries and few studies were done in the mining field. In addition, the role of automation in the developing world is not fully covered particularly mining industry which is the greatest contributor of gross domestic product and most importantly foreign currency. This research assessed the current level of automation and its impact on workforce job security in the mining industry.

1.2 Statement of the problem

The substitution of human capital with automation is increasing in various mining processes at Shamva Mine and it is likely to intensify with the expansion of the mine through the Open Pit project. It is predicted that by 2024, the labour budget will reduce by 30 to 40%. Shamva mine has been transformed from using traditional methods of mining to advanced technology mining by acquisition of autonomous machine such as Autonomous Haulage vehicles, and automated machines such as survey drones and some information management systems. Despite the positive effects of automation in the mining sector such as increased productivity, (Kuznetsov & Aksyonov 2019), improved health and safety (Siau, 2018), high-efficiency, minimum cost, and reduced accidents (Choi, 2018), there has been a significant decrease in the number of employees, as many have been displaced or laid off. It is against this background that the study seeks to explore how adoption of technology affected workforce job security and to identify possible strategies that can be taken to curb the impacts.

1.3 Research Objectives

1. To determine the extent to which Kuvimba mining company implement automation in mining processes.
2. To establish the impacts of automation of mining processes on workforce job security in mining Industry.
3. To explore the perceptions of the workers, management and other stakeholders on the impacts of automation on workforce job security.
4. To establish strategies that can be implemented to mitigate job losses due to automation of the mining processes.

1.4 Research questions

1. Does Kuvimba implement automation in mining processes?
2. How does automation of mining processes affect workforce job security in mining Industry?
3. How do workers, management and other stakeholders perceive the impacts of automation on workforce job security?
4. What possible strategies that can be implemented to mitigate job losses due to automation of mining processes?

1.5 Hypothesis

H_0 Automation of mining processes does not affect workforce job security in the mining sector
H_1 Automation of mining processes affects workforce job security in the mining sector

1.6 Research Assumption

The sample size employed produced data adequate enough to examine the research problem. It is difficult to gather data from a huge population since this is time consuming and as such, a sample should be a representation of the entire population. Thus, the sample size used was a representative sample. It is also assumed that the chosen sample sizes made it easy for the researcher to manage research participants and as such all participants were able to provide their different opinions regarding subject under study.

The research instruments used (questionnaire, interview guide) provided adequate information the impact of automation in the mining sector in Zimbabwe. As such, all those requested to respond to the questionnaire were keen to participate in the study and they provided answers that were genuine when answering the given question.

1.7 Purpose

The purpose of the study is to explore the impact of automation on workforce job security and to identify strategic that can be implemented to curb the impacts of automation on workforce job security in the mining sector

1.8 Justification

This research will be most appropriate for Shamva as there is limited information on the implementation of automation at the mine and the effects that result from it. Moreover, there is need for research that identifies strategies for mitigating job losses at Shamva Mine and others in the group. The research will provide an in-depth analysis of the effects of automation based on the fact that Zimbabwean government has a vision to transform Zimbabwe an upper middle income economy by 2030 and increase employment and mining Industry is the backbone of Zimbabwe's economy.

1.9 Justification

Determining the impacts of automation on workforce job security in the mining sector and possible strategies that can be taken can help the mining industry in Zimbabwe at large to develop more effective and sustainable approaches to automation. It will also provide wider implications of automation for employment and economy.

1.10 Significance/Importance of the study

1.10.1 To theory

This study provides theoretical influences to existing literature on how the implementation of technologies in the mining sector affects workforce job security. The study also assesses key factors that drive mining companies to rely on automation technologies or solutions for mining decisions in the mining industry. This study determines how employees respond to automation as well as the responses in mining industry. In addition, potential barriers and challenges attributed to automation technologies in the mining sector, and how these barriers can be addressed were discussed. This made this study different from other studies.

The study has also used the Technology Acceptance Model (TAM) in order to understand how workers perceive and accept artificial intelligence technologies in the mining sector. It consists of two primary factors: perceived usefulness and perceived ease of use. In this study, perceived usefulness refers to the extent to which workers believe that automation of the mining sector enhances their mining experience, while perceived ease of use relates to the perceived simplicity of using automated tools. By examining these factors, researchers can assess worker's attitudes and intentions toward adopting technologies. This further makes the study unique. The TAM model has been used in various studies (Venkatesh et al., 2019; Borrero et al., 2018).

1.10.2 To practice

Understanding impact of automation on workforce job security in the mining sector could help to better appreciate the correlation between artificial intelligence technologies and employees in the mining sector. This also informs managers on developing appropriate strategies based on automation which will promote growth of the mining sector. In addition, it helps to understand the inherent or external factors that give rise to automation in the mining sector. According to Pham et al. (2019), factors such as of employees drive business results. Hence, a business that is hell-bent on having a good prediction over their business performance; needs to have perfect know-how concerning the way they have introspection over one of their most valuable resource-workers (Pham et al., 2019). Therefore, the ability to be trusted, be helpful, and derive values are central directing the action(s) of employees.

Despite widespread use of automation in many organizations, there are many challenges that impede or affect employees. This study will provide useful information with regard to internal and external factors affecting employees in the mining sector. As a result, the study provides solutions to counteract challenges and helps to develop AI based technologies meet the various demands of workers regardless of age, gender or educational level. This will also assist in improving the quality of the information and technology given to the mining industry.

The results and recommendations of this study benefited mining companies to identify the most influential strategies, within the confines of the regulations. Mining companies could thus put

emphasis on the most effective strategies to reach the diverse scope of workers, with varying demographic variables. Internally, as profit making organizations, they could in turn advance on their net profits, upsurge their share of throat, cut on expenses, and potentially cataract the savings to employees.

1.11 Delimitation

1.11.1 Time delimitation

The study covered the period December 2020 to October 2023. This would sufficiently prove the needed information for the study and will also assist in achieving the research objectives. This also gave the researcher enough time to gather information from participants with regards to impacts of automation in the mining sector. Hence, participants could also have ample time to provide information regarding their beliefs, emotions and feeling towards the use of automated based machineries in the mining sector.

1.11.2 Geographical delimitation

The research put more focus on Kuvimba group of mines, Mashonaland Central province, Zimbabwe. The study thus no other geographical locations were used. The justification enlightening this choice was required to alleviate on the costs of the study. The chosen area had a number of consumers as compared to towns and cities and as such, this enabled the researcher to solicit more information regarding the automation in the mining sector.

1.11.3 Methodology delimitation

Pragmatism approach with a cross-sectional study design was used in this study. Both quantitative and qualitative methods were used to gather information. A total of 60 participants from the Kuvimba group of mines were used. This study uses a simple selective sample to select 60 participants. Triangulation of research equipment is done. Researcher drafted questionnaires, guided using closed and open-ended questions. Interview guide was also sued to solicit information from key informants in the mining sector. The survey was designed for employee's participation. Questionnaires are randomly distributed to selected participants.

1.12 Dissertation outline

Chapter One:

This chapter is a pre-emptive motivation that describes the background, problem statement, and the objectives. Research questions, purpose of the research, justification, significance, assumptions of the research, and delimitations. It is this chapter where the research gap is identified. Hence, global, regional and local status in terms of automation was discussed.

Chapter two:

This chapter focuses on a literature review describing the adoption of artificial intelligence, theories underpinning the study, and impacts of automation of the mining sector on workforce job security in the mining sector. It is also the literature review that identifies incomplete routes to research.

Chapter three:

This chapter describes the research methodology. In addition, this chapter will also explain and endorse research philosophy, study design, sampling and sampling techniques, data collection and analysis methods, and ethics. The results and analysis procedure will also be given.

Chapter four:

This chapter focuses on presentation and analysis of the primary data collected through questionnaires and interviews. Presentation of primary data findings have been facilitated through bar charts/pie charts and tables. Brief discussions have been included to explain each chart. Findings of the literature review are compared to primary data findings in this chapter, and in-depth discussions are provided in relation to each individual research objective

Chapter five:

In this chapter, the conclusion of the summary as well as recommendations will be given and these will be based on the study results. Recommendations will be made on actions that can take to reduce loss of jobs due to automation in the mining sector in Zimbabwe.

1.13 Chapter summary

Chapter one was an introduction of the study topic to the readers. This section went on to expound the background of the study and the statement of the problem and clarified the focal point of the study. The study objectives and research questions were established. The parameters and organization of the study were picked out.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

In this chapter implementation of automation in the mining sector will be discussed, the impact of automation on workforce job security will also be discussed. This chapter discusses the research's guiding hypotheses. The research on automation models will be explored, along with how it fits into each stage of the mining process, hurdles to its implementation in the mining sector, and effects on output. The chapter finishes by describing any gaps in the body of knowledge that were uncovered during the literature review.

2.1 Definitions (conceptual and operational)

2.1.1 Automation

Automation is widely defined as the intelligent management of a system using appropriate technology so that its operation can occur without direct human involvement. (Lynas & Hoberry 2011). Automation has increasingly become the source of efficiency, safety and production in the recent years. In mining industry, automation takes various forms that include autonomous vehicles, remotely operated equipment and censored based monitoring equipment. Autonomous mining technology has facilitated the operating of machines away from hazardous environments. The use of autonomous equipment has resulted in benefits such as improved safety features, few safety incidents, reduced operating costs and increased efficiencies. (Telematics, 2023).

Technology in the mining industry is currently in a transition era between high automation and full automation, that is Autonomy 1.0 to 2.0 (Adams 2022). There is value addition in mining operations through automation and this supports sustainability of the mining business. The degrees of automation include manual operations, assistive automation, partial automation conditional automation, high automation and full automation. A study by the International Institute of Sustainability Development (IISD) (2019) discovered that automation is increasingly being applied in the mining industries, mainly in the drilling, blasting and hauling. The study also found

out, automation leads to massive improvements in safety as well as increased production while saving costs.

However, the study also established that despite the advantages of automation, there are potential job losses and in some areas quite significant number of job losses, that is mainly in manual related jobs such as lashing. On the other hand, another study by The International Council on Mining and Metal (CMM) (2018) determined that automation in mining improves safety and production as well as reducing environmental impacts of mining operations. CMM however also noted some benefits of automation, that is, the creation of job opportunities in data analysis and systems maintenance.

While most studies revealed benefits of automation in mining industry, other studies revealed concerns about the potential negative impacts of automation on employment in the industry. A good example is a study that was done by World Economic Forum (2018) that revealed potential displacement of workers up to 375 million by 2030 and mining industry being the most affect industry. Although there are various concerns on the impact on employment and job losses, the use of automation in mining industry will continue as companies seek to maximize production and also optimize efficiencies while being sustainable. McKinsey Global Institute (2017) predicted that up to 800million workers globally will be displaces. However, he also noted that, other job opportunities will be created as a result of automation.

2.2.2. Implementation of automation in the mining sector

Automation may be applied across the entire gold mining process, from ore removal to product, and is a useful tool for the mining sector. Only a few of the several industries using automation are retailing, construction controlling, corporate organization, and client service (Alsheiabni et al., 2018; Jelonek et al., 2019). Automation may be applied throughout a company with potential to change aspects or process at the organization (Wamba-Taguimdje et al., 2020).

Replacing human labor automated machinery is known as automation, but the development of human intellect through the availability of information that can support decision-making is known as augmentation (Wamba-Taguimdje et al., 2020). Automation and augmentation are useful for

many organizational duties or the organization's consumers as a result of better or new services and products which use Artificial Intelligence.

Self-driving automobiles, speech- or text-outputting voice recognition systems, and trained neural networks that can cut down on energy consumption in businesses and are just a few examples of applications that demonstrate how artificial intelligence has the potential to boost company efficiency (Brynjolfsson, 2017). Additionally, it has been proposed by writers that technology based deep learning and machine learning could boost corporate productivity by affecting Research & Development, creativity, production of fresh notions (Aghion et al. 2019; Cockburn et al. 2019).

However, not all scholars concur with these optimistic assessments of automation`s potential for revolution. For instance, Gordon (2018) argued that the current slowdown in productivity will not primarily be brought on by IT and other types of innovation and that productivity growth in the United States over the coming several decades may be considerably slower. He claims that the association between important inventions like cellphones and the productivity performance of the United States from 2004 to 2014 has not been definitively shown.

It is now widely accepted that the notion that extremely intelligent computers may automate human employment and cause a sharp acceleration of technology-driven growth and productivity gain is untrue (Nordhaus, 2021). As a test of theory in the context of business development, Nordhaus (2021) coined that Artificial Intelligence affect economic distinctiveness, it would need to incorporate all human tasks. Aghion et al.'s (2019) research demonstrates that conceptually, it is a plus input in a business's procedure which has the power changing company routine because of influence on the expansion of novel ideas and expertise including value in resolving complex problems.

Brynjolfsson et al. (2017), alluded that Artificial Intelligence can be considered an extra type of incorporeal investment in the invention function of businesses since it increases productivity in a way similar to other kinds of inputs. Developing new business practices, datasets, and human capabilities that are unique to the firm would be the practical application of AI technologies.

2.2.3 Case Study Company Literature Review section

Kuvimba Mining House is state owned Leading Mining investment mining organization with the government having 65% shares and 35% privately owned. Its head office is at Borrowdale Office Park Central Block, Harare. The government established Kuvimba mining as a national strategy to give the mining industry a new lease of life in line with the second republic's economic development thrust and a vision to create a better future for Zimbabwean people. The company was registered in 2020 according to Companies and other Business Entities Act. Government and other interested groups got the ordinary shares.

The organisation values include zero harm, resilience, collaboration, integrity, innovation and sustainability. Kuvimba Mining house specializes in Gold, Nickel and Lithium mining and also boasts of possessing the largest chrome and lithium deposits in Zimbabwe. The company has several mining companies that fall under clusters, that is, the gold, energy and base metal clusters. The Gold Cluster includes Freda Rebecca Mine, Jena mine and Shamva Mining Company. The Energy cluster has Sandawana mines and Bindura Nickel Cooperation while the base metal cluster has Zimbabwe Alloys and Great Dyke Investments. This research focused on effects of Automation of the Gold Cluster mines as the case study.

