ST.MARY'S UNIVERSITY

SCHOOL OF GRADUATE STUDIES

THE ROLE OF INNOVATIVE MINING ON PERFORMANCE: THE CASE OF ETHIOPIAN MINING SECTOR.

BY

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JANUARY 2025

ADDIS ABABA, ETHIOPIA

ST.MARY'S UNIVERSITY
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THE ROLE OF INNOVATIVE MINING ON PERFORMANCE (THE CASE OF ETHIOPIAN MINING SECTOR).

A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES ST. MARY'S UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE MASTERS IN PROJECT MANAGEMENT (MPM).

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Student’s Declaration

I, the undersigned, declare that this study entitled 'The Role of Innovative Mining on Performance: The Case of Ethiopian Mining Sector' is my work, submitted for the grant of a degree of Masters of project management at St. Mary's University in Addis Ababa. This work has not been submitted for a degree program at any other university, and all sources of materials used in the study have been duly acknowledged.

Place: Addis Ababa, Ethiopia

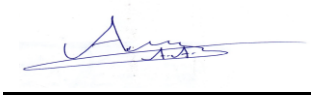
Signature: _____

Date: Dec. 2024

Certificate of Approval

This is to certify that Almaz Debebe's study, 'The Role of Innovative Mining on Performance: The Case of the Ethiopian Mining Sector', undertaken for the Masters of Project Management (MPM) at St. Mary's University, is original and has not been submitted earlier for any Degree, either at this university or at any other university.

Research Advisor: Alazar Amare (PhD.)

Signature: 

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The Board of Examiners

As members of the board of examiners for the final MA thesis open defense Examination, we certify that we have read and evaluated **Almaz Debebe's** thesis and examined the candidate**.** We recommend that the thesis entitled "**The Role of Innovative Mining on Performance: The Case of Ethiopian Mining Sector**" be accepted as a partial fulfillment for the reward of a Master of Arts degree in Project Management.

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Table of Contents

List of Tables

List of Figures

List of Images

Acronyms

SPSS 25: Statistical Package for the Social Science version 25

Abstract

This study investigates the role of innovative mining techniques in enhancing the performance of the mining sector in Southern Ethiopia, with a particular focus on the Gamo Zone in Kamba Woreda. Understanding the implications of technological advancements in enhancing efficiency and productivity is crucial for leveraging Ethiopia's large mineral resources. A concurrent mixed-method approach was employed, integrating a QUAL + quan design. *Data were collected from a sample of 55 stakeholders, including miners, government representatives, and industry experts, through structured questionnaires. The collected data were then analyzed using descriptive statistics. The main findings suggest a low adoption rate of technological innovations, with 76.4% of respondents indicating insufficient integration of modern methods into operations. Barriers such as inadequate training, limited financial resources, and insufficient government support were prevalent, with 60.0% of participants identifying these factors as significant impediments.*

Additionally, while innovative mining practices have the potential to enhance socio-economic conditions and infrastructure, environmental degradation remains a concern, particularly regarding deforestation and loss of biodiversity (85.5%). To overcome these challenges, stakeholders should prioritize improving training programs, increasing government support through financial incentives, and actively engaging local communities in mining activities. The study highlights the need for a collaborative approach to promoting the effective adoption of innovative mining technologies, ultimately contributing to sustainable development within the Ethiopian mining sector.

(***Keywords:*** *Innovative*, *Sustainable*, *Biodiversity*, *Socio-economic*, *Degradation*, *Ethiopia).*

CHAPTER ONE

INTRODUCTION

This chapter presents the study's background, problem statement, objectives, research questions, significance, scope, content, and conclusion.

1.1 Background of the Study

Ethiopia has witnessed impressive expansion in the mining industry. There has been steady policy formulation and implementation of regulations to lure investments and ensure that mining is done sustainably. Its mining sector is crucial to the country's economy, as it constitutes exports and job opportunities. The common minerals with mineral potential, Ethiopia is a blessed country, endowed with a variety of mineral deposits.

These deposits include precious and semi-precious stones like Opal, Garnet, Citrine, Obsidian glass, Agate, Aquamarine, Amethyst, and Peridot. Additionally, there are Gemstones such as Sapphire, Emerald, Ruby, Diamond, Apatite, Red Garnet, Rutile quartz, Amber, and Tourmaline; Precious Metals such as Gold, Platinum, and Silver; Industrial Minerals such as Coal, Pumice, limestone, Dolomite, Phosphate, Kaolin, and Quartz, Coal, Industrial quartz, Marble, Bentonite, Chromite, Beryllium, Kaolin, Feldspar, Talk nickel, and Silica; Metallic minerals like Lead, Iron, Copper, Tantalum, Lithium ore, Zinc, Chromite, Malachite, Galena, Cobalt, and Uranium are among the most valuable commodities (Min-Tex, 2024).

These minerals are among the most valuable commodities on which the country's economy depends. However, despite this potential, the sector remains underdeveloped, contributing less than 1% to the GDP (World Bank, 2021). Artisanal and small-scale mining (ASM) is significant in Ethiopia, involving individuals and groups who utilize minimal mechanization (Hailu & Alemu, 2022). ASM supports the livelihoods of over 1.2 million people directly and indirectly supports around 7.5 million people (IGF, 2017). However, challenges such as limited access to markets, financial services, and adequate equipment persist. The government has prioritized formalizing and supporting ASM to enhance its economic contribution and ensure sustainable development (Elias & Alemu, 2022).

The interview conducted with Mr.Takele Uma, who appeared in the article published by Capital Ethiopia on January 14, 2023. The article clearly explains the contribution of the mining sector to the country's economic development. It focuses on this topic and explains in detail how sustainable mining transforms the mining sector and the country's economy across the spectrum.

The success and profitability of such endeavors rely on integrating mineral resources and a highly skilled and motivated labor force (Y.Yihdego et al., 2018, p.327). The mining industry has benefited the economy of many nations that have embraced it including Ethiopia. However, obsolete mining practices have their demerits in terms of environmental distraction and low output. In recent years, innovative mining techniques have emerged as a potential solution to these challenges. This study aims to investigate the role of innovative mining methods on the performance of the Ethiopian mining sector, specifically in southern Ethiopia, Gamo Zone, Kamba Woreda.