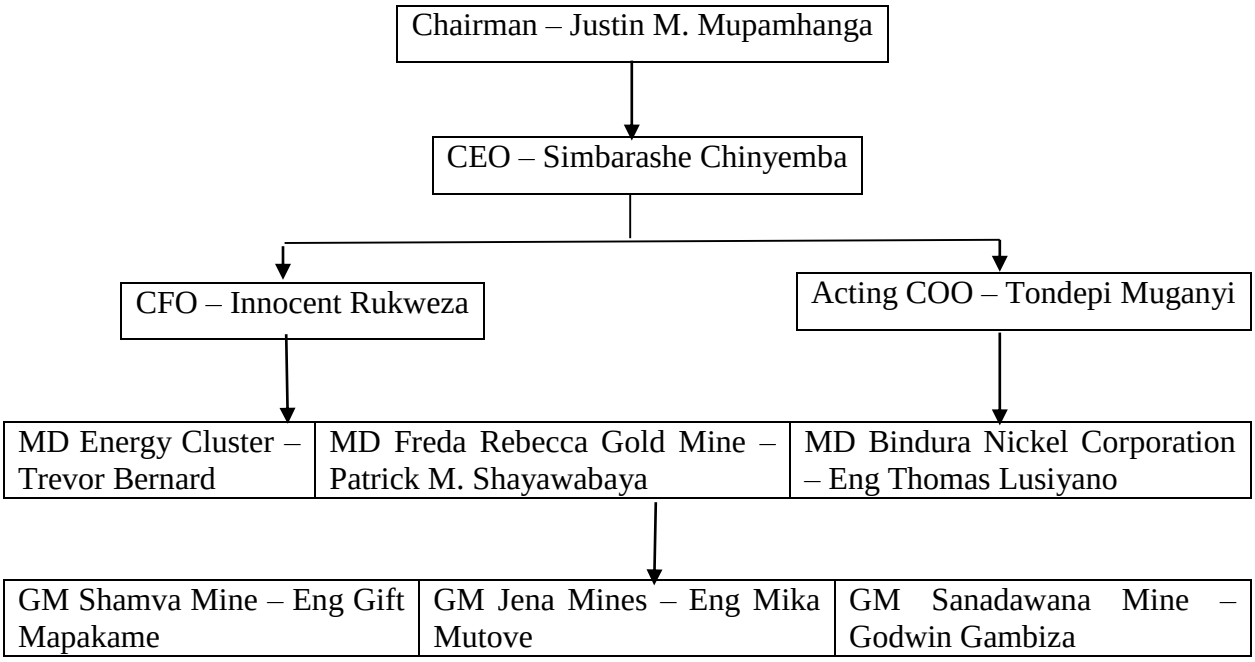
2.2.3.1 Kuvimba Mining House Gold Cluster

Kuvimba mining house Gold Cluster has Jena Mines, Shamva Mine and Freda Rebecca Mine. Jena Mine is situated in Silobela and has its history dating back to 1898. The mine has evolved from producing high-grade blending with low grade ores that are mined from shallow vertical shafts. Jena mines has an average production of 30kg per month with a strong workforce of 703 employees. Shamva mine was acquired by Kuvimba mining house in 2020 after Metallon Corporation was put on corporate rescue.

Shamva mine started operations in 1893 and has to date produced 2.3 million ounces of gold from 28.5 million tons of gold ore at a grade of 2.5g/t. Shamva mine is located North east of Harare in the green belt and has about 900 employees. Shamva mine is involved in both open pit and underground mining. Currently the mine does not process gold ore but haul the ore to Freda Rebecca Mine for processing. Kuvimba Gold cluster major production is at Freda Rebecca Gold

Mine which is situated in Bindura, Mashonaland Province. Freda Rebecca has around 700 employees. This mine operates both open cast and underground mining at low grade high tonnage strategy. Freda Rebecca Mine has 20-year production and has an impressive consistent monthly production of 260kg.

Kuvimba Mining House Board of Directors



2.3 Impact of automation on workforce job security

Autonomous support systems in the field of AI and machine learning are being researched by various companies to develop the first automated system that can reduce the need for human intervention in hazardous mining operations (Van Duin, Meers, Donnelly, and Oxley, 2013). Roof support is a critical and dangerous task in mining, and accidents often occur due to roof falls during support operations (Ghasemi et al., 2012; Peng, 2015). The weak areas of the roof and strata, water inrush, and release of hazardous gases pose significant risks to workers. To address this, an autonomous cutting machine can be employed, where roof support becomes an integral part of the machine. It can shield the areas after cutting, install bolts, and provide temporary support to the exposed strata while progressing further for production.

In the context of mining operations, deep learning and machine learning have demonstrated their effectiveness in various applications when trained on diverse image datasets (Balasundaram & Venkatagiri, 2020). Researchers have suggested the use of machine learning algorithms to improve the automatic segmentation of mineral phases based on X-ray microcomputed tomography (μCT) images. However, obtaining μCT images is costly and time-consuming, resulting in a limited dataset.

To overcome this limitation, a supervised machine learning algorithm can be employed, where the user defines the underlying pattern of the data, and the computer system builds a prediction model based on this pattern using the training data. Even with a small number of images, this approach can effectively address the problem. The supervised classification method has been utilized to generate a 2D mineral map of chromite samples using optical microscopic images. Additionally, other ML techniques have been applied to address various input features related to the mineralogical study in the mining and minerals industry.

In the domain of geochemical data analysis, deep learning algorithms have been used to extract features related to mineralization, enhancing the accuracy of classification or prediction. By replacing manual selection methods, deep learning algorithms such as deep auto encoder networks, deep vibrational auto encoder networks, and convolutional auto encoder networks have been employed to recognize geochemical anomalies associated with mineralization (Balasundaram & Venkatagiri, 2020). These deep learning techniques can be combined with other anomaly detection methods to further improve their effectiveness.

2.4 Perceptions of the workers, management and other stakeholders on the impacts of automation on workforce job security

Artificial intelligence technologies have a positive financial impact on the mining sector because of budget savings, better productivity, decreased worker exposure to dangerous conditions, continuous production, and greater safety (Nah 2020). These innovations have had a difficult time being embraced in the fields of commerce, finance, technology, the workforce, and society.

2.4.1 Resistance from workers

More than ten years ago, mining began integrating AI and autonomous technology, but since then, progress has been agonizingly sluggish and hampered by difficulties and failures (Nah 2020). The principal challenges applying knowledge is the opposition of employees, managers, plus Artificial Intelligence researchers who are skeptical about true effects of modern technology on careers, finances, the community and on societal relations (Kappal, 2017; Siau, 2018; Siau and Yang, 2017).

Siau and Wang, 2018) claims uncertainty about the conduct of Artificial Intelligence and self-directed systems, fear losing one's job to technology, unequal wealth and capital distribution, and worry about the deployment of technology in the future are the main causes of pessimism. According to Nah (2020; Nah and Benbasat 2019), it is also not immediately clear how AI technology can support both individual and group decision making.

2.4.2 Slow improvements in intelligent systems

Slow progress is another barrier to the advancement of AI and automation in intelligent systems (Siau, 2017). Lack of clarity on obtaining capital funding when the future and benefits of technology implementation, hindrance in obtaining supervisory approvals, the high preliminary venture and capital needs, the lack of skilled workers, the inadequate infrastructure for technology implementation, the diminishing supply of quality ores and rock crystal resources that prevent significant investment.

According to Pham & Afify (2005), data is today recognized as a resource that fosters not just societal and economic growth but also the continued advancement of AI technology. The mining industry, on the other hand, frequently promotes the use of constantly updated hardware plus software, ultimately cause offline engines, secluded data and disjointed software. The industry can only use artificial intelligence under specified conditions, such as having access to super powered data, specific request scenarios, a mathematically solid procedure model with other prerequisites. Exploratory research is fairly easy to conduct, however real-world industrial operations have a lot of challenges (Yu and Liu, 2003).

2.4.3 Data acquisition

The challenge in applying ML to manufacturing is gathering the necessary data. Many redundant and unnecessary pieces of data may be gathered, which can be troublesome for some machine learning (ML) algorithms and decrease their effectiveness (Yu & Liu, 2018). The bulk of machine learning algorithms, according to Pham and Afify (2020), only work with data that comprises continuous and nominal values. There are still some aspects of the available data for successful application, even though ML typically permits knowledge extraction and produces improved results compared to most traditional techniques by using fewer necessities for the accessible data (Yu & Liu, 2018). The importance of understanding the data is highlighted by this. Hoffmann (1990) proposed that, in contrast to conventional methodologies, which put a lot of work into gathering data, ML lays a high emphasis on data preparation.

After data has been protected, pre-processing is frequently needed to get the data suitable for the technique of choice (Widodo & Yang, 2017). The processing of the data can have a considerable impression on the outcomes. Though, the most common data cleaning and regularization methods can be carried out using a number of standardized technologies. Any modifications to the training data must also be verified. This might make it challenging to train particular algorithms. In actual industrial practice, values for certain attributes are often not included in the data collection (Pham & Afify, 2020).

There are a ton of articles that show how ML techniques work well for specific problems. But the outcomes of the tests are frequently kept secret from the broader population. Because of this, it is challenging to examine the findings impartially, objectively, and to draw a conclusive comparison. The standard method for selecting appropriate ML procedure for a convinced can be:

• A person must first consider the availability and description of data, including whether it is labeled or unlabeled, and whether there is any available expert knowledge, before deciding on a supervised, unsupervised, or RL technique.

• Second, it's crucial to think about how widely utilized techniques, such their propensity to handle high dimensionality, might be applied to address the specifics of the research topic. Care must be taken to thoroughly assess data sorts, construction plus general volume of data obtainable for training and evaluation.

2.5 Possible strategies that can be implemented to mitigate job losses due to automation of mining processes

2.5.1 Management Leadership

Top management should be exemplary in order to improve the working conditions and reduce loss of job and this can be achieved through putting theory into practice (Manuele, 2014). Senior management's commitment and support was most frequently found on mining sites with outstanding performance (Nawi *et al.,* 2016). Commitment and support could also be demonstrated by a clearly defined job responsibilities and proper allocation of competent manpower and project resources (Yiu *et al.,* 2018). This encourages employees to feel loved and motivated to work thereby improving sense of security (Alarcon *et al.*,2016). Also, assigning roles and responsibilities to subordinates boosts their self-esteem and desire to abide to regulations (Yiu *et al.,* 2018). The commitment of mining managers to labour practices in Zimbabwe is however not always a priority as it is regarded as an expense to the company hence it is limited. Such a scenario does not set a good example for all employees on labour issues thus efficient implementation is deterred.

2.5.2 Training of Workers

It is fundamental to train employees so that they have a better understanding of various opportunities that automation can bring (Mitullah and Wachira, 2013). If employees appreciate knowledge about the effects of automation this increases commitment to work (Sharma and Mishra, 2020). Thus, they can be able to easily identify and manage potential hazards and avoid incidents thereby promoting worker productivity due to improved competence. In most developing countries, majority of employees in the mining industry are illiterate and compelled to work in high-risk situations (Koehn, 2010). In addition, these workers are accorded little health and safety protection hence needs to be trained to be part of unions that advocate for better labour standards.

2.5.3 Improving the Working Environment

Kim *et al.,* (2016) identified poor working conditions as a major challenge to implementation of automation. Adverse work conditions include poor infrastructure, unavailability of required PPE, segregating workers, extreme weather conditions and long working hours. Thus, improving these conditions enhances the effectiveness of automation program. Mwombeki (2015) observed that reducing exposure to heat at mining sites also reduced work illness of contractors in Tanzania. Similarly, Koehn (2015) deduced that provision of adequate protective gear and normal work shifts was strongly associated with reduced work injuries. In another study Robinson (2013) reported that work related injuries decreased when migrant workers were mixed with locals. This increased their confidence as it removed the inferiority complex and enhanced their effective participation in work tasks.

Gusti *et al.,* (2019) advocated for planning to incorporate the cost of temporary weather protection so as to provide a comfortable work environment. Also, adequate ventilation and humidity and temperature controls should be put in place. This guarantees improved employee productivity and reduces lost time related to incidents. In addition, March (2009) reported that provision of adequate water and sanitation services is essential to ensure that workers are safe from illnesses. It is therefore, necessary for mining companies to provide suitable work premises.

In Zimbabwe most mining employees work under direct sunlight exposed to the heat and ultra-violet radiation (Chigara and Moyo, 2017). Minimizing exposure by reducing work hours or providing sunhats and plenty of fluids to reduce dehydration is therefore required. Likewise, Chan, Yam, Chung, & Yi, (2012) reported that mining workers are subjected to heat stress from confined spaces and outdoor physical work areas. Ultimately, such conditions lead to reduced worker performance and give rise to negative perception towards automation.

2.6 Theoretical framework

Several theories attempt to clearly explain the concept of automation and the consequences of using automation in various sectors of the economy particularly manufacturing and mining industries. The consequences include job displacement and changes in labour markets. Some key

theories include Technological Unemployment Theory, Skill Biased Technological Change, Creative Destruction Theory and the Task Based Theory.

2.6.1 Theory of Technological Unemployment

People who are unemployed and looking for work due to innovations in production processes are referred to as experiencing technological unemployment. (Kochariska & Klimczuk, 2015). According to the theory of technological unemployment, automation results in job displacement and unemployment. This is as a result of machinery and technology replacing human labour.The theory was established in the early 19th century when the Luddite movement in England protested against the introduction of weaving machines. Brynjolfson and MacAfee (2014) contended that a significant worry with the growing use of automation is technological unemployment.

2.6.2 Theory of Skill-Biased Technological Change

The theory was first initiated by Murphy and Katz (1992). According to the theory, automation causes a shift in the demand for employees' skills, favouring highly educated and skilled workers. The two reiterated that the widening skills gaps in the labour market between highly skilled and low skilled workers are partly caused by technological advancements. Katz and Murphy indicated that technological advancements enhance the abilities of highly skilled labourers while replacing those of less skilled workers.

This theory was validated by empirical research done by Autor et al. (2003), which verified that low-skilled workers' employment and wages decreased as a result of technological advancements. Autor and Acemoglu (2011) went on to demonstrate that technological advancements increased the need for workers with interpersonal and cognitive skills while decreasing the need for workers performing routine duties. According to the Skill Biased Technological Change Theory, education and training expenditures are critical for preparing workers for advanced technologies and giving them a competitive advantage in the job market.

2.6.3 Theory of Creative Destruction

Schumpeter first established the Creative Destruction Theory in 1942. According to the theory, automation leads to the dismantling of existing industries and jobs while generating new ones and

other industries in their stead. He maintained that technological advancements are the primary forces behind economic success, progress, and growth. Research by Muro et al. (2017) clearly revealed that automation generated new jobs in data analysis and software development, lending support to this theory. This theory has major ramifications and is highly significant in the mining industry.

Recent years have seen enormous technological advancements in the mining sector. The invention of steam power in the 19th century marked the beginning of technological advancements, which continued with the adoption of contemporary drilling, excavation, and hauling equipment. With the introduction of remotely operated machinery, autonomous vehicles, sensor-based monitoring systems, and remotely operated equipment, the mining industry has seen a new wave of technological advancements and automation. Old industries and jobs have been destroyed as a result of these changes, while new industries and jobs have been created. A useful framework for comprehending the effects of technological advancements and automation in mining is provided by the creative destruction theory. The possible negative effects of automation must be carefully considered by policymakers and business executives, who must then devise plans to reduce job losses and promote growth that is wholly inclusive.

2.6.4 Theory of Task-Based

According to the theory, by Autor and Dorn (2013), automation causes a shift in demand for specific tasks within jobs rather than the displacement of entire jobs. They maintained that while automation increases non-routine tasks like creativity and problem solving, it decreases routine duties and assignments. Several writers conducted research to bolster this theory. Acemoglu and Restrepo (2020), for instance, discovered that automation leads decreased routine tasks and an increase in non-routine tasks.

2.6.5 Theory of Rational Expectations for Technology Adoption

Davis (1989) established the reasonable prospects hypothesis of technology adoption. According to the theory, in order to increase the adoption of technology, it is important to understand user motivations and modify deployment messages and materials to take these groups' perspectives into account. This theory demonstrates that a company's perception of a technology's advantages and

disadvantages will determine how quickly it is implemented. According to this theory, the extent to which interested parties assess a technology's ability to increase corporate profits, cut expenses, or improve efficiency will determine whether or not it is adopted.

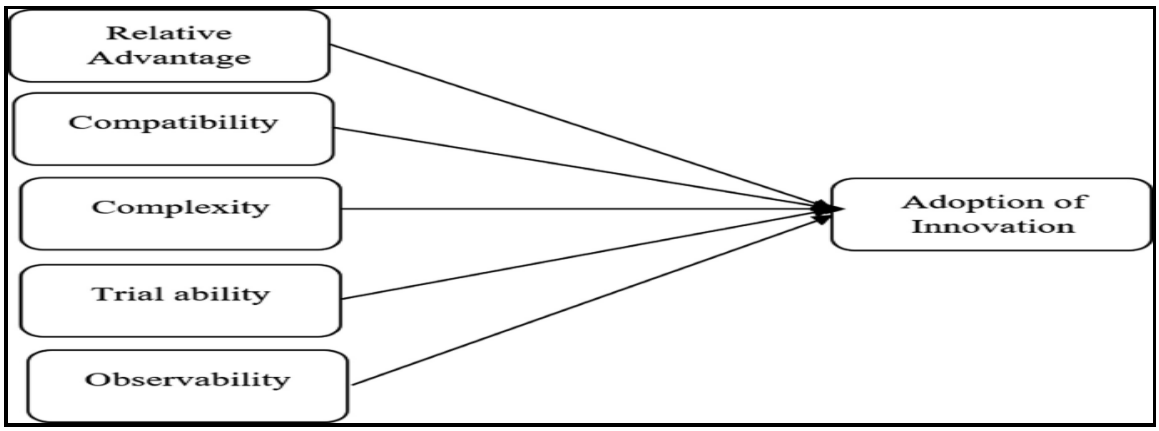


Figure 2 1 Adoption of Innovation

2.7 Empirical Studies

To ensure the growth and innovation of both mines and their communities, leaders in this respect need to take long-term strategic plans and the relationships between mines and communities into consideration. According to the International Council of Mining (2018), mining executives should create a strategic vision that allows cooperation with stakeholders, employees, communities, and regulatory bodies. This will enable the addressing of the advantages and hazards of automation in a cooperative manner.

Automation is a well-defined concept that refers to the replacement of humans by machines, such as robots operating on an assembly line. This description also applies to the automation that AI makes possible. However, it omits the quick adjustments that AI brings about. Modern AI developments have enabled machines to grow, learn, and adapt—a process that will finally increase their performance (Coombs et al., 2020). As a result, more difficult cognitive tasks like learning and problem-solving are automated by AI technologies (Lee et al., 2019). Many refer to this automation as intelligent automation (Welling, 2019).

Assignments such as knowledge and service work that were previously thought to be too difficult to automate can now be done so thanks to intelligent automation (Coombs et al., 2020). One instance is the automatic processing of emails by virtual robots (Wamba-Taguimdje et al., 2020). AI is used in the manufacturing and construction sectors to automate inventory and replenishment, as well as planning and budgeting (Wamba-Taguimdje et al., 2020). AI can affect customers' experiences by offering digital and robot services in the context of services (Prentice et al., 2020). Chatbots, conversational software programs that mimic human communication abilities, are one example of this (Nuruzzaman & Hussain, 2018). Chatbots can provide voice or text assistance to clients (Castillo et al., 2020).

World Economic Forum (2020) showed that the mining industry must focus investing in reskilling and upskilling programs that allow workers to adapt to new technologies. The researcher established a gap on how leadership influence is used in strategic decision on mitigating the impact of automation in mining industry, particularly in developing nations such as Zimbabwe. Singularity is the theory that human labour could be automated by vast intelligent computers, resulting in a sharp increase of technology-driven growth and increased productivity. Conceptually speaking, AI is an additional input in a company's production process that has the ability to alter firm performance because of its impact on the creation of rather rejected, as demonstrated by Aghion et al. (2019). Nordhaus (2021) tested that theory in the context of economic expansion, AI would need to take on all human tasks in order to develop such "economic new ideas and technologies, and because it would become handy in solving difficult problems."

In the production function of businesses, automation should be viewed as an extra intangible capital, since increasing investment in AI technology may boost productivity in a manner similar to that of other factor inputs. Brynjolfsson et al. (2017). When technologies are used effectively, new intangible assets like datasets and firm-specific human skills are created, along with new firm processes. Given that, the literature mentioned above is essentially devoid of empirical data to support either position, making it highly speculative. Empirical research to date has mostly concentrated on three areas or approaches: industrial robots and task automation, patents, and the lack of measures that would cover the full variety of technology use in firms.

Even though the application of autonomous technologies in mining began more than ten years ago, it is moving at an excruciatingly slow pace and has encountered variuos obstacles and setbacks. Resistance from employees, managers, and even technology researchers who are not certain of the true implications of this technology on jobs, economics, social systems, working relationships, and societal makeup is one of the biggest obstacles to technology implementation (Kappal, 2017; Siau, 2018; Siau and Yang, 2017).

The main reasons for opposition are fear of losing one's job to technology, uncertainty about the future of technology implementation, unequal wealth and capital distribution, unknown behaviour of technology and autonomous systems, and complicated and complex interactions and relationships with technology (Siau, 2017; Siau and Wang, 2018). In addition, it is vague on how technology can help with both individual and group decision-making (Nah 2020; Nah and Benbasat, 2019).

2.8 Literature gaps

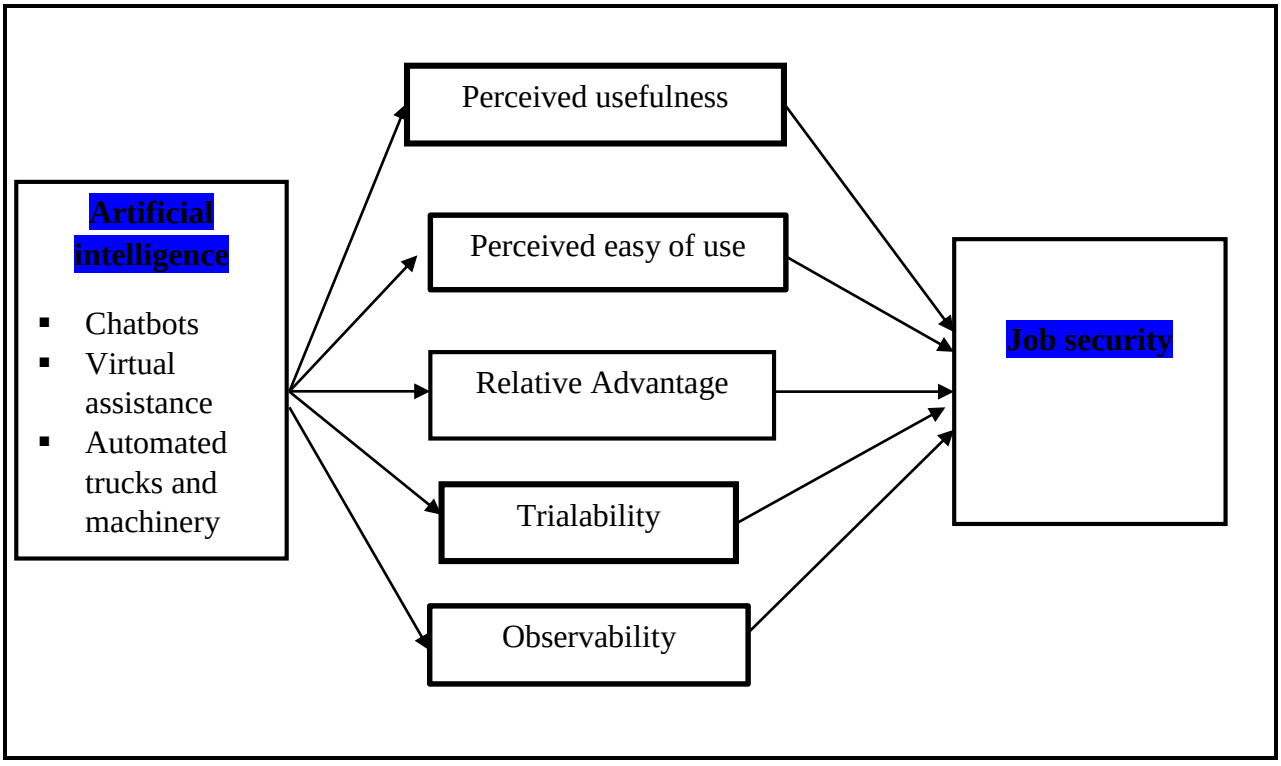
Studies by (Coombs et al., 2020; Lee et al., 2019) focused on developed countries like USA N and China and no studies were conducted in Zimbabwe to determine the impact of automation on job security. Similar previous research has been conducted by different scholars Chen et al., 2021 however most respondents in the study are from Asia, Europe, African countries and the United States meanwhile this research is mainly focused in Zimbabwe. In addition, little research has been done on the implementation of artificial intelligence technologies, such as personalized recommendations and virtual assistants and their influence on the mining sector performance,

Results from the mentioned surveys on artificial intelligence and job security patterns have been contradictory. There were both favorable and unfavorable outcomes. A smaller number of theoretical concepts are specifically focused on the occurrences of perceptions and the influence on AI in particular sectors contexts in the existing literature. This aspect of theories is particularly acute in research on perceptions to influence job security. Phenomena vary from culture to culture and from sector to sector, so in order to properly understand phenomena, a variety of designs must be developed and peculiar sector settings must be addressed. Given that a large portion of the

research at hand looks on the phenomena regarding those corporations that operate in first world countries, there is an urgent need to advance knowledge that addresses the foundations of artificial intelligent and the influence of job security in mining sector in developing nations. Due to the significant differences between developing and developed countries, it is necessary to completely explore the paradigms and delve into the concepts from the perspective of the developing countries in many domains.

2.9 Conceptual Framework

A conceptual framework is a structure which the researcher believes can best explain the natural progression of the phenomenon to be studied (Camp, 2001) . It is the researcher's justification for the approach they will take to investigate the study problem. An integrated approach to examining a topic is presented by the conceptual framework (Smith & Liehr, 2023). The conceptual framework in statistical analysis logically organizes the main study concepts, providing a visual representation of their relationship to one another (Grant et al., 2014). The conceptual framework suggests that the successful usage of Artificial intelligence will practically influence job security in the mining sector.



Source: Researcher's conceptualization (2023)

Several businesses incorporate AI and Machine Learning into their operations. By utilizing a chatbot or AI-powered virtual assistant, businesses can not only increase revenue but also save money and provide superior customer service. According to chatbots saved $8 billion in business expenses by 2022. Therefore, it is not surprising that virtual assistants and chatbots have become increasingly popular. This digital assistant can work on its own or with a live customer service representative. Additionally, chatbot is a specific technology that allows customers to hold a conversation with a computer. The bots can learn to respond to inquiries, give suggestions, and make reservations just like a human. All these chatbots and virtual assistants use Natural Language Processing to figure out what a user wants or mean when they ask a question or make a request and then respond conversationally

Moreover, utilizing virtual assistants or chatbots in business means less manual labor for customers, while they provide 24/7 service and enhance the overall experience of an e-commerce website. In the world of online commerce, AI systems work around the clock. With the machine's assistance, a company can give the impression to its customers that it is available across all channels at all times to meet customer requirements (Cheng, 2020). This is especially helpful if the company operates on a global scale and its customers are spread across multiple time zones. However, what if customers have inquiries or demands that are beyond the scope of chatbots and AI assistants, then, they help customers get human help as soon as possible.

For example, about WhatsApp, WhatsApp's response time is nine times faster and easier than a phone conversation. The majority of customers (70%) prefer to send a message instead of making a phone call. WhatsApp's direct messaging features are helpful for businesses to cut down on expenses (Muetal et al., 2021)

2.10 Chapter conclusion

The chapter discussed literature on the impact of automation on workforce job security in the mining sector. This chapter also highlighted the theories underpinning the study, definition of key phrases, conceptual framework and study's guiding hypotheses. It looked at the body of research on the automation models, how it was integrated into mining process. It is evident that there is

little written material available, specifically in the mining sector. The next chapter will discuss the study methodology.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

According to Grove et al. (2012), the research methodology involves applying the steps, strategies, and procedures to allow one to gather and analyses data. This chapter presents the research methodology used to conduct the study in order to achieve the aims and objectives of the study. The chapter presents a detailed description of the strategies, techniques and methods applied in undertaking the present study. Hence, chapter discusses research methodology, philosophical underpinnings, research design, sampling method, the sample size, research instruments, and data collection procedures and analyses.