Status of the Mining Sector in Kamba Woreda

In Southern Ethiopia, various sectors extract precious and semi-precious stones and industrial minerals, utilizing traditional mining techniques. Some of these associations have established direct market chains with mining exporters. The mining activities in this Zone are primarily located in three woreda (districts). Mineral deposits of Gamo Zone are Beryllium, Blue Agate, Aquamarine, Cole, Smoky Quartz, Industrial quartz, Amazonite, tourmaline, and Opal. Therefore, among these three woreda, I have selected Kamba Woreda as the focus of my research. The three words are discussed as follows in detail:-

A. Geresa Woreda: There are four associations among them two are involved in industrial mining. These associations have faced challenges due to the region's geographical landscape, which includes mountainous areas, as well as a lack of access to foreign markets, expertise, technology, and financing. Consequently, these associations have ceased their operations and exited the association. On the other hand, the remaining two associations focus on blue agate, a semi-precious stone. They mine three to four tones every 15 to 30 days. However, their traditional methods of extraction, which solely rely on manual labor, did not make them efficient. For example, if they were to adopt modern technologies, they could potentially increase their output to more than 30 to 50 tons per month.

B. Garda Marta Woreda: This woreda was home to three associations engaged in the industrial mineral beryllium. However, due to inadequate traditional mining techniques, they could not meet the market demands in quality and quantity, which led the associations to withdraw from the mining sector. In contrast, new investors have entered the area, investing in infrastructure, employing X-Y coordinates, and conducting cadastral surveys to identify lands rich in mineral deposits. This allows associations to adopt improved practices, benefiting investors and the local community.

C. Kamba Woreda: Initially, in this woreda, there are seven associations engaged in the extraction of semi-precious and precious stones. Among the three Woreda mentioned, Kamba Woreda offers a favorable working environment. Each association includes 8 to 12 stakeholders, which creates job opportunities for the local community, and they maintain direct market chains with exporters. Before executing mining operations, these associations will conduct thorough research, engaging experts in chemistry, geology, and other relevant fields. This approach serves as a valuable lesson for other mining sites, highlighting the importance of expertise, sufficient financial resources, and other integration of modern technology to ensure success in the mining sector.

Previous Works on the Role of Innovative Mining on Performance

There is a direct relationship between the role of innovative mining strategies and the performance of associations, especially in developing countries. Hilson & Maconachie (2020) have remarked that the operation of advanced technologies and new mining practices increased both the output and efficiency of mining associations in the sub-Saharan region. Such innovations have advanced not only the productivity of the companies but also the economic development of the area by enhancing the use of resources by providing well-paying and secure jobs.

Flores et al. (2024) attributed the exposure of the mining associations to the advancement of technologies and new extraction methods with the enhancement of efficiency, lower operational costs, and improved safety conditions. The authors were equally interested in the use of innovative practices and technologies. Such practices increased the mineral output and profitability of the mining associations in the developing parts of the country. However, there is still a glaring gap in the research that examines such issues as the role of innovative practices in mining activities in the southern Ethiopia, Gamo Zone.

Research indicates that technical developments are crucial for enhancing the productivity and efficiency of mining operations. Triwahyono et al., (2023) highlighted the fact that through the application of modern tools and practices, mining organizations can achieve enhanced performance levels. This study seeks to fill the clear void in the current literature concerning the role of innovative mining practices and their performance efforts in Southern Ethiopia. Although a good number of studies have been carried out regarding mining innovations and the benefits they have at the global level, the consequences for local mining associations are difficult to grasp.

This study aims to identify the benefits and challenges of applying modern technologies in the traditional mining context to positively contribute to the economic growth and sustainable development of the Zone. Moreover, new mining tactics have enhanced operational performance by adhering to resource extraction and management compliance. These innovations enable effective resource extraction, decreased environmental damage, and improved safety.

On the other hand, Flores et al. (2024) also adopt a similar view, arguing for integrating sustainable development in mining methods. This leads not only to positive results in the associations' performance but also enhances their competitive position in the market. Companies may create positive images and improve their financial outcomes by undertaking environmental protection and social responsibility.

1.2 Statement of the Problem

Innovative mining techniques have been regarded as integral and crucial to the performance of the mining business, especially in developing parts of the world. Studies conducted in many areas, including Ethiopia, indicate that productivity and operational efficiency can be enhanced through modern technologies. For example, an investigation by Senbete (2018) found that new mining methods introduced to small-scale mining associations in Ethiopia doubled the output to over 40%. This shows the positive change by going out of the box in conventional mining procedures.

Mining formations in rural areas of Ethiopia implemented better mineral processing technologies. Not only did they enjoy increased outputs, but they also enhanced their market responsiveness, thus helping local economies greatly. Correspondingly, a study by Sanchez et al. (2019) on East African countries showed that technological improvement in mining operations enhanced workers' safety and minimized adverse environmental roles, thus demonstrating the invaluable benefits of innovation in the sector.

However, despite these positive trends noted elsewhere and in other contexts, it is paradoxical that a significant body of literature that focuses solely on the roles of technological change in the Gamo Zone of Southern Ethiopia is in short supply. Most of the current studies are focusing on the general mining issues. However, it is important to explore how local technological innovations in mining could be used by local mining associations to improve and promote sustainable economic growth (Elias & Alemu, 2022).

The gaps mentioned have been addressed owing to the present study, which will look at the prospect of modern mining technologies used locally. It will enumerate the challenges and advantages of technologies used in the local Kamba Woreda. (Sanchez H. 2020) by looking into these factors, the outcomes of this study will enhance efficient decision-making on the part of miners and all those involved in the adoption and integration of innovative mining technologies into business systems. Besides, this study will be mandatory in expanding the knowledge of the mining sector and its role in economic growth.

1.3 Objective of the Study

1.3.1 General Objective

The general objective of this study is to examine the role of innovative mining practices on the performance of the mining sector in Southern Ethiopia, with due consideration to the Gamo Zone of Kamba Woreda.

1.3.2 Specific Objectives

Based on the general objective, the specific objectives are mentioned as follows:-

1. To identify the current innovative techniques employed among mining associations in Kamba Woreda.
2. To assess the role of innovative mining techniques on the performance of Ethiopian mining sectors.
3. To identify the factors that influence the adoption of innovative mining techniques among mining associations in Kamba Woreda.

1.4 Research Questions

This study will focus on the following research questions:

1. What innovative mining techniques are currently being utilized among mining associations in Kamba Woreda?
2. How does the innovative mining technique affect the performance of Ethiopian mining sectors?
3. What factors influence the adoption of innovative mining techniques among mining associations in Kamba Woreda?

1.5 Significance of the Study

This study is intended to present valuable policy options to a considerable number of associations, government institutions, and mining companies operating within the zone. By tackling these different aspects such as infrastructures, technologies, ecological, and financial limitations within the mining sector, the homework will assist in formulating effective measures to advance practices. The particular aim of this study is to develop a clear blueprint that will promote the practice of mining mineral resources most sustainably within the context of Ethiopia. In the end, such a blueprint will reinforce energy security, cut down on greenhouse gas emissions, provide local jobs, and encourage inclusive economic growth. Moreover, the results will contribute to the existing stock of information on the role of advanced mining technologies in the development of the Ethiopian mining sector generally.

1.6 Scope of the Study

This study covers the mining activities in Southern Ethiopia, Gamo Zone Kamba woreda. It includes both small-scale and large-scale mining associations. The innovative practice in mining and its impacts on the performance of the mining sector in operational aspects within Kamba Woreda have been thoroughly assessed. This paper is geographically focused on this area to uncover detailed insights into challenges and opportunities associated with mining innovations in South Ethiopia.

1.7 Limitations of the Study

The interests of the participants of the survey in this study are essential, but this study must also be evaluated on a few limitations:

- Even though the southern part of Ethiopia's population formed sufficient respondents in the study, the sample perspective was enough for the study's objective. However, it may not represent the range of stakeholders in the region's mining, such as small-scale and artisanal miners.
- Self-reported data may be inaccurate due to social pressure, as respondents tended to underestimate or overestimate their level of technology and training received.
- The study was limited to one place: Gamo Zone, Kamba Woreda, and hence, its results are not applicable in other areas of Ethiopia or diverse socioeconomic environments.

1.8 Operational Definitions of Terms

Innovative mining techniques: These are new or improved methods, technologies, and practices used in the mining sector to enhance productivity, reduce environmental impact, and improve safety.

Performance refers to the efficiency, effectiveness, and overall success of the Ethiopian mining sector in terms of output, revenue, employment, and environmental sustainability.

Ethiopian Mining Sector: This refers to the mining sector in Ethiopia, encompassing both small-scale and large-scale mining operations.

1.9 Organization of the Study

This study is divided into five chapters. The first chapter defines the research subject, gives background information, describes the problem, states the objectives, and explains the relevance and scope of this study. The second chapter discusses the available literature on the subject matter, explains the theoretical approaches including relevant models, and reviews empirical works and models that integrate innovative practices in the mining sector with performance measures. In chapter three, the research design is explained; the research population and its sample, the method of gathered data, data processing and analysis techniques, and ethical guidelines are all discussed. Chapter Four emerges and processes the information derived from the study, focusing on the demographic aspect of the information collected and addressing the study questions. The last chapter comprehensively discusses the research findings and the study conclusion, provides suggestions and recommendations to the relevant associations, and further identifies the gaps for future studies to deepen the understanding of the mining sectors.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

INTRODUCTION

Innovative mining methods can enhance the mining sector by increasing resource utilization efficiency, reducing environmental degradation, and improving operational performance. This chapter examines the relevant literature on innovative mining methods and their role in the mining sector, especially in Southern Ethiopia, Gamo Zone Kamba Woreda.

Other researchers have investigated the role of innovative mining methods in other regions with promising results. However, concerns remain regarding the social and environmental roles of such techniques. Therefore, the risks and advantages of different innovative mining methods should be properly ascertained because most of such methods are resource-centered. The regions may be of unlike socio-economic and ecological contexts.

2.1 Theoretical Review

2.1.1 Mineral Resources of Ethiopia

As discussed in the first chapter, Ethiopia has diverse minerals. It is rich in natural resources such as gold, copper, iron ore, coal, gemstones, and industrial minerals. These resources have the potential to secure the advancement of different sectors in Ethiopia, such as mining, manufacturing, and construction industries, as well as serving the needs of the jewelry industry.

2.1.2 Community Engagement and Social Responsibility

Community engagement and social responsibility form the basis for modern mining. Positive relations with local communities involve addressing social impacts and ensuring that mining is ethical as a means of sustainable development. Effective community engagement requires openness in communication, active listening, and responsiveness to community concerns. This can be done through periodic community forums, updates on the status of projects, and details regarding mining operations and safety measures (Gavin & Roy, 2020).

Mining companies must also prioritize social responsibility by investing in community development projects, providing job opportunities, and ensuring the well-being of local populations. By fostering trust and collaboration, companies can navigate the complex terrain of their social responsibilities while ensuring that the natural resources they extract contribute to the well-being of the communities they affect (Hailu & Alemu, 2022).

2.1.3 Issues Related to Mining Sectors

Some aspects of the world economy, like the mining sector, and other business sectors, tend to have worries and churn about several issues. One of the key issues is the cost and availability of minerals monetarily. In addition, the mining sectors faced challenges from various factors including regulation, permits, security, and unavailability of skilled personnel, financial capacity, smuggling, and environmental impact assessment that add cost and risk to mining operations. These are some of the challenges that need to be tackled to sustain the growth and development of Ethiopia's mining sector and tap its maximum potential for the economy.

There are several practical recommendations made by Gavin, H., and Roy, M. (2020) about performance improvement of mining operations and enhancing the practice of responsible and inclusive mining in sub-Saharan Africa. Some of these recommendations include:

i. **Security (Safety):** Mining operations pose the risk of theft, sabotage, and other criminal acts, and they have strong security implications. The authors recommend that as the region seeks to encourage more responsible and inclusive mining, security improvement within the mining area is needed, especially through active community engagement and effective measures to safeguard miners.

   According to Negarit Gazeta (2018), any sector shall ensure employees are well trained and qualified. Furthermore, the industry shall provide safety equipment such as appropriate clothing, safety shoes, protective equipment, and other related safety and health equipment.

ii. **Providing Access to Finance:** The mining sector also faces these issues regarding funding or investment. The authors suggest increasing access to formal financing through grants, loans, or tax benefits to support growth and assure the competitiveness of both large—and small-scale mining operators.

iii. **Expert:** Creating and implementing relevant training programs, which will teach miners about new technologies and practices and enhance their safety and environmental protection practices (Author(s), 2020). Expert issues include the specific knowledge and skills required to be applied within the mining sectors. Southern Ethiopia, mining associations have struggled to hire and retain skilled people in their business such as geologists, engineers, and specialists in environmental science.

Moreover, on Federal Negarit Gazeta. (2018), explains in detail that any license holder can employ a qualified foreign expert only if the license holder provides evidence that the job cannot be done with a local expert alone. In addition, it stated that the hired foreign employee will have enough time to transfer his knowledge to the local employee in this way, the associations or the mining sectors will earn more knowledge and experience.

iv. **Fostering Public-Private Partnerships:** Supporting the efforts of government bodies, mining organizations, and residents to combine their capabilities and resources in furthering inclusive and sustainable approaches to mining.

v. **Associations:** The mining sector is mandatory for associations, especially for job opportunities and economic development. Such companies, for instance, have also been unable to obtain practical, financial, technological, human, and other support that could enable them to scale up and achieve global competitiveness.