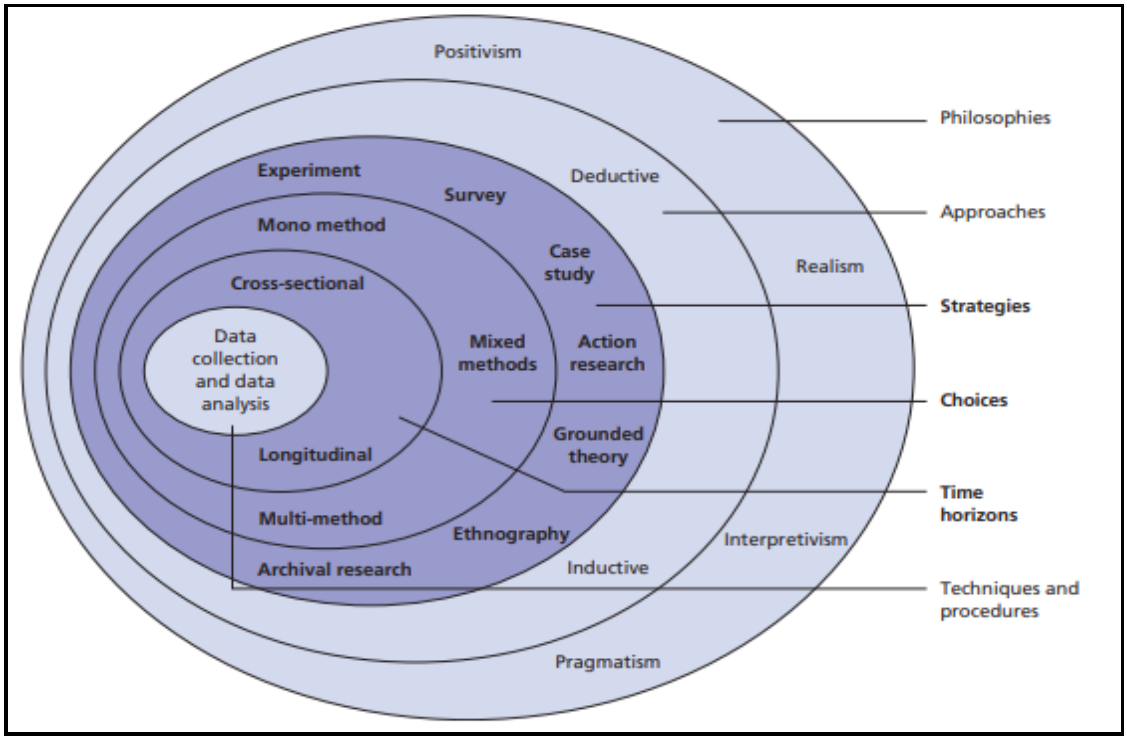


Figure3. 1: Philosophical frameworks

3.2 Philosophical frameworks

In this study, pragmatism research philosophy was used. Thus, a mixed methods research design was employed. Thus, pragmatic philosophy helped the researcher to gather information using logical, quantitative and more objective scientific methods (Sullivan, 2011) as well as qualitative

data to explore the effects of automation on workforce job security in mining sector. In addition, the philosophy helped the researcher to test hypothetically-deductive generalizations.

3.2.1 Positivism

Positivism, as explained by Creswell (2013), is a perspective that assumes knowledge and the world exist independently of individuals' subjective perceptions. It argues that science employs objective techniques to uncover the realities that exist in the world. The emphasis in positivism lies on the use of objective, rational, and measurable scientific methods to test hypothetical generalizations. This philosophical approach is especially prominent in the natural sciences, where researchers rely on observable social entities. The importance of quantifiable observations and subsequent statistical analysis is also emphasized in positivism.

Researchers adhering to the positivist philosophy follow highly structured methodologies to facilitate hypothesis testing, as noted by Polit and Beck (2012). These methodologies provide a systematic framework that ensures consistency and reliability in the research process. One notable aspect of positivist research is that researchers are unable to manipulate the resources during data collection, as the resources are considered independent of the subject of the study. The main aim of positivist knowledge is to describe phenomena based solely on observable and measurable aspects. From this perspective, knowledge that goes beyond direct observation and measurement is regarded as impossible. As a result, the research approach within positivism tends to be primarily descriptive.

Scholars have offered further insights into positivism and its implications. For instance, Auguste Comte, often referred to as the father of positivism, argued that the development of knowledge should be grounded in empirical observations and evidence (Comte, 1830). He emphasized the importance of objectivity and the use of scientific methods to understand the natural and social world.

However, it is important to acknowledge that positivism has its critics. Some scholars argue that strict adherence to positivist principles may limit the understanding of complex social phenomena, as it overlooks the subjective experiences and meanings that individuals attribute to their actions

(Guba & Lincoln, 1994). They argue for alternative approaches, such as interpretivism, which focus on understanding subjective meanings and social contexts.

In conclusion, positivism is a philosophical perspective that assumes the existence of an objective reality independent of individuals' perceptions. It emphasizes the use of objective, rational, and measurable scientific methods to uncover knowledge about the world. Positivism is commonly observed in the natural sciences, where researchers rely on observable social entities. While positivism offers valuable insights and has contributed to scientific progress, it is essential to consider alternative perspectives that recognize the importance of subjective experiences and interpretations in understanding complex social phenomena.

3.2.2 Participatory

The research philosophy employed in this study primarily relies on qualitative research methods, although it can also serve as a foundation for quantitative research. The underlying assumption of this philosophy is that the researcher works collaboratively with the participants to avoid further marginalization resulting from the study. According to Neuman (2000), participatory research provides an opportunity for participants to raise awareness and advocate for change to improve their lives. It is focused on bringing about practical changes in practices, and at the conclusion of participatory research, the researcher advances an action agenda for change. Participatory research goes beyond the traditional role of the researcher as an observer and data collector. It recognizes the importance of active engagement and collaboration with the participants throughout the research process. By involving the participants as partners in the research, their voices and perspectives are valued, and their expertise is acknowledged. This approach not only enhances the quality and relevance of the research findings but also empowers the participants to take an active role in shaping the research outcomes.

Scholars in the field of participatory research, such as Reason and Bradbury (2008), emphasize the transformative potential of this approach. They argue that participatory research can lead to personal and collective empowerment, as well as social and institutional change. By giving room for participants to raise awareness and advocate for change, participatory research creates opportunities for individuals to actively address the challenges they face in their lives and work

towards improving their circumstances. Moreover, participatory research often includes an action agenda for reform, which is an essential component of the research process. This agenda outlines specific steps and strategies for implementing the desired changes identified through the research. It not only aims to improve the lives of the participants but also has the potential to impact the institutions and systems in which they are embedded. The concept of participatory research has roots in critical theory and social justice principles. It seeks to address power imbalances and create space for marginalized voices to be heard. By actively involving participants in the research process, participatory research challenges traditional notions of research as an objective and detached endeavour, and instead promotes a more democratic and inclusive approach to knowledge production.

In summary, the research philosophy of participatory research emphasizes collaboration with participants to avoid marginalization and promote meaningful change. It provides an opportunity for participants to raise awareness, advocate for change, and improve their lives. Participatory research is focused on practical changes in practices and often includes an action agenda for reform. By embracing this philosophy, researchers can create research that has the potential to transform the lives of participants, the institutions they are associated with, and even the researcher's own life.

3.2.3 Constructivism

The research philosophy is grounded in the assumption that individuals have an inherent desire to comprehend the world they inhabit. According to Merriam (2009), individuals are driven to seek understanding and make sense of the complex environments in which they live and work. This research philosophy recognizes the importance of acknowledging individuals' innate curiosity and their motivation to gain insights into their surroundings.

The primary goal of this research approach is to heavily rely on the participants' perspectives and comments on the specific situation being studied. Denzin and Lincoln (2018) emphasize the significance of participant viewpoints in qualitative research. By prioritizing the participants' voices, researchers can gather rich and diverse perspectives that contribute to a comprehensive

understanding of the research topic. This approach ensures that participants' experiences and interpretations are given prominence in the research process.

Open-ended questions are frequently utilized in this research philosophy to encourage participants to share their views openly. The advantage of open-ended questions, were that, the researcher managed to prompt participants to reflect deeply on their experiences and articulate their thoughts in their own words, resulting in rich and authentic data.

Qualitative researchers often employ open-ended questions to facilitate attentive listening and understanding of participants' experiences in their real-life settings. According to Denzin and Lincoln (2018), open-ended questions enable researchers to engage in active listening, paying close attention to what participants say or do within their natural contexts. By actively listening, researchers can capture the nuances, emotions, and complexities conveyed by participants, enhancing the depth and richness of the research findings.

In summary, the research philosophy under discussion is based on the assumption that individuals seek understanding of the world they inhabit. Merriam (2009) highlights the intrinsic motivation that individuals possess to comprehend their surroundings. The primary aim of this research approach is to rely on the perspectives and comments of the participants, as emphasized by Denzin and Lincoln (2018). Open-ended questions are a valuable tool in qualitative research, allowing participants to freely express their views and enabling researchers to actively listen and comprehend the intricacies of participants' experiences in their natural settings.

3.2.4 Pragmatism

For the purpose of the study the pragmatism philosophy was adopted. The philosophy provides for the use of both qualitative and quantitative methodologies in collecting information and answering research questions. Pragmatism provides a basis for practical research through using the mixed approach which helps to clarify the data presentation process the research (Saunders et al, 2009). Therefore the approach provided a better foundation for the researcher to fully explore the phenomenon instead of using a single method approach. Pragmatism allowed the researcher to

study the automation and workforce job security at Kuvimba group of mines using appropriate methods, both qualitative and quantitative approach.

3.3 Research approaches

The research methodology is composed of both the qualitative research and quantitative research. Qualitative and quantitative research methods can be described based on purpose of the research, data collection process and analysis of data (Kumar, 2005). In this study both qualitative and quantitative research methods were employed.

3.3.1 Quantitative research

This research approach focuses on measuring the extent of variation in a phenomenon through the use of structured and predetermined methodologies. The analysis of quantitative data involves employing statistical procedures to examine relationships and patterns. In the context of the study on automation and workforce job security in the mining sector, the researchers utilized quantitative research methods to investigate the quantitative associations between these variables. This research approach allows for the quantification of the problem at hand by generating numerical data or transforming data into usable statistics. It enabled the researcher to quantify attitudes, opinions, behaviors, and other defined variables, providing a solid basis for drawing generalizable conclusions from a larger sample population.

These methods often include surveys, face-to-face interviews, website interceptors, online polls, and systematic observation. Surveys, for instance, allow researchers to collect data from a large number of participants using standardized questionnaires, ensuring consistency and comparability across responses. Face-to-face interviews provide an opportunity for in-depth exploration of variables, while systematic observation enables researchers to systematically record and analyze behaviors in a controlled setting. Moreover, quantitative research enables researchers to uncover patterns and relationships through statistical analysis. These statistical analyses contribute to the formulation of evidence-based conclusions, providing researchers with a rigorous framework for interpreting and reporting their findings.

In summary, quantitative research involves the representation of findings in numerical form to describe and explain a phenomenon. This research approach employs structured data collection methods and statistical analyses to uncover patterns, relationships, and associations between variables. By utilizing quantitative research methods, researchers can generate objective and generalizable insights, contributing to evidence-based decision-making in various fields.

3.3.2 Qualitative research

Qualitative research allows for an in-depth analysis of the subject matter, as it focuses on exploring and understanding underlying reasons, opinions, and motivations. It is often used as an exploratory research approach to generate insights, develop ideas, and form hypotheses for potential qualitative or quantitative studies. Qualitative research is particularly useful in uncovering trends in thought and opinions, as well as delving deeper into complex problems (Creswell, 2013). By employing techniques such as focus groups, individual interviews, and participation or observation, researchers can gather rich and detailed data that captures the nuances and depth of participants' experiences. These methods provide an opportunity for participants to express their perspectives and contribute to the understanding of the research topic.

In qualitative research, the sample size is typically small, and participants are selected based on specific criteria or quotas (Guest, Bunce, & Johnson, 2006). This allows researchers to focus on gathering in-depth information from a targeted group of individuals who possess relevant knowledge or experiences related to the research topic. By selecting participants strategically, researchers can ensure that the collected data is representative of the phenomenon under investigation and provides meaningful insights. Moreover, qualitative research is valuable in generating a comprehensive understanding of the subject matter by capturing the context and complexity surrounding it. Scholars such as Denzin and Lincoln (2018) highlight that this research approach enables the exploration of multiple perspectives and the identification of themes and patterns within the data. Through careful analysis and interpretation, researchers can uncover underlying meanings, social dynamics, and cultural influences that contribute to a deeper understanding of the research topic.

In summary, qualitative research focuses on describing variation in a phenomenon using an unstructured and flexible methodology. Qualitative data collection methods, such as focus groups and interviews, provide rich and detailed insights. The sample size is typically small, and participants are selected strategically to fulfill specific criteria or quotas. By capturing the context and complexity of the research topic, qualitative research offers a comprehensive understanding of the subject matter.

3.3.3 Research design

A cross-sectional survey was employed in this study to collect participant data. A cross sectional survey was chosen because, it enables the research to gather data from a variety of sources and to converge the data to illuminate the case while giving the research answers to how and why type questions. In addition, it takes into consideration how a phenomenon is influenced by the context within which it is situated (Cooper, 2016).

3.4 Study population and sample size

3.4.1 Study population

The group of mines was the researcher's main focus. The researcher focused on group of mines. The total population of miners across the three mines is above 6000 employees.

3.4.2 Sample size

A sample is a small proportion of a population selected for observation and analysis (Jackson: 2011). Yard's formula with 90% level of confidence and 10% the error margin was then used to determine the sample size. This is shown below:

Where……. n: is the sample size

N: the target population

e= the error term at 90% level of confidence

$$n = \frac{6000}{1+6000(0.1)^2}$$

n= 61 respondents

The sample size of the present study is 61 respondents; a higher population size indicates a higher sample size.

3.4.3 Sampling

According to Brixton (2010) sampling is the act, process, or technique of selecting a suitable sample, or a representative part of a population for the purpose of determining parameters or characteristics of the whole population. According to Churchill et al., (2010), there are two sampling methods namely probability and non-probability sampling. Probability sampling include random sampling, stratifies, cluster and systemic sampling whilst non-probability include, quota, convenient and judgmental sampling (Cresswell, 2009). Probability sapling was used that is, simple random sampling to select, a total sample of 120 respondents out of 12 life assurance companies. The researcher used simple random sampling because each employee had an equal chance of being chosen (Ahmed, 2014).