Negarit Gazeta (2018).pp10141-10142, identified government assistance only for small-scale and large-scale artisanal miners in identifying mineral deposits, providing technical and administrative support and training, and advising them on treatment, transportation and storage, and market chain.

vi. **Smuggling:** It challenges mining and other sectors regarding revenue loss, safety, legal issues, and loss of face. The next steps must be to combat smuggling and promote responsible mining practices for a sustainable future. Illegal mining poses a threat to modern practices, especially in remote areas. Ensuring compliance with regulations and raising awareness among local communities about the benefits of legal mining is crucial. The government should prioritize outreach programs to empower communities to make informed decisions.

vii. Infrastructure: Theron and Volk (2016) analyzed and emphasized the importance of resilient infrastructure development in the mining industry. Infrastructure is needed to extract resources efficiently and effectively. It will also help reduce mining's environmental impact. Therefore, by investing in modern, sustainable infrastructure, associations can enhance their operational capabilities.

As stated in the newspaper Federal Negarit Gazeta (2018), regarding the rules and regulations of mining institutes in Southern Ethiopia, the license owner may construct the infrastructure necessary for the mining operation. Infrastructure and other facilities to be built by the license holder must conform to appropriate designs and technical standards to assure their safety and efficient use.

2.2 Empirical Review

2.2.1 Lack of Innovation in the Mining Sector

The lack of innovation in mining projects is discussed as found in the literature as follows:

2.2.1.1 Lack of New Product Development

According to PwC (2016), a mine that lacks innovation will have high extraction costs and face challenges in reaching new mineral deposits compared to a mine employing high technological innovation. As discussed in the theoretical review, several factors are crucial for the effective and efficient extraction of minerals in Ethiopia's mining sector. In particular, deep expertise, availability of capital, assurance, and legal frameworks are the relevant elements that enable inventiveness within the industry.

The research discovered that the absence of financial support, technical personnel, and change embrace are the main factors that make mining projects achieve little regarding innovation. Without a clear view of the likely economic benefits of innovation, there

will likely be little investment and focus on the innovative aspects of mining projects. Consequently, the lack of innovation leads to the absence of new services and products, ineffective competition, low profitability, and contraction in growth in the mining role.

2.2.1.2 Reduced Efficiency

Chow (2007) and EY, 2014, as referenced in Takalani N. & Malekana, L. (2023), insist that managing mining projects with the aim of innovation is mandatory for success. Based on Chow (2007), without innovation at the heart of a firm's strategy, that firm will always be a follower in the industry and stagnate in growth and profitability. Furthermore, without innovation, mines experience reduced productivity, a lack of new products, no competitive edge, and less profitability. This results in limited growth in mining projects. EY (2014) adds that project sustainability cannot be achieved if mines fail to reduce operational costs to remain profitable.

Chow (2016) goes one step further to clarify that if the project operation cannot realize a return on mining investment throughout its life, then there is little or no potential for the growth of that mine. This has the possibility of reducing the operational efficiency of the mine and increasing its cost of production without new ideas introduced in the mining projects. This can cause reduced profitability for mining sectors and hinder their ability to compete in the global market. When we saw the Southern Ethiopia mining sector, they traditionally extracted mines only using a labor force that caused rework, mining waste, time waste, labor cost waste, and no quality nor quantity mines were mined.

2.2.1.3 Safety

The use of artisanal mining techniques can be dangerous and result in mishaps, injuries, and even death. The mining industry may not think of creative solutions to safety problems. Furthermore, mining without safety equipment puts employees in danger resulting in legal suits, and damage to one's reputation. The authors stress the importance of prioritizing safety in mining operations to protect surrounding communities and workers from potential hazards. Implementing and adhering to stringent safety protocols lowers the likelihood of accidents and fosters an industry-wide culture of accountability and responsibility, the two, in particular, improve overall safety outcomes (Theron and Volk, 2016).

2.2.1.4 Environmental Impacts

Theron and Volk (2016) uphold the need for the impact assessment of mining activities on the environment. These approaches are important in formulating ways that protect the local population and the environment. Due to increasing regulatory pressure, mining companies have to place environmental stewardship at the center of their operations to maintain their social license to operate.

2.2.2 Innovation in the Mining Sector

2.2.2.1 Overcoming Challenges

According to a study by Sanchez F. and Hartlieb P. (cited in the Author (s), 2020), the mining sector has recently faced major operational challenges. To overcome natural challenges such as declining ore grades, deeper deposits, and harder rock formations while addressing growing environmental and social concerns, the industry has been compelled to improve its processes throughout the entire value chain continuously. Innovation has become indispensable in providing suitable solutions to overcome these difficulties, thereby ensuring the longevity and sustainability of mining activities.

2.2.2.2 Sustainability

(Sanchez F. & Hartlieb P's) the study (cited by the Author(s), 2020) affirmed that innovation is mandatory in the mining business as it provides a solution to enhance process efficiency, lower costs, and mitigate the increasing social and environmental concerns sustained by communities and authorities. It has also aided the development of new deposits in difficult conditions such as low grade, extreme temperature, deposit depth, hard rock, and stress factors.

2.2.2.3 Waste Prevention

In the years to come, environmental sustainability will be one of the trends that will greatly influence the technologies used in mining. Waste management and energy consumption are significant constituent elements of sustainable development. As important to minimize the environmental impact of mining operations, the authors underline the adoption of integrated waste management approaches. Theron and Volk (2016) find that the waste minimization approach enhances the effective use of materials and other resources and promotes minimal toxicity levels and waste generation. By adopting the waste prevention technique for operational resources, the

mining sector can promote the sustainability of the business while improving the efficiency of the operations.

I. Waste Management

In ore treatment, grinding and adding water and chemicals often treat ores. So, most of the waste generated in the treatment is moved from the plant as a slurry, which returns excess water to the plant. Some of the waste materials and tailing are most often deposited anywhere. They include but are not limited to, pond storage, dry stacking, underwater dumping, or even ocean deposition. In this case, adequate care is also required to select the technique (Theron and Volk, 2016).

II. Overburden Management

Theron and Volk (2016) provide perspectives on the latest trends and more effective methods of handling overburden, which is material that must be taken to reach the ore. They suggest that improving technologies in overburden management not only lessens the extent of physical disturbance or ecological effects that result from mining activity but also encourages the restoration of excavated landscapes. By using best practices in overburden handling, mining operations can better align with environmental sustainability goals.

Effective overburden management means reintroducing the overburden material into the worked-out sections of the mine. Overburdens are often vegetated with trees to increase the soil's pH, moisture, and nutrient content. A new pit should be mechanically excavated only after the current depleted pit has been fully utilized. Proper stacking and machine compaction should be done on the overburden dumps, and the height and slope of the dump should be controlled to avoid accidents. Catchment management is also important in preventing flooding due to heavy rains.

III. Recycling

Theron and Volk (2016) also point out the necessity of integrating recycling practices within the mining scope of operations. They argue that recycling is deliberate not only in recovering useful substances but also in 'lessening the strive to obtain new resources, the process of which may be quite destructive to the environment'. Mining firms can do more to promote a greener industry, such as adopting "circular economy" practices in the mining sector.