3.5 Sources of data

3.5.1 Primary data

This data is collected through methods such as interviews and questionnaires, enabling researchers to obtain specific information tailored to their research objectives. However, primary data collection requires careful planning and execution, as highlighted by Malhotra (2017), to design appropriate data collection instruments, elicit meaningful responses, and consider ethical considerations to protect participant rights and privacy. Overall, the use of primary data allows researchers to gather firsthand insights, address specific research questions, and ensure the accuracy and relevance of the collected information.

3.5.2 Secondary data

Secondary data was be collected from existing records on employee performance, so as to help come up with information relating to the impact of automation on workforce job security. The data was collected from Human resources department reports, performance reports, Annual bulletins on the company`s state of affairs in relation to performance. Such information helped the researcher to familiarize with the area under investigation as well as in identifying gaps that need

to be filled.

3.6 Research Instruments

3.6.1 Survey questionnaire

The research used survey questionnaire to gather data from participants. According to Kothari (2004) questionnaires are most used when there is a desire to gain information from a large sample of people. The researcher designed a survey questionnaire comprising sections namely, the first section included question on respondent's demographic characteristics, second section has questions the extent to which mining companies implement automation in mining processes. The third section has questions on impacts of automation of mining processes on workforce job security in mining Industry.

The fourth section has questions on the perceptions of the workers, management and other stakeholders on the impacts of automation on workforce job security. The last section has questions on strategies that can be implemented to mitigate job losses due to automation of the mining processes. All measurement items were drawn from existing prior literature, and they were adapted to fit within the context of the present study. Structured questionnaire was chosen since they are inexpensive to administer. This idea is supported by Kothari (2004) who argued that, questionnaires are most used when there is a desire to gain information from a large sample of people.

3.6.2 Interview guide

To gather qualitative data an online interview with 5 participants was used. By carrying out the interview the researcher was able to drill down into the impact of automation on workforce job security. This helped to triangulate data and gave a comprehensive view of the subject under study. In order to gain further information, the researcher conducted a semi-structured interview and solicited questions from the respondents.

3.7 Data collection methods

3.7.1 Questionnaire

This involved administering a set of formal questions to a selected group of people and recording their responses. A total of 61 questionnaires were administered. Questionnaires were electronically delivered to respondents. Pilot test was conducted to test whether the employees understood the questionnaire and adjustments were affected to suit the jargon that is understood by the study participants.

3.7.2 Interview guide

The researcher used semi-structured interviews in which Key Informants were asked to respond to the open-ended questions in the interview guide and they had the freedom to answer extensively, and to provide details regarding the questions asked. The interviews were recorded while detailed notes were being taken. Interviews took approximately 45 minutes to complete.

3.8 Data analysis and presentation

Data analysis involves, deriving meaning from information gathered from the study. The researcher made use of the SPSS software (version 20.0) to capture, code and analyze data from the questionnaires.. Qualitative data was arranged and placed into appropriate themes which were relevant to answering the research questions.

3.8.1 Data presentation

Data was presented using tables, charts and graphs generated from the SPSS software. The graphs used include bar graphs and pie charts which are easy to interpret and understand. Data was mostly presented in terms of frequencies and percentages.

3.9 Validity and reliability

- **Validity**

Validity means the extent in which an instrument measures what it is claimed to measure (Beck and Polit, 2012). According to Kothari (2004) validity is the "extent to which a test measures what it is supposed to measure and also the appropriateness with which inferences can be made on the basis of the test results." In order to incorporate validity in this study, the questionnaires were pre-tested in a pilot study. The questionnaires were then corrected and adjusted so that they focus on relevant areas of the study. Pilot tests are meant to test the questionnaires, and interview's relevance, suitability and precision with items not meeting the criterion being dropped (Creswell, 2009).

- **Reliability**

Reliability is very important in any research in proving the objectivity with the piece of work conducted (Creswell, 2009). Kothari (2004) contends that reliability is a central concept of measurement and basically means consistency. A research is said to be reliable when it can produce the same results even when different researchers repeat the same method in the same research context. Reliability testing was done on the research instrument before conducting this study. The researcher also borrowed ideas from other studies in order to come up with a questionnaire.

3.10 Ethical consideration

Ethics refer to rules of conduct in research" (Creswell, 2009). As data collection methods are established, it is important to consider whether the research techniques are likely to cause any physical or emotional harm. Kothari (2004) argued that ethics helps scholars to deal with ethical predicaments that rise in research.

- **Informed consent**

The research participants were given an informed consent form to sign. This was done to clearly explain the purpose of the study to the research participants (Creswell, 2009). Therefore, the

research aim was also explained to all the respondents and this was done so that there will be victimization of any individual included in the study. According to Bhattacherjee, (2012), informed consent means the researcher and the respondents agree to participate and provide information without being forced to so.

- **Confidentiality, Privacy and Anonymity**

Privacy in relation to research refers to protecting sensitive information to avoid harm (Reid et al., 2018). Confidentiality deals with concealment of information to protect the respondent (Beck, 2012). The principle of confidentiality was upheld by the researcher throughout and participants were ensured. Name of the respondents were not disclosed and on the instrument no one was allowed to write his or her name. This was done to make sure that all issues of privacy were respected (Kothari, 2014).

Bhattacherjee, (2012) argued that avoidance of harm refers to an obligation to provide information about the study to potential subjects before data collection. The main intention is to avoid harm and help respondents to decide whether they wish to participate in the study. In this research issues that were not disclosed include, among others, the name of the researcher, and the purpose of the study and the benefits of the study.

3.11 Chapter summary

The purpose of this chapter was to validate how the researcher intends to collect data for the target population. As such the research philosophy and design, sampling techniques, size and methods were elaborated. Data collection methods, presentation, analysis and ethical considerations were also elaborated. From the chapter the researcher adopted a pragmatic philosophy which guides a quantitative and qualitative method to data collection and analysis. Data will be collected using questionnaires and interviews. The Data analysis will be captured, coded and analyzed using SPSS software. Data will be presented in different forms, tables, pie charts and graphs. The following chapter will present and analyses collected data.

CHAPTER 4: DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.0 Introduction

This chapter presents and analyses the study findings obtained through the questionnaire dissemination and interviews. Hence this chapter will highlight the profile of respondents, data presentation, discussion and analysis of the study objectives. Much of the comparison will be on understanding if the arguments by scholars in literature matched with reality as obtained from the research findings. The results are presented in tables, bar graphs and pie chart.

4.1 Questionnaire Response Rate

The study managed to administer a total of 61 questionnaires, and a total of 57 questionnaires were returned. Thus, a 93.4 % questionnaire response rate was observed which was fairly high (Table 4.1). As confirmed by Saunders *et al.* (2019), questionnaire response rate should be above 70%. The response rate observed in this study was higher than the 47% reported by Cek and Eyupoglu (2020). In addition, the questionnaires were sent via email and google forms hence maximizing the response rate. Therefore, the 93.4% observed in this study is within the required range.

Table 4 1: Questionnaire response rate (where n=57)

Research instrument	Administered Questionnaires	Responded Questionnaires	Response rate (%)
Questionnaire	61	57	93.4
Total	61	57	93.4

4.2 Reliability test

Data is processed through a reliability and validity test before being used in a multiple regression analysis of the questionnaire data. According to Copper and Schindler (2003), and Mohammed (2016) the reliability is analysed using Cronbach's alpha, which is a coefficient of internal consistency. The acceptable reliability value should be 0.7 and higher. The questionnaire reliability

for the present study yielded a value of 0.81 (Table 4.2), which indicated a strong internal consistency in relation to the sample.

Table 4 2: Reliability statistics of the study questionnaire

Study Variable	No. of items	Cronbach's Alpha
Socio-demographic information	3	0.776
Extent to which mining companies implement automation in mining processes.	5	0.812
The impacts of automation of mining processes on workforce job security in mining Industry	4	0.796
Perceptions of the workers, management and other stakeholders on the impacts of automation on workforce job security	5	0.881
Strategies that can be implemented to mitigate job losses due to automation of the mining processes	4	0.798
Overall	**21**	**0.8126**

4.3 Socio-demographic characteristics of respondents

The socio-demographic attributes assessed in this study were age group, gender, and highest level of education attained.

4.3.1 Age class

The dominant age class was the 31-40 years' group attaining a value of 50.9%, whereas the > 40 years' group (26.3%) was the lowest (Figure 4.1). in addition, all the age categories were represented thus the mindset and opinions of particular age groups were determined.

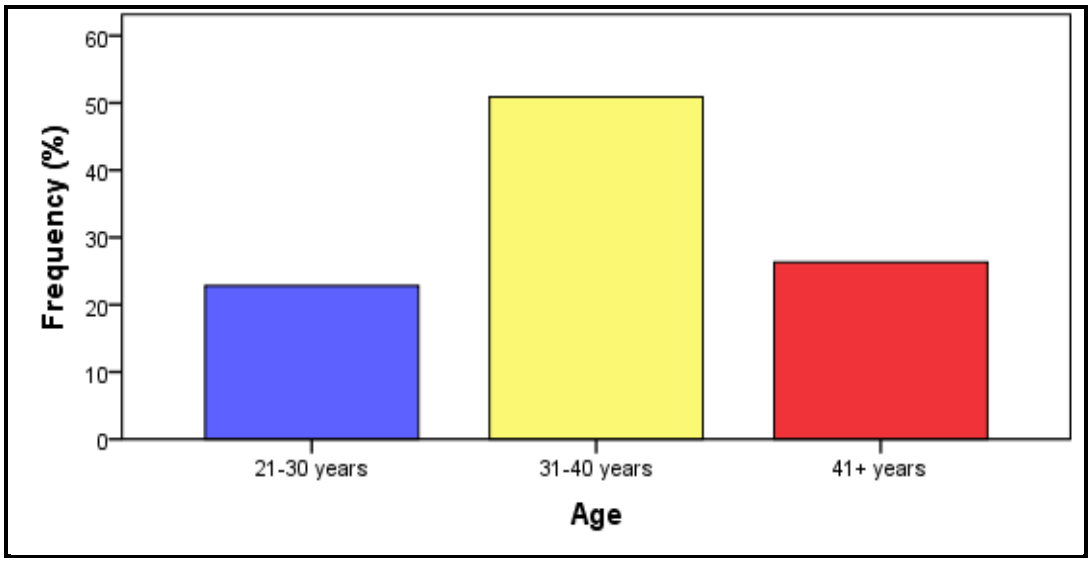


Figure 4. 1 Age class of study respondents

4.3.2 Gender

Figure 4.2 shows that the respondents were males (70%), whereas the females represented 30% of the sample size. This is shown in Figure 4.2 below. It is important to represent both genders during questionnaires, and this should be evenly distributed between both genders, thus acquiring information from both sets.

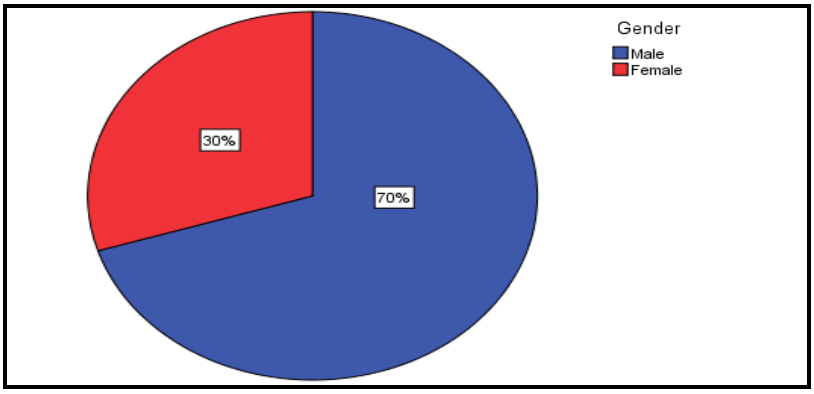


Figure 4. 2: Gender of the study respondents

4.3.3 Academic Qualification

Figure 4.3 shows the highest academic qualifications achieved by the respondents. The majority of the respondents attained degree level (45.6%). Diploma level was accomplished by 26.3% of

the respondents, whereas 19.3% attained certificate level education, with the remaining 8.8% (other) consisting of no formal education, and primary education.

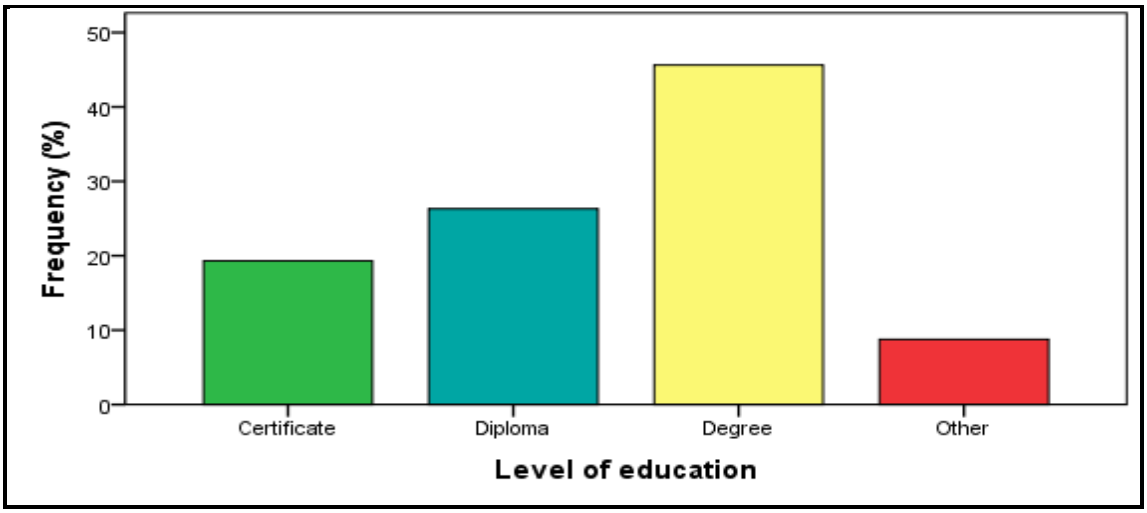


Figure 4. 3: Academic qualifications of respondents

4.3.4 Participants according to Mining Company

The figure 4.4 below indicate 43.9% were from Shamva Gold Mine (SGM), followed by from Freda Rebecca Gold Mine (33.3%) and a few form Bindura Nickel cooperation (22.2%). This could be linked to the impacts of automation at SGM, hence majority of employees were concerned.