There exist possibilities for recycling waste materials in the mining sector. More minerals can be recovered through re-processing or the materials can be used for construction purposes at the site. Waste from mines is also utilized in the provision of embankments, and construction of haul roads. Some tailing wastes can be used as granular base and sub-base, as an engineered fill in embankments, or as aggregates in asphalt, which helps in conserving resources greatly (Theron and Volk, 2016).

IV. Safety in Mining Operation

Encouraging investment in research and development to identify and implement innovative technologies and practices that can improve the safety, environmental sustainability, and social impact of mining operations (Hilson and Maconachie, 2020). In Kamba woreda, safety is a paramount concern in the mining industry, where the inherent risks associated with operations can lead to severe injuries, fatalities, and detrimental environmental impacts if not properly managed. To improve safety and risk management measures, mining sectors should practice safety management rather than wait until an accident occurs. The following picture illustrates the mining practices in Kamba woreda mining without any protective equipment:

Image 2.2.2.1: Source Kamba Woreda active mining site (2024)

To conclude, it is important to state that safety measures in mining operations are not only undertaken to protect workers and communities but also to benefit the overall viability and profitability of the mining ventures. Emphasizing education, technology, and management best practices, the mining sector has excellent potential to achieve a much safer working environment and significantly prevent accidents and injuries.

2.2.3 Artisanal Mining

Wakiaga, J., & Gankhuyag, U. (2024, April 29) laments that the “orphans” of the mining industry are Artisanal and ASM. According to the global mining industry, artisanal mining is likely a ‘surviving sector’. Even some governments regard it as such. Nonetheless, more than 40 million artisanal miners work in mines worldwide and support their communities. Their work contributes to meeting the increasing demand for minerals used in everything from buildings and roads to solar panels, batteries, and smartphones.

Small-scale or artisanal miners make up eight or nine out of ten mining workers. Artisanal mining is the second or third largest occupation in many developing nations, especially in Africa, behind retail trade and agriculture. Compared to subsistence farmers, artisanal miners are thought to earn more money. Artisanal miners are increasingly extracting so-called "critical minerals." Due to the lack of exploration in the world and severe resource shortages, their contribution is noteworthy. As an illustration, cobalt, tungsten, tin, tantalum, and copper are mined in Zambia. Because of their in-depth familiarity with the area, artisanal miners frequently rely on local knowledge and are the first to find precious minerals, making them the "native geologists “Wakiaga, J., & Gankhuyag, U. (2024, April 29).

Artisan miners have the same challenges and problems all over the world. Southern Ethiopian small miners are also mining by labor force and will somehow contribute to the country's economy. However, artisanal miners are oppressed, stuck in hazardous informal mines, and constantly suffering from health problems, accidents, and health risks. Additionally, surrounding communities experience the severe negative impacts that mining activities have on the environment such as loss of forests, loss of biodiversity, pollution, disruption of aquatic ecosystems, and soil degradation.

Image 2.2.3.2： Source Kamba Zuria woreda active mining site (2024).

2.2.4 Gaps and Arguments

It is possible to expect great positive changes in implementing the mining sector activities, as these will probably become more efficient, cost-effective, and environmentally friendly. Nonetheless, several prerequisites have to be satisfied for these advantages to be fully enjoyed. These include the lack of infrastructure, environmental issues, and a disparity between the maximal development of the industries and their current development.

For the mining sector to overcome these obstacles there is a need to prioritize investments in modernization and embrace emerging technologies, innovations, and business models. For example, Hilson & Maconachie (2020) mention a gap in the infrastructural development required to enhance innovation and growth of artisanal and small-scale mining within South –Sahara Africa. They argue that improving infrastructure would favor the mining sector by promoting enhanced innovative sustainable and competitive practices.

In the same line of thought, the results obtained by Author(s) (2020), also bring to light, another gap, which is the disconnection between the existing needs of the mining industry and the existing demands for inventiveness. They claim that failure to adopt inventiveness in the sector will only lead to failure in resolving pertinent controversies concerning the environment and improvement in the health and safety of the operations. Transforming business models and integrating new technologies, help the mining sector to overcome such challenges and hence perform better.

Yihdego et al. (2018) also observe the wide performance gap between the potential contribution of the Ethiopian mining sector and the realized output. Rich in mineral resources, the mining sectors in Ethiopia struggle with poor infrastructure and the environment, as well as limited investment. Solving these problems by initiating appropriate investments in innovations would assist the industry in achieving its fullest potential.

2.3 Conceptual Framework

The conceptual framework serves as a starting point for analyzing the role of innovative mining practices in the performance of the Ethiopian mining sector. Using Gamo zone, Kamba woreda as a case study for this thesis, this study aims to understand how the adoption of innovation influences performance parameters. This framework guides the examination of the impact of innovative practices on the sector's mining performance.

Key Components of the Conceptual Framework:

1. Innovative Mining Techniques: Innovative mining practices include new or improved approaches, technologies, and training and development, which are used to optimize mining operations, minimize the ecological footprint, and maximize safety in mining activities. Specifically; Automation, digitalization, sophisticated waste recovery technologies, and environmental sustainability principles.

2. Performance Metrics: This section deals with various criteria used to measure the efficiency and effectiveness of mining operations.

Key Indicators include-

- ✧ Productivity: Presented as a measure of output per worker or output per unit of the amount of resources used.
- ✧ Environmental Sustainability: Estimation of the ecological footprint of mining operations, in particular waste generation and resource efficiency.
- ✧ Expertise: investing in time and money to enhance employee skills.
- ✧ Operational safety: minimizing accidents

3. Influencing Factors:

- ✓ External Factors: Regulatory environment, socio-economic factors, access to technology, and market conditions.
- ✓ Internal Factors: Organizational culture, management practice, workforce skills, and financial strength.

Innovations are expected to lead to different results with:

- ✧ Better operational efficiency and productivity.
- ✧ Better care of the environment and truer sustainability.
- ✧ Better health and safety for workers.
- ✧ More competitiveness in national and international markets.

4. Feedback loop: The framework works on a feedback loop, where better performance not only sustains the commitment to innovative practices but also attracts further investments, which then allow for further innovations.

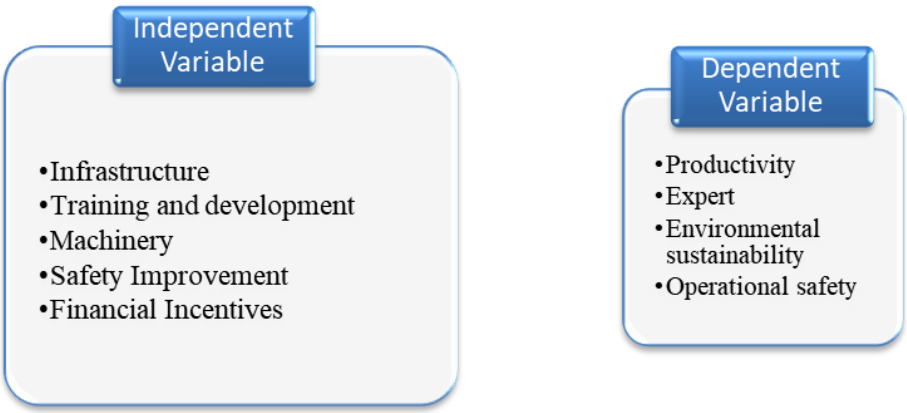

Figure 2.3.1: Dependent and independent variables

CHAPTER THREE

RESEARCH METHODOLOGY

INTRODUCTION

This chapter outlines the research methodology. It will clearly define the research approach, design, data sources, data collection instruments, the population to be studied, the sampling method, the variables to be measured, data analysis, validity and reliability of the research findings, and ethical considerations.

This study employed a concurrent mixed-approach tool to analyze the role of innovative mining practices in the mining sector. The concentration was directed at mining activities in Southern Ethiopia, a major mining district endowed with rich mineral resources and considerable mining activities. The analysis seeks to assess the contribution innovation in mining methods and technologies will have in increasing productivity, reducing costs, and preserving the environment.

3.1 Research approach

A concurrent mixed approach has been implemented to achieve the study's objectives. This approach will use structured questionnaires as the focal point in the data acquisition process. It seeks to offer an exact understanding of the roles of innovative mining techniques introduced on the different Southern mining performance indicators.

3.2 Research design

The study employed a QUAL + quan design the mixed research approach. This design allows us to understand the extent to which inventiveness in mining has changed the performance indicators of the sectors.

3.3 Population and Sampling

3.3.1 Population

The population for this study consists of sectors operating in Southern Ethiopia Kamba woreda, including five associations with 50 employees and 10 government bodies.

Table 3.3.1.1: Total Population of the Study

S/N	Population Group	Description	Number of participants
1	Mining Sectors	Associations and companies in Kamba Woreda	50
2	Government Agencies	Regulatory bodies and agencies involved in mining	10
Total Participants			**60**

Source: Own survey 2024

3.3.2 Sample Size & Techniques

The research employed a non-probability sampling method to draw a sample from the population. Purposive sampling was employed to ensure that participants had relevant experience and knowledge of innovative mining practices.

Apart from the employees, the population comprises 10 government institutions and regulatory authorities regarding the mining industry. It will also include representatives of the local communities, particularly those who suffered from mining activities. This variety of groups will allow for a better representation of the modern practices and adaptations in the mining sector in the southern part of Ethiopia.

3.4 Sources of Data

Cooper and Schindler (2008) categorize the data as primary, which is available with a purpose or objective set out in the research project, and secondary data, which has been obtained or sourced out by somebody else. To achieve the aims and objectives of the study more elaborately, the researcher employed both data sources, sourcing additional secondary data from the journals and articles.

Structured surveys, interviews, and observations will form the data sources for this study. Key members like mining company managers, government officials, and sector practitioners have been handed surveys with some quantitative questions generalizing the perception of the company's performance regarding the new practices in the sectors. Furthermore, such stakeholders have been interviewed to provide qualitative perspectives on their innovative experiences in the mining practice. In addition, observations have been carried out at mining locations to evaluate the application of relevant technologies and robotics processes.

3.5 Data Collection Tools

Ngechu (2004) notes that different procedures are employed when gathering information and the selection of tools depends on the respondents, topic, objectives, and expected study results. In the case of this study, we have used a questionnaire.

3.6 Measurement of Variables

To ensure comprehensive data collection, 24 questionnaire items have been grouped into five sections with the aim of mandatory variables that are independent and dependent being measured which is critical as far as the objectives of this study are concerned. This created a conducive setting for addressing the research questions on the role of innovative practices in the mining sector on the performance index. Five questions were adopted from the paper of Y. Yihdego et al. (2018) on adopting innovative technologies that targeted the industry in the Gamo Zone in South Ethiopia. In particular, five questions focused on how mining has influenced the local economies and the environment adopted from Senbete, A. (2018), and 5 questions focused on the contextual challenge and additional insights.

The remaining questions included a more general one aimed at covering the overview of the current mining practices and techniques employed for extracting and a policy-related one intended to evaluate the form of the existing policy. On the other hand, contextual questions will consider the development of the mining sector concerning other socio-political and economic factors in the region of South Ethiopia. This organized method seeks to develop practical solutions for the policymakers and other stakeholders in the sector.

3.6.1 Measurement of Independent Variables

The independent variables in this study encompass implementing innovative mining technology and processes: machinery, training and development, infrastructure, safety improvement, financial incentives, and waste management. These variables were assessed through survey questions. The present study focused on emerging technological trends such as automation, data analysis, and sustainable mining practices with transformation and operational efficiency effects (Sanchez & Hartlieb, 2020).

3.6.2 Measurement of Dependent Variable

The dependent variables for this study included several performance metrics, particularly the focus on revenue, expertise, environmental sustainability, operational safety, and productivity. These performance metrics have been measured through the mining sector's survey questions. This study will look into the problems experienced in the mining sector as it seeks to embrace innovations. Those problems may include resistance to change, difficulty re-skilling employees, and integration of new technologies. Such problems can be focal points to the sector's inventiveness and competitive advantage (Sanchez & Hartlieb, 2020).

3.7 Data Analysis

The data collected were analyzed using descriptive statistics, while some ideas were explored as themes. The respondents' data has been summarized and described using descriptive statistics. Thematic analysis dealt with some of the key patterns or trends of the qualitative data. Sanchez and Hartlieb (2020) stress that appropriate data analytics is critical for resource estimation consistent with sustainability by assessing environmental impacts and efforts to reduce the ecological footprint.

3.8 Questionnaire

The questionnaire has been developed to determine the influence of innovative mining technologies on the performance of the mining sector around Gamo Zone, Kamba Woreda in Southern Ethiopia. Other areas covered by the questionnaire include demographic characteristics, existing mining operations, innovative technologies, and their degree of diffusion and challenges to be embraced. In addition, it examines the role of these changes in such performance indicators as revenue, profitability, productivity, and ecological well-being while collecting data about possible technological changes together with the level of assistance from the government or international agencies. Lastly, there is a section that is not restricted that invites the participants to give further clarifications or comments, the questionnaire was targeted at a wider group including managers of the mining firms, personnel of the government, and other industry experts to be able to obtain enough qualitative and quantitative data.