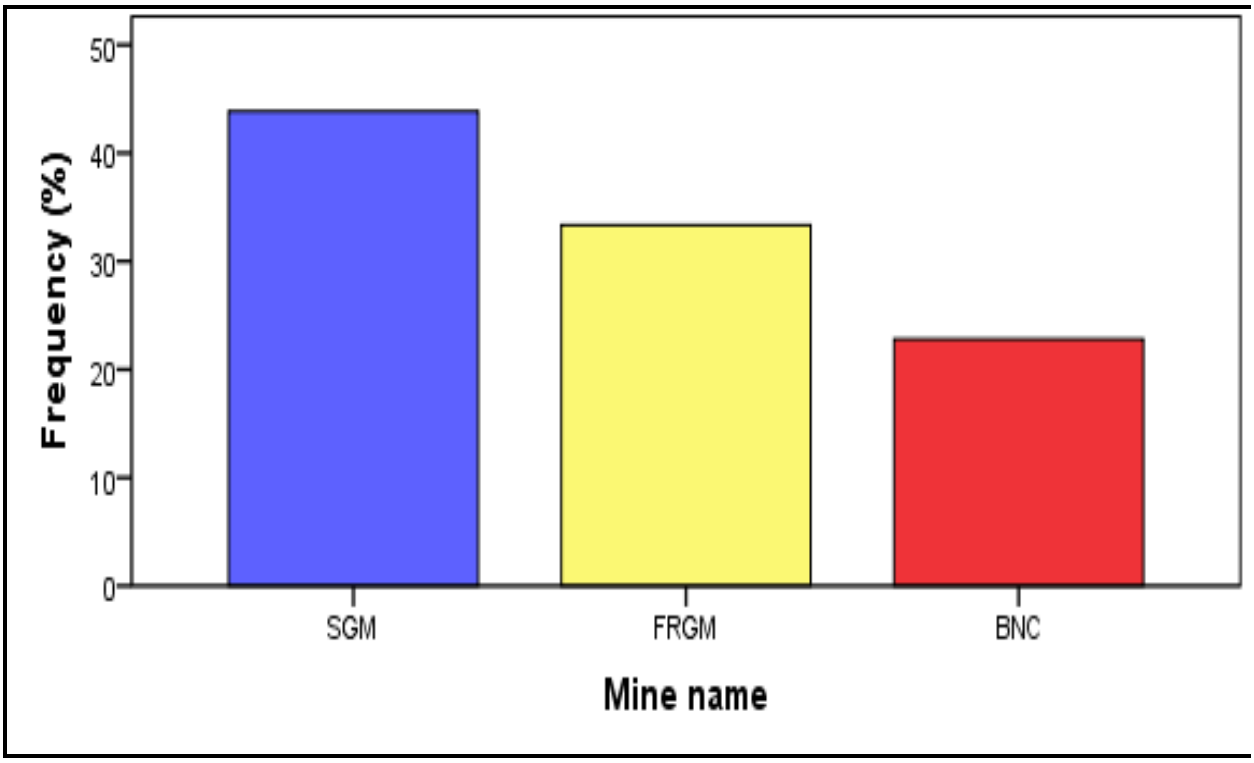


Figure 4. 4: Participants according to mining company

4.4 Descriptive statistics for exploring the effects of automation on workforce job security in mining sector

Descriptive statistics were employed to explore the effects of automation on workforce job security in the mining sector. This was portrayed by means, standard deviations, and percentages. The following sub-sections describe and explainthe effects of automation on workforce job security in the mining sector. These are further explained in the following sub-sections.

4.4.1 The extent to which mining companies implement automation in mining processes

Table 4 3: Factor analysis results for the extent to which mining companies implement automation in mining processes *(N=57)*

Variables	SD	D	N	A	SA	Mean	Std. Deviation	Skewness	Kurtosis
The mine has implemented digitalisation across all mining processes	0	0	17.5	56.1	26.3	3.91	0.662	0.096	-0.647

Does the mine use automated machinery when mining	0	7	5.3	49.1	38.6	3.53	0.710	-0.251	-0.116
The mine have operational procedures for using automated machinery	0	0	50.9	36.8	12.3	4.39	0.701	-0.706	-0.662
The transportation of ore from underground is automated	0	0	14	68.4	17.5	3.96	0.566	-0.011	0.294
Loading and offloading of ore is automated	2	1.4	19.3	64.9	14	4.02	0.641	-.0437	1.009

NB: SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

Results indicated of participants agreed (56.1%) that the mine has implemented digitalisation across all mining processes. The results also show that most (49.1%) of the participants agree that the mine use automated machinery when mining. This could be linked to vehicles are tracked, the mine detect mineral using machinery, off lading and loading is also done automatically through the use of conveyor belts and automated trucks. Efficient operation of the transportation system is particularly important, as ore transportation costs typically account approximately 50% of the cost incurred during production (Roumpos et al., 2014). This concurs with many studies which were conducted to enhance the use of equipment and operational transport systems through application simulation techniques (Kuznetsov and Aksyonov 2019 Moradi Afrapoli et al., 2019).

However, traditional methods of using mathematical means, do not take into account unexpected leading to mining equipment failure. Additionally, trucking systems (THS) have remained known as targets for applying machine learning methods for ore production. Therefore, it is crucial to manage all mining processes, as poorly managed mining activities can adversely affect mining profits and productivity (Hartman and Mutmansky, 2002; Choi and Nieto, 2011).

The study results also show that of participants (50.9%) were neutral on the fact that the mine have operational procedures for using automated machinery. This serves to confirm that employees are not aware of the procedures for using automated machinery which could be attributed to

implementation of artificial intelligence in few specific departments or areas in the mining process such as mineral processing, ore determination and monitoring of dangerous gases and transportation of ore. Hence majority of participants (68%) agree that, transportation of ore from underground is automated. In addition, the mean value of 4.04 under the variable, loading and offloading of ore is automated indicate that mining companies have implemented artificial intelligence in the mining processes.

4.4.2 The impacts of automation of mining processes on workforce job security in mining Industry

Table 4 4: Factor analysis forimpacts of automation of mining processes on workforce job security in mining Industry *(N=57)*

Variables	SD	D	N	A	SA	Mean	Std. Deviation	Skewness	Kurtosis
Automation of the mining processes affected job security	0	12.3	5.3	49.1	33.3	3.47	0.782	-0.375	-0.377
There are risks of losing job due to automation of mining	0	1.8	5.3	54.4	38.6	3.63	0.616	-0.501	-0.179
Automation reduced the number of workers at the mine	0	0	28.1	64.9	7	4.21	0.559	0.046	-0.130
Automated machinery replaced human resources	3.5	1.8	28.8.2	54.4	10.5	4.05	0.895	-1.500	3.419

NB: SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

The results show that of participants agree that automation of the mining processes affected job security. This is evidenced by mean value of 3.47. This implies that 82.4% of the participants agree. This serves to confirm that automation pose a threat to employee`s job security. In addition, results indicate that, most of the participants (54.4%) agree that there are risks of losing jobs due to automation of mining. This clearly shows that employees fear their jobs to technology and this emerged as a critical challenge in the mining sector.

The results also show that 64.9% of participants out of 51, who participated in the study, agree that automation reduced the number of workers at the mine. This could be linked to retrenchment of workers due to adoption of technology. Hence, single AI based machinery can operate and produce results efficiently, a task that can be done by more than 5 workers (Peng, 2015). Another area of AI and machine learning implementation is autonomous support systems and several companies are researching to provide the first such autonomous system that will reduce the need of human intervention for this delicate and dangerous mining operation (Van Duin, et al., 2013).

It is interesting to note that 54.4% of participants agree that automated machinery replaced human resources. This was also supported by one of the interviewees, respondent B who stated that,

> *Automation has threatened our job security and employees at the mine are not secure, in next 10 to 15 years i do not think we will be holding our positions, in fact technology is proving to be more effective than humans.*

Respondent E also shared the same sentiments,

> *I do not personally see the relevance of people in mining activities if technology can and is able to do everything from extraction, processing until a finished product is produced. One day will have robots doing interviews and as such the need for human resources department becomes questionable.*

Overall, this serves to confirm that automation of the mining processes has negative impact on job security of the employees in the mining industry. Hence, Deep learning and ML have produced accurate results in different applications when various images are available for the training as observed by Balasundaram & Venkatagiri, (2020). Therefore, the mining sector has been significantly affected by automation in terms of job security.

4.4.2.1 Hypothesis testing

Regression was used to forecast the effect of independent variables on the dependent research variable and establish the degree of statistical significance between research variables. The model summary is used to establish the extent of sufficiency of the regression model in clarifying the association between research variables as shown in Table 4.5

Table 4 5Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.801[a]	.642	.635	.156	.642	98.421	1	55	.000

a. Predictors: (Constant), Automation

The Model Summary shown in Table 4.5 shows the presence of a moderate positive linear relationship between automation and workforce Job security with an R value of 0.642. Thus, R-square value of 0.801 is used to explain the automation to workforce job security is shown inferential statistics. The results indicate that 64% of the participants were in support of the view that automation affect workforce job security. Hence the study accepts the null hypotheses which state that: *H_1 Automation of mining processes has a significant impact on workforce job security in the mining sector.*

4.4.2.2 Analysis of variances

The analysis of variances determines the ability of the regression model forecast the automation workforce job security. This is done by considering the F value and the significance value as indicated in Table 4.6.

Table 4 6 Analysis of Variances

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.386	1	2.386	98.421	.000[b]
	Residual	1.333	55	.024		
	Total	3.719	56			

a. Dependent Variable: Job. Security

b. Predictors: (Constant), Automation

Results in Table 4.6 above shows that the multiple regression model was statistically significant ($p<0.05$) in forecasting the impact of automation on workforce job security. Thus, F-value of

98.421 which is greater than 10 suggest that automation of mining processes has a statistically significant effect on workforce job security.

4.4.3 Perceptions of the workers, management and other stakeholders on the impacts of automation on workforce job security

Table 4 7Factor analysis forperceptions of the workers, management and other stakeholders on the impacts of automation on workforce job security (N=57)

Variables	SD	D	N	A	SA	Mean	Std. Deviation	Skewness	Kurtosis
The use of automated machinery has affected employees	1.8	0	10.5	59.6	28.1	3.77	0.854	-0.610	-0.029
The implementation of automation at the mine negatively influenced workforce job security	0	0	26.3	49.1	17.5	3.95	0.854	-0.610	-0.029
Automation of mining processes does not affect workforce job security	0	0	24.6	50.9	22.8	3.98	0.744	-0.241	-0.404
Automation has improved health and safety of employees	1.8	0	21.1	54.4	22.8	3.93	0.776	-0.827	2.268
Automation increased the number of workers at the mine	15.8	57.9	26.3	0	0	4.11	0.646	-0.099	-0.537

NB: SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

The results in table 4.7 above indicate that 59.6% agree that the use of automated machinery has affected employees. This clearly shows that employees are expressing dissatisfaction automation. In addition, 49.1% of the participants agree that the implementation of automation at the mine negatively influenced workforce job security. However, a significant number of participants, (50.9%) agree that automation of mining processes does not affect workforce job security. This is similar to the finding by Siau, (2018), who argued that the principal challenges applying

knowledge is the opposition of employees, managers, as well as Artificial Intelligence researchers who are skeptical about true effects of modern technology on careers, finances, the community and on societal relations. Therefore, some employees may be affected whilst other may not particularly those in the information technology department.

Majority, 54.5% agree that automation has improved health and safety of employees. This concurs with Welling (2019) who argued that, health and safety laws are made mandatory in various aspects such as pre-employment health examinations and as such mining companies are eager to digitalize hazard identification and risk control. This is crucial in maintain safe working environment. Similarly, Coombs et al., (2020), argued that AI can also condense the spell required to do a sum of essential corporate tasks, error degrees and lag times, by automating certain activities. This is contrary to when the operation is carried out by a human employee.

Therefore, using artificial intelligence mechanize the pictorial detection of codes and warrant plates in mining company trucks as well as boosting efficiency (Demlehner & Laumer, 2020). As a result, the chances of Human employee mistake will be reduced or eliminated and transparency increased when replacing human work with technology (Finch et al., 2017). The results also indicate that 57.9% disagree the view that automation has increased the number of employees. This serves to confirm that automation has to a larger extent affected job security of employees despite perceived benefits such as improved productivity, efficiency and health and safety.

4.4.4 Strategies that can be implemented to mitigate job losses due to automation of the mining processes

Table 4 8: Factor analysis for strategies that can be implemented to mitigate job losses due to automation of the mining processes *(N=57)*

Variables	SD	D	N	A	SA	Mean	Std. Deviation	Skewness	Kurtosis
Training of workers on the use of automated machinery helps to reduce job losses	0	0	17.5	59.6	21.1	3.93	0.678	-0.271	0.221
Allocation of roles and responsibilities	0	0	14	54.4	28.8	3.81	0.693	-0.057	-0.223

Implement automation in high risk areas	0	1.8	21.1	63.2	14	4.04	0.654	-0.432	0.832
Implementation of laws to protect workers	1.8	5.3	19.3	50.9	22.8	3.88	0.888	-0.863	1.086

NB: SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

Participants agree (59.6%) that training workers on the use of automated machinery helps to reduce job losses. This was further mentioned by majority of respondents during the interview sessions. It was stated that employees need re-skilling and up skilling and there is also need to channel resources towards training as compared to outsourcing resources for equipment operation. Similarly, Yoon *et al.,* (2018) reported that lack of training cause poor implementation of automation in most mining industries whereas Hermannus (2009) reported that neglect of AI by managers and employees was ascribed to a failure in education and training. Therefore, training is a vital component that can be implemented to mitigate job losses due to automation of the mining processes

The results also show that 54.4% of the participants agree that allocation of roles and responsibilities is vital in the quest to mitigate job losses due to automation of the mining processes. This helps employees to evaluate their positions at the organisation and they will also recognise the need to upgrade their skills to meet the demands of technological advancement. The results also show that 63.2% of the participants agree that there is need to automation in high risk areas. This will ensure safe working environment and will not affect job security. However, this is largely dependent on management commitment. Senior management's commitment and supportmost frequently found on mining sites with outstanding safety performance (Nawi *et al.*, 2016). Commitment and support could also be demonstrated by a clearly defined safety organization with specified job responsibilities and proper allocation of competent manpower and project resources (Yiu *et al.,* 2018).