3.9 Ethical Considerations

Permission for the study was obtained from St. Mary's University, student support office. Ethical issues were addressed by informed consent from the respondents, ensuring that they were fully aware of the study's purpose, procedures, and their right to withdraw at any time without consequences. Protecting the collected information was ensured in compliance with the relevant moral principles and requirements. Confidentiality was prioritized, and all data were anonymized to protect the identities of the participants.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS, AND INTERPRETATION

INTRODUCTION

This chapter presents the findings from the study that focused on the research question and assessed the impact of modern practices implemented in the mining sector in Ethiopia relative to its performance. The collected data has illustrated to inform the respondents of the expectations over interest in performance in the context of technological innovations and performance. The chapter approach includes response rates, the locations and basic demographic characteristics of the respondents, and descriptive results.

4.1. Response Rate

The study distributed 55 questionnaires, and all 55 have returned. This is quite encouraging because it represents a 100 percent response rate. Given that such a high proportion of the stakeholders within the mining sector responded, one can expect the findings to mirror the sentiments of the sector's stakeholders accurately.

4.1.1 Demographic Characteristics of Respondents

The characteristics of the respondents were analyzed based on demographic variables such as sex, age, level of education, years of experience within the mining industry, and the respondent's organization. The demographic data shows that a wide range of respondents participated in the research, which further improves the findings since different backgrounds, experiences, and organizational types are employed.

4.1.1.1 Gender

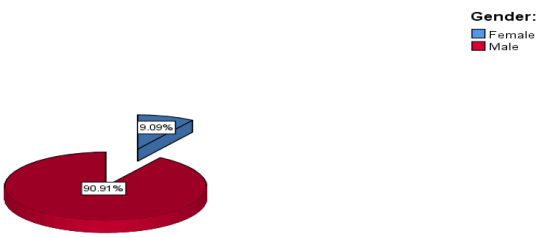

Figure 4.1.1.1.2: The gender rate of respondents

Figure 4.1.1.1.2 shows the survey results. Approximately 90.91% of respondents were male, whereas 9.09% identified themselves as female, showing that there were strong male respondents. As can be seen, the representation of women in the survey is low.

4.1.1.2 Age

Table 4.1.1.2. *The age rate of respondents.*

Age:					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	20-30 years	28	50.9	50.9	50.9
	31-40 years	23	41.8	41.8	92.7
	Above 50 years	4	7.3	7.3	100.0
	Total	**55**	**100.0**	**100.0**	

Source: Researcher's computation with SPSS 25

Table 4.1.1.2 shows a survey attracted many young adults as a majority 50.9% of the respondents were between the ages group of 20 to 30. Based on the results it can also be assumed that the representation of middle-aged adults ranging between 31 to 40 is significant as 41.8% of the respondents. However, older adults aged 50 and over who participated in the survey were only 7.3% of the total respondents indicating a lesser representation of older adults within the respondent pool.

4.1.1.3 Educational Background

Table 4.1.1.3: The respondent's educational level (1)

Educational Level (Please specify your highest level of education attained):					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	N.B: Table 3.1	19	34.5	34.5	34.5
	BSC	12	21.8	21.8	56.4
	Certificate	13	23.6	23.6	80.0
	Diploma	5	9.1	9.1	89.1
	MSC	6	10.9	10.9	100.0
	Total	55	100.0	100.0	

Source: Researcher's computation with SPSS 25

Tables 4.1.1.3 form a broad picture of the level of education varsities of the respondents ensuring there is no overlap in responses. Of the respondents, 65.5% responded to having attained their highest education as follows: 21.8%, which was a bachelor's degree (BSC) holder, reflected a higher education attainment. Additionally, 23.6% held certificates meaning they had undergone vocational or technical education training. Relevantly significant percentages also held diplomas 9.1% and master's degrees 10.9% showing a presence of advanced education.

Table 4.1.1.4: Respondents education level (2)

Other please specify:					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	N.B: Table 3	36	65.5	65.5	65.5
	Elementary	2	3.6	3.6	69.1
	High-school completed	8	14.5	14.5	83.6
	Not educated	8	14.5	14.5	98.2
	Society representative	1	1.8	1.8	100.0
	Total	**55**	**100.0**	**100.0**	

Source: Researcher's computation with SPSS 25

On the other hand, Table 4.1.1.4 covers the remaining respondents 34.5%, indicating that 3.6 % completed elementary education, 14.5 % responded completing secondary education, an equal percentage was reported as members of the non-formal educational category, and 1.8 % of society representative. Overall, these tables highlight the range of education received among the respondents, where some had no education at all while some had reached higher than postgraduate level.

4.1.1.4 Working Experience

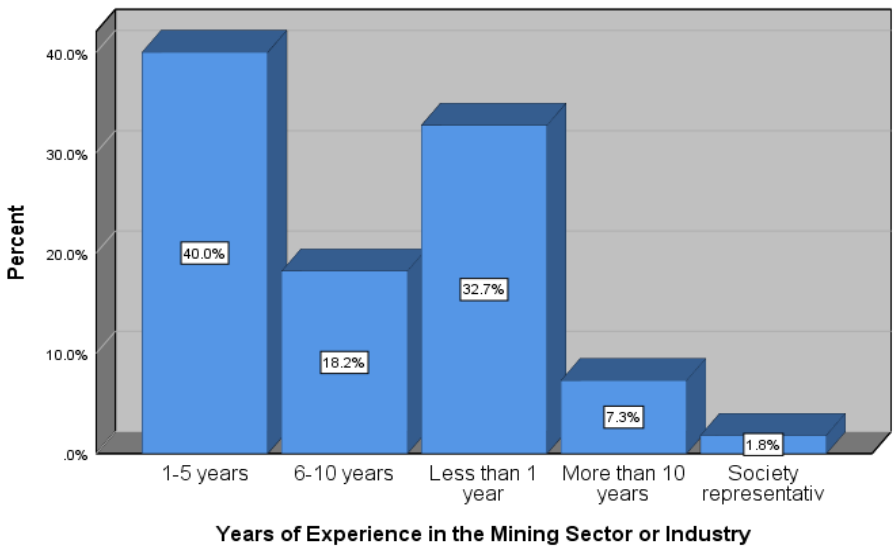

Figure 4.1.1.3: Respondent's years of experience in the mining sector (industry).

Defining the problem for further research, the relatively high percentage (40.0% per figure 4.1.1.3) of respondents with less than 5 years of experience indicates a lack of training and development opportunities to widen these individuals' skills and

knowledge base. A small percentage (7.3%) of the respondents who have more than 10 years of experience also proves that there is a certain level of experience in the working population.