Finding form some respondents indicated that, it is inevitable to avoid automation but there is need to improve employee's knowledge on automated machinery, multi-skilled labour training and limit automation to few mining processes. Respondent A mentioned that,

> *Knowledge should continue to improve among mining workers to embrace technology whilst training employees affected to empower them by creating other projects.*

Respondent C also stated that

> *Before implementation of automation at the mine there is need to conduct pre-survey to determine who is going to be affected, which process is going to be affected and how best can the affected worker be capacitated or given knowledge to remain employed*.

Respondent D was of the opinion that,

> *Implementation of technology or digitalization of mining processes is not bad but the mine should not implement automation across all sections. This will ensure that other sections where most people work will be partially automated thereby reducing job loss.*

Overall, findings indicate that employees are not against the idea of automation rather they are advocating for training of employees, improve knowledge among workers, creation of projects to sustain possible chancing of losing jobs to artificial intelligence. The same findings were echoed by Sharma and Mishra, (2020), who posits that, if employees appreciate knowledge about the effects of automation and particular risks to their jobs, this will increase compliance to AI based requirements. Thus, they can be able to easily identify and manage potential risks and avoid job loss thereby promoting worker productivity due to improved competence. In most developing countries, majority of employees in the mining industry are illiterate and compelled to work in high-risk situations (Koehn, 2010). Therefore, capacitating of workers through training, education is important in curbing job losses due to automation of mining processes.

4.5 Summary

In this chapter, research results were analysed, presented and discussed through the use of pie charts, tables, graphs and narrative discussions. Chapter five which follows gives a summary of the research study, conclusion and recommendations thereof**.**

CHAPTER 5: SUMMARY CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter focuses on the summary and draws conclusions and recommendations in relation to exploring the effects of automation on workforce job security in mining sector. It involves the summary of major findings based on the analysis of available data and the stated objectives of the study. The chapter also recommends further research that can be done in respect to the effects of automation on workforce job security in mining sector

5.1 Summary of findings

5.1.1 The extent to which mining companies implement automation in mining processes

Results indicated that the mine has implemented digitalisation across all mining processes. The study also revealed that Kuvimba mining House use automated machinery when mining. Hence, vehicles are tracked, the mines detect mineral using machinery, off lading and loading is also done automatically through the use of conveyor belts and automated trucks.It was observed that Kuvimba mines have operational procedures for using automated machinery. Transportation of ore from underground is automated. However, Shamva Mine still has most underground operations under manual operations as indicated by the use of jack hammers and some lashing activities observed.

5.1.2 The impacts of automation of mining processes on workforce job security in mining Industry

The results showed that automation of the mining processes affected job security. The study also revealed that there are risks of losing jobs due to automation of mining processes. In addition, automation reduced the number of workers at the mine. This could be linked to retrenchment of workers due to adoption of technology. It was noted that automated machinery replaced human resources. Therefore, automation of the mining processes has negative impact on job security of the employees in the mining industry. Presence of a moderate positive linear relationship between

automation and workforce Job security was observed. Multiple regression model was statistically significant ($p<0.05$) in forecasting the impact of automation on workforce job security. Therefore, automation of mining processes had a statistically significant effect on workforce job security.

5.1.3 Perceptions of the workers, management and other stakeholders on the impacts of automation on workforce job security

The study revealed that the use of automated machinery has affected employees. The study also observed that automation of mining processes improves health and safety of employees and to some extend does affect workforce job security. However, some participants opined that automation had increased the number professional and technical employees but reduced the large number of unskilled workforce through retrenchment. The interviews also revealed that, the mines preferred fixed time unskilled contract workers whose contracts can be terminated. Hence, automation has to a larger extent affected job security of employees despite perceived benefits such as improved productivity, efficiency and health and safety.

5.1.4 Strategies that can be implemented to mitigate job losses due to automation of the mining processes

Training workers on the use of automated machinery helps to reduce job losses. It was suggested that employees need re-skilling and up skilling and there is also need to channel resources towards training as compared to outsourcing resources for equipment operation. In addition, allocation of roles and responsibilities is vital in the quest to mitigate job losses due to automation of the mining processes. There is need to automate in high risk areas to ensure safe working environment and will not affect job security. Ffindings indicated that employees are not against the idea of automation rather they are advocating for training of employees, improve knowledge among workers, creation of projects to sustain possible chances of losing jobs to artificial intelligence and technology.

5.2 Conclusions

5.2.1 The extent to which mining companies implement automation in mining processes

It can be concluded that digitalisation has been implemented across all mining processes in Kuvimba group of mines. In addition, mining companies use automated machinery when mining, vehicles are tracked, the mine detect mineral using machinery, off lading and loading is also done automatically through the use of conveyor belts and automated trucks, mining companies have operational procedures for using automated machinery and transportation of ore from underground was automated.

5.2.2 The impacts of automation of mining processes on workforce job security in mining Industry

The study concluded that automation of the mining processes affected job security, reduced the number of workers at the mine, automation of the mining processes negatively impacts on job security of the employees in the mining industry. There is a positive relationship between automation and workforce Job security was observed.

5.2.3 Perceptions of the workers, management and other stakeholders on the impacts of automation on workforce job security

As observed form the study, automated machinery affected employees. Automation of mining processes improved health and safety of employees and increased the number of professional employees and reduced manual work. Therefore, automation has to a larger extent affected job security of employees despite perceived benefits such as improved productivity, efficiency and health and safety.

5.2.4 Strategies that can be implemented to mitigate job losses due to automation of the mining processes

Training workers on the use of automated machinery, re-skilling and up skilling, channelling resources towards training as compared to outsourcing resources for equipment operation, allocation of roles and responsibilities, automation in high risk areas to ensure safe working environment were important strategies that can be implemented to mitigate job losses due to automation of the mining processes.

5.3 Recommendations

Based on the above results, the researcher recommended the following:

5.3.1 Laws and policies

This study noted that automation of the mining process significantly influenced workforce job security. Therefore, the government should implement laws that protect workers despite the use of artificial intelligence technologies. Policies should be put in place by Government and mining organizations to ensure that workers are valued and protected. Strategic plans should be developed and allow workers to participate in the implementation of automation and advanced technologies in order to give confidence to employees and secure their jobs.

5.3.2 Training and development

The study also recommends that mining organizations must provide training for workers on automation this can be done through, educational grants or incentives to motivate workers to advance their knowledge in the field of automation. This will positively improve adoption of automation in the mining sector.

5.3.3Alternative means of employment

The mining sector should consider alternative means of employment to secure jobs for unskilled labor. This may be in the form of projects such as implementing solar systems as alternative source of power. Solar plants will reduce cost of electrical energy and at the same time provide employment to those displaced by technology. Kuvimba mines may also create recreational centers since it has a massive drive to improve wellness of its employees and their families. In particular,

Shamva Mine may install water processing plant to improve the quality of water for their workers and mine community while creating employment and reducing the cost of domestic water.

5.4 Recommendations for future research

This study explored the effects of automation on workforce job security in mining sector using a cross section design. Future studies should be carried out in other sectors of the economy; for example, in the, energy sector, meat industry and in the tobacco sector among other sectors to fully understand the impact of automation on employee job security. Future research may also focus on strategic plans on sustaining high levels of employment in mining industry in the verge of continued use of advanced technologies and artificial intelligence.

Since the study focused on automation and job security further research could be done on evaluating the effectiveness of automation in various sectors of the economy for development of strong framework to manage job loss in the country.

REFERENCES:

References

Aíaz-Rodríguez, N., Del Ser, J., Bennetot, A., Tabik, S., Barbado, A., & Benjamins, R. (2020). Explainable Artificial Intelligence (XAI): Concepts, taxonomies, opportunities and challenges toward responsible AI. Information Fusion, 58, 82–115

Abadi, M., Agarwal, A., Barham, P., Brevdo, E., Chen, Z., Citro, C., et al. (2015). TensorFlow: Large-scale machine learning on heterogeneous distributed systems. arXiv [Preprint]. arXiv: 1603.04467. Available online at: https://arxiv.org/pdf/1603. 04467.pdf

Abbasi, A., Sarker, S., & Chiang, R. H. (2016). Big data research in information systems: toward an inclusive research agenda. Journal of the Association for Information Systems, 17(2)

Acemoglu, D., Autor, D. (2011). Skills, Tasks and Technologies: Implications for Employment and Earnings. Handbook of Labour Economics,4,1043-1171

Adams T. (2022). Autonomous mining technology – 10 terms You Must Know. *Industry Articles*

Afiouni, R. (2019). Organizational learning in the rise of machine learning. International Conference on Information Systems, Munich, Germany

African Development Bank (2021). Impact of Covid 19 on Mining Case Studies of Four African Countries. *Working Article Paper 357*

Alanazi, H. O., Abdullah, A. H., and Qureshi, K. N. (2017). A critical review for developing accurate and dynamic predictive models using machine learning methods in medicine and health care. J. Med. Syst. 41, 69. doi: 10.1007/s10916-017-0715-6

Ali, D.; Frimpong, S. Artificial intelligence, machine learning and process automation: Existing knowledge frontier and way forward for mining sector. Artif. Intell. Rev. 2020, 53, 6025–6042. [Google Scholar] [CrossRef]

Al-Mukhtar, M., Al-Yaseen, F., and Sahib, J. (2020). “Modelling water quantity parameters using artificial intelligence techniques, a case study Abu-Ziriq marsh in south of Iraq,” in IOP Conference Series: Materials Science and Engineering, Vol. 737 (IOP Publishing). Available online at: https://iopscience.iop.org/article/ 10.1088/1757-899X/737/1/012156

Alpaydin, E. Introduction to Machine Learning; MIT Press: Massachusetts, MA, USA, 2020; pp. 1–13. [Google Scholar]

Alzubi, J.; Nayyar, A.; Kumar, A. Machine learning from theory to algorithms: An overview. J. Phys. Conf. Ser. 2018, 1142, 012012. [Google Scholar] [CrossRef]

Amer-Yahia, S., Basu Roy, S., Chen, L., Morishima, A., Abello Monedero, J., Bourhis, P., & Demartini, G. (2020). Making AI machines work for humans in FoW. ACM SIGMOD Record, 49(2), 30–35

Anon. (2020). AI is essential to India's future of work, study finds. M2 Presswire Arrieta,

Arndt, D. C. (2000). Integrated dynamic simulation of large thermal Systems (Ph.D. thesis) University of Pretoria, Pretoria. Chu, F., Wang, F., Wang, X., and Zhang, S. (2014). A hybrid artificial neural network-mechanistic model for centrifugal compressor. Neural Comput. Appl. 24, 1259–1268. doi: 10.1007/s00521-013-1347-5

Autor, D, Katz., & Kearney. (2006). The Polarization of the US Labour Market. American Economic Review,96(2), 189-194

Autor, D. H., Levy, F., & Murnane, R, j. (2003). The Skills Content of Recent Technological Change: An Empirical Exploration. Quarterly Journal of Economics,118(4).1279-133

Baby, C. J., Khan, F. A., & Swathi, J. (2017). Home automation using IoT and a chatbot using natural language processing. 2017 Innovations in Power and Advanced Computing Technologies (iPACT)

Baier, L., Jöhren, F., & Seebacher, S. (2019). Challenges in the deployment and operation of machine learning in practice. In Proceedings of the 27th European Conference on Information Systems (ECIS),

Bauer, W., & Vocke, C. (2019). Work in the age of artificial intelligence– challenges and potentials for the design of new forms of humanmachine interaction. International Conference on Applied Human Factors and Ergonomics

Benbya, H., Nan, N., Tanriverdi, H., & Yoo, Y. (2020). Complexity and information systems research in the emerging digital world. MIS Quarterly 44(1), 1–17

Beyer, M., & Laney, D. (2012). The importance of "Big Data": a definition.

Buckle, M. (2021) Disruptive technologies in Mining Industry: Opportunities, Risk, Mitigation and Resolving Disputes.

Bytniewski, A., Matouk, K., Chojnacka-Komorowska, A., Hernes, M., Zawadzki, A., & Kozina, A. (2020). The functionalities of cognitive technology in management control system. Asian Conference on Intelligent Information and Database Systems

Castillo, D., Canhoto, A. I., & Said, E. (2020). The dark side of AIpowered service interactions: exploring the process of codestruction from the customer perspective. The Service Industries Journal, 1–26

Chakravorty, S. S., Dulaney, R. E., & Franza, R. M. (2016). ERP implementation failures: a case study and analysis. International Journal of Business Information Systems, 21(4), 462–476

Chauhan, S.; Rühaak, W.; Khan, F.; Enzmann, F.; Mielke, P.; Kersten, M.; Sass, I. Processing of rock core microtomography images: Using seven different machine learning algorithms. Comput. Geosci. 2016, 86, 120–128. [Google Scholar] [CrossRef]

Chen, J., Tao, Y., Wang, H., & Chen, T. (2015). Big data based fraud risk management at Alibaba. The Journal of Finance and Data Science 1(1), 1–10

Cilliers, C., Brand, H. G., and Kleingeld, M. (2016). "Benchmarking electricity use of deep-level mine compressors," in 2016 International Conference on the Industrial and Commercial Use of Energy (Cape Town: IEEE), 208–216. Available online at: https://ieeexplore.ieee.org/document/7605638

Cirillo, D., Catuara-Solarz, S., Morey, C., Guney, E., Subirats, L., Mellino, S., & Chadha, A. S. (2020). Sex and gender differences and biases in artificial intelligence for biomedicine and healthcare. NPJ Digital Medicine, 3(1), 1–11

Colas, F., and Brazdil, P. (2006). Comparison of SVM and some older classification algorithms in text classification tasks. IFIP Int. Federat. Inf. Process. 217, 169–178. doi: 10.1007/978-0-387-34747-9_18

Collins, C., Dennehy, D., Conboy, K., & Mikalef, P. (2021). Artificial intelligence in information systems research: A systematic literature review and research agenda. International Journal of Information Management, 60, 102383

Coombs, C., Hislop, D., Taneva, S. K., & Barnard, S. (2020). The strategic impacts of Intelligent Automation for knowledge and service work: An interdisciplinary review. The Journal of Strategic Information Systems, 29(4), 101600

Crawford, J. A., Joubert, H. P., Mathews, M. J., and Kleingeld, M. (2019). Optimised dynamic control philosophy for improved performance of mine cooling systems. Appl. Thermal Eng. 150, 50–60. doi: 10.1016/j.applthermaleng.2018.12.160

Damper, R. I., Marchand, Y., Adamson, M. J., & Gustafson, K. (1999). Evaluating the pronunciation component of text-to-speech systems for English: A performance comparison of different approaches. Computer Speech & Language, 13(2), 155–176

Dastin, J. (2018). Amazon scraps secret AI recruiting tool that showed bias against women. Reuters. Retrieved 15/06 from https://www. reuters.com/article/us-amazon-com-jobs-automation-insight/ amazon-scraps-secret-ai-recruiting-tool-that-showed-bias-againstwomen-idUSKCN1MK08G

Davenport, T. H., & Ronanki, R. (2018). Artificial intelligence for the real world. Harvard Business Review, 96(1), 108–116

Dedrick, J., Kraemer, K. L., & Shih, E. (2013) Information technology and productivity in developed and developing countries. Journal of Management Information Systems, 30(1), 97–122

Dellermann, D., Lipusch, N., Ebel, P., Popp, K. M., & Leimeister, J. M. (2017). Finding the unicorn: Predicting early stage startup success through a hybrid intelligence method. International Conference on Information Systems (ICIS), Seoul, South Korea

Demidova, L. A., and Sokolova, Y. S. (2021). "Approbation of the data classification method based on the SVM algorithm and the k nearest neighbors algorithm," in IOP Conference Series: Materials Science and Engineering, Vol. 1027 (IOP Publishing). Available online at: https://iopscience.iop.org/article/10.1088/ 1757-899X/1027/1/012001/meta

Demlehner, Q., & Laumer, S. (2020). Shall we use it or not? Explaining the adoption of artificial intelligence for car manufacturing purposes In Proceedings of the 28th European Conference on Information Systems (ECIS), Online

Du Plessis, G. E., Arndt, D. C., and Mathews, E. H. (2015). The development and integrated simulation of a variable water flow energy saving strategy for deep-mine cooling systems. Sustain. Energy Technol. Assess. 10, 71–78. doi: 10.1016/j.seta.2015.03.002

Duan, Y., Edwards, J. S., & Dwivedi, Y. K. (2019). Artificial intelligence for decision making in the era of Big Data–evolution, challenges and research agenda. International Journal of Information Management, 48, 63–71

Dwivedi, Y. K., Hughes, L., Ismagilova, E., Aarts, G., Coombs, C., Crick, T. … Eirug, A. (2021). Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. International Journal of Information Management, 101994

Gartner Borges, A. F., Laurindo, F. J., Spínola, M. M., Gonçalves, R. F., & Mattos, C. A. (2020). The strategic use of artificial intelligence in the digital era: Systematic literature review and future research directions. International Journal of Information Management, 102225

Géron, A. Hands-on Machine Learoing with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems; O'Reilly Media: California, CA, USA, 2019; pp. 1–33. [Google Scholar]

Guntoro, P.I.; Ghorbani, Y.; Butcher, A.R.; Kuva, J.; Rosenkranz, J. Textural Quantification and Classification of Drill Cores for Geometallurgy: Moving Toward 3D with X-ray Microcomputed Tomography (µCT). Nat. Resour. Res. 2020, 29, 3547–3565. [Google Scholar] [CrossRef]

Harmse, M. D. (2021). Optimising mining refrigeration systems through artificial intelligence (Master's thesis). North-West University. Harmse, M. D., Jacobs, J. A., van Laar, J. H., and Schutte, C. (2022). "Dynamic control of centrifugal compressors using neural networks," in Proceedings of the Second Southern African Conference for Artificial Intelligence Research, 155–170.

International Council on Mining and Metals (2018). The Role of Mining in the Circular Economy

International Institute for Sustainable Development (ISD). (2019). The Mining a Mirage? Reassessing the Shared-Value Paradigm in Light of the Technological Advances in the Mining Sector.

Jung, D.; Choi, Y. Systematic review of machine learning applications in mining: Exploration, exploitation, and reclamation. Minerals 2021, 11, 148. [Google Scholar] [CrossRef]

Kawaguchi, K., Kaelbling, L. P., & Bengio, Y. (2017). Generalization in deep learning. arXiv preprint arXiv:1710.05468

Keding, C. (2020). Understanding the interplay of artificial intelligence and strategic management: four decades of research in review. Management Review Quarterly, 71(1), 91–134.

Khonakdar-Tarsi, I.; Fotuhi-Firuzabad, M.; Ehsan, M.; Mohammadnezhad-Shourkaei, H.; Jooshaki, M. Reliability incentive regulation based on reward-penalty mechanism using distribution feeders clustering. Int. Trans. Electr. Energ. Syst. 2021, e12958. [Google Scholar] [CrossRef]

Kirchmer, M., & Franz, P. (2019). Value-Driven Robotic Process Automation (RPA). International Symposium on Business Modeling and Software Design

Lovells, H. (2018). The benefits and Pitfalls of Mining Automation

McKinsey & Company. (2023) Has Mining lost its Lustre? Why Talent is Moving Elsewhere and How to Bring Them Back. *February 14 2023. Article*

McKinsey Global Institute. (2017). A Future That Works: Automation, Employment and Productivity.

Muro, M., Maxim, R., & Whiton, J. (2017). Digitalization and the American Workforce. Brookings Institution.

Parades, D. Flemmings-Munos D. (2021). Automation and robotics in mining: Jobs, income and inequality implications: *The Extractive Industry and Society. Vol 8. Issue 1*

White S. (2022). Local Economic Development. *Simonwhite.au*

World Economic Forum. (2018). The Future of Jobs Report 2018

APPENDICES

APPENDIX I: QUESTIONNAIRE FOR PARTICIPANTS

My name is Mercy T. Gundidza, I am a student at the Midlands State University. I will be carrying out a study: **Exploring the effects of automation on workforce job security in mining sector: a case of Kuvimba group.** I kindly request you to participate in the study. There are no costs and risks associated with the research.

Participation in this study may not benefit you directly but may provide information that may benefit you and others regarding automation and hob security. Your name and identity will not be revealed or published anywhere. The information will be kept confidential and will be used for the purpose of the study only. Data will be coded to promote anonymity. Your participation in this study is voluntary and you may withdraw from the study at any time without a penalty and this will not influence your working conditions at this institution. Data collected will not be shared with anyone without your permission**.**

SECTION A: DEMOGRAPHIC INFORMATION

Age: 21-30 years☐ 31-40 years☐ >41 years ☐

1. Gender: Male ☐ Female ☐
2. Level of education: Certificate ☐ Diploma ☐ Degree ☐ other ☐
3. Mine name: ……
4. Designation: ……..

SECTION B: THE EXTENT TO WHICH MINING COMPANIES IMPLEMENT AUTOMATION IN MINING PROCESSES.

Indicate the extent to which you agree with the following items using the following ratings:

SCALE: = Strongly Disagree, **2** = Disagree, **3** = Neutral, **4** = Agree and **5** = Strongly Agree

The extent to which mining companies implement automation in mining processes (EMIAP)

Code	Item	1	2	3	4	5
EMIAP 1	The mine has implemented digitalisation across all mining processes					
EMIAP 2	Does the mine use automated machinery when mining					
EMIAP 3	The mine have operational procedures for using automated machinery					
EMIAP 4	The transportation of ore from underground is automated					
EMIAP 5	Loading and offloading of ore is automated					

SECTION C THE IMPACTS OF AUTOMATION OF MINING PROCESSES ON WORKFORCE JOB SECURITY IN MINING INDUSTRY

The impacts of automation of mining processes on workforce job security in mining Industry (IAMJS)

Code	Item	1	2	3	4	5
IAMJS 1	Automation of the mining processes affected job security					
IAMJS 2	There are risks of losing job due to automation of mining					
IAMJS 3	Automation reduced the number of workers at the mine					
IAMJS 4	Automated machinery replaced human resources					

SECTION E THE PERCEPTIONS OF THE WORKERS, MANAGEMENT AND OTHER STAKEHOLDERS ON THE IMPACTS OF AUTOMATION ON WORKFORCE JOB SECURITY (PIWJS)

Code	Item	1	2	3	4	5
PIWJS 1	The use of automated machinery has affected employees					
PIWJS 2	The implementation of automation at the mine negatively influenced workforce job security					
PIWJS 3	Automation of mining processes does not affect workforce job security					
PIWJS 4	Automation has improved health and safety of employees					
PIWJS 5	Automation increased the number of workers at the mine					

SECTION F STRATEGIES THAT CAN BE IMPLEMENTED TO MITIGATE JOB LOSSES DUE TO AUTOMATION OF THE MINING PROCESSES

Strategies that can be implemented to mitigate job losses due to automation of the mining processes (SMJLA)

Code	Item	1	2	3	4	5
SMJLA 1	Training of workers on the use of automated machinery helps to reduce job losses					
SMJLA 2	Allocation of roles and responsibilities					
SMJLA 3	Implement automation in high risk areas					
SMJLA 4	Implementation of laws to protect workers					

5. Any comments that you may wish to make relating to this research and/ or any other issues that may be missed or omitted in this questionnaire which you find relevant for the research

.....

Thank you for your participation

APPENDIX II: Participant consent form

I volunteer to participate in a research project conducted by Mercy. T. Gundidza a student enrolled at Bindura University of Science Education. I understand that University students are expected to conduct a research and submit a dissertation as part of the graduation requirements. This research is designed to gather information on the topic, exploring the effects of automation on workforce job security in mining sector: a case of Kuvimba group of mines. I have agreed to be one of the approximately 5 people being interviewed for this research. My participation in this research is voluntary. I understand that i will not be paid for any participation. I may withdraw or discontinue participation at any time without penalty.

I have been given a copy of this consent form.

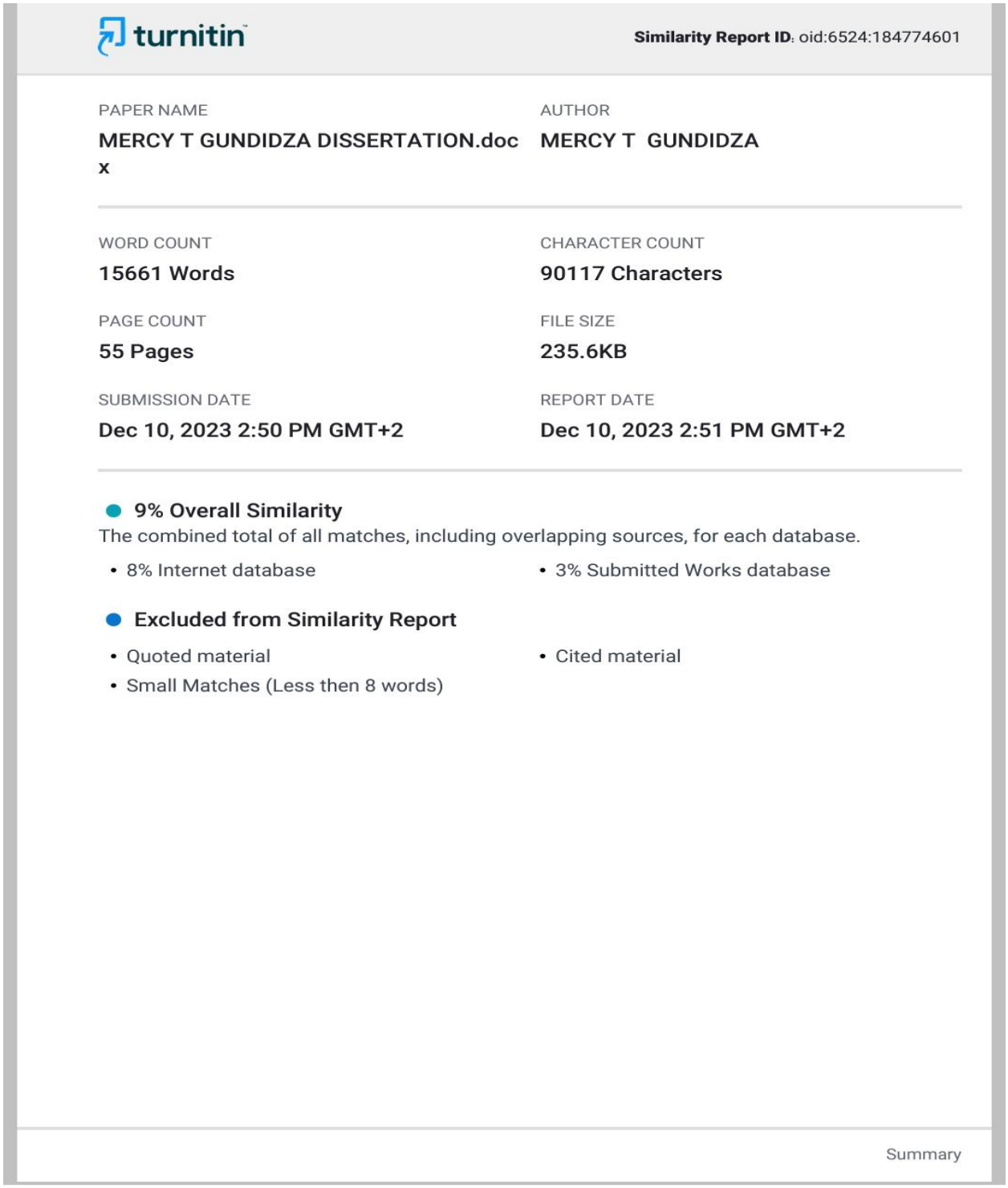
My signature _____ _____

Date…….

APPENDIX III: Interview Guide

1. How do you rate the implementation of automation in mining processes?
2. How would you describe mining performance after adoption on automated machinery?
3. In your opinion, how does automation affect job security?
4. Is there a relationship between automation and job security? Explain
5. What do you think are the impacts of automation on job security?
6. Is automation beneficial to employees? Explain
7. What are the possible measures that can be taken to protect workers from losing jobs due to automation of mining processes?

APPENDIX 1V: Turnitin Report



turnitin

Similarity Report ID: oid:6524:184774601

PAPER NAME
MERCY T GUNDIDZA DISSERTATION.docx

AUTHOR
MERCY T GUNDIDZA

WORD COUNT
15661 Words

CHARACTER COUNT
90117 Characters

PAGE COUNT
55 Pages

FILE SIZE
235.6KB

SUBMISSION DATE
Dec 10, 2023 2:50 PM GMT+2

REPORT DATE
Dec 10, 2023 2:51 PM GMT+2

9% Overall Similarity
The combined total of all matches, including overlapping sources, for each database.

- 8% Internet database
- 3% Submitted Works database

Excluded from Similarity Report

- Quoted material
- Cited material
- Small Matches (Less then 8 words)

Summary