4.1.1.5 Organizational Information

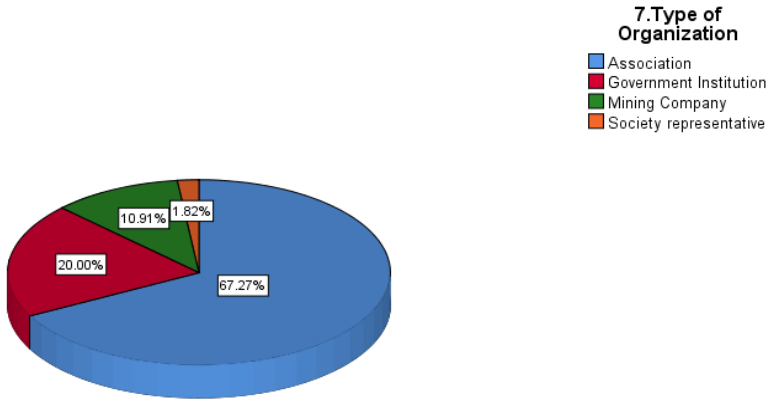

Figure 4.1.1.4: Respondents' organizational information

Based on the above figure 4.1.1.4, most respondents (67.27%) belong to associations, suggesting a good representation of these groups in the survey. One-fifth (20.0%) of respondents were government institutions, indicating much interest from public sector entities. Mining companies (10.91%) and 1.82 % society preventative are also present, showing society's involvement.

Number of employees

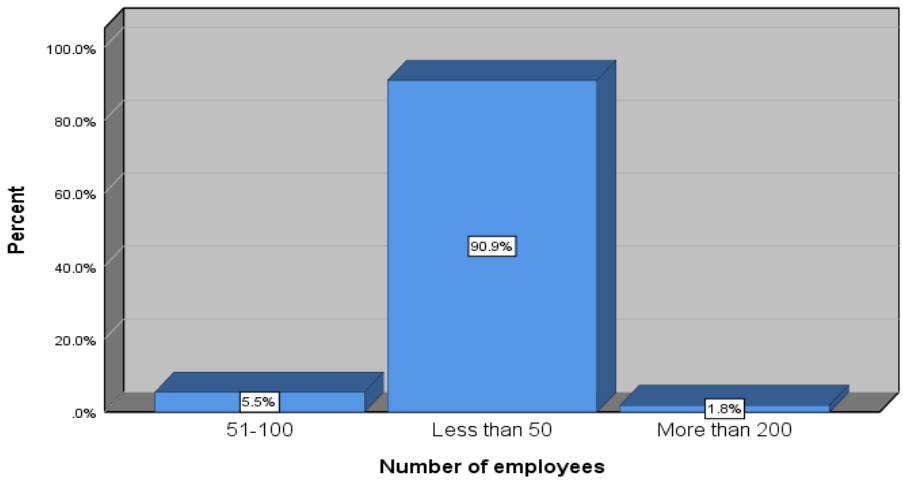

Figure 4.1.1.5: Number of employees in the firm

Figure 4.1.1.5 implies that most respondents (90.9%) indicated that their organizations have fewer than 50 employees. This highlights that the sector is predominantly

composed of small-sized sectors. The other small portion (1.8%) of organizations have more than 200 employees, indicating the rarity of large-scale operations within the surveyed group. In addition, 5.5% of organizations have highlighted having 50 to 100 employees, suggesting that medium-sized organizations are relatively uncommon in the industry.

Table 4.1.1.5: Respondents' position in the firm.

Position / Title :					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Cashier	1	1.8	1.8	1.8
	Coordinator XYZ	2	3.6	3.6	5.5
	Enterprises organizing expert	1	1.8	1.8	7.3
	General Manager	1	1.8	1.8	9.1
	Irrigation Engineer	1	1.8	1.8	10.9
	Mines	1	1.8	1.8	12.7
	Mining directorate	2	3.6	3.6	16.4
	Mining expert	2	3.6	3.6	20.0
	Owner	5	9.1	9.1	29.1
	Planning Department	1	1.8	1.8	30.9
	Researcher	2	3.6	3.6	34.5
	Society representative	1	1.8	1.8	36.4
	Stakeholder	35	63.6	63.6	100.0
	Total	**55**	**100.0**	**100.0**	

Source: Researcher's computation with SPSS 25

- **Predominant Role—Stakeholder**: Table 4.1.1.5 shows that the majority (63.6%) of respondents occupied the position of "Stakeholder," which means that there are a large number of people who take part in or have an interest in different aspects of the mining associations, which is a bit crowded for the sector.
- **Diverse Role:** Besides the stakeholders, Table 4.1.1.5 shows many other positions, such as the coordinators, general managers, and employees of the mining directorate, each contributing to a small portion of the total responses.
- **Ownership and Management:** This shows the dominance of leadership and ownership roles, as 10.9% of the respondents marked themselves as either owners or general managers. This portrays a good setting for an organization or company.

- **Specialized Roles:** Other roles, such as mining expert, enterprise expert, or, researcher appear to be more specialized but were filled by individual respondents reflecting the diversity of respondents within the sector.

4.2 Current Innovative Techniques and Extracting Practices

4.2.1 Machinery

The study assessed the current mining activities and the level of technology use among the respondents. The findings also note that most people point out the lack of funds as a critical impediment to the embracing of modern mining technologies.

Supporting the QUAN + qual data, one of the respondents reflects on the machinery used during mining extraction:

> "Using small-scale methods to extract valuable minerals (Labor force) and animal transportation, such as donkeys".

Table 4.2.6: Current mining operations and extraction practices.

Please describe your organization's current mining operations and extraction practices:					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		4	7.3	7.3	7.3
	First, we do Exploration, finding, and testing then sorting out the minerals based on their quality. Then finally, we will supply to the needy local and foreign markets.	2	3.6	3.6	10.9
	Geological Mapping, Geophysical Mapping, Geochemical mapping, Mineral Exploration, GIS and Remote sensing, Drilling, Reserve estimation	1	1.8	1.8	12.7
	Geological mapping, Mineral exploration	1	1.8	1.8	14.5
	Giving mining license	1	1.8	1.8	16.4
	In the field of mining, industrial mining, construction inputs, and gemstones are available.	2	3.6	3.6	20.0
	My organization is a Regulatory body	1	1.8	1.8	21.8
	Society representative	1	1.8	1.8	23.6
	Using Small scale to extract valuable minerals and other geological materials	1	1.8	1.8	25.5
	Using small-scale methods to extract valuable minerals (Labor force) and animal transportation, such as donkeys.	31	56.4	56.4	81.8
	We are starting to know	2	3.6	3.6	85.5
	We are working in the rain to extract sand out of the water.	2	3.6	3.6	89.1
	We do not work at this time because it is a rainy season that makes it slippery, and we need to dig more than 4 meters.	6	10.9	10.9	100.0
	Total	**55**	**100.0**	**100.0**	

Source: Researcher's computation with SPSS 25

Table 4.2.6 summarizes the current mining operations and the extraction techniques employed by the respondents. The majority (56.4% use these small-scale methods based on human labor and animal power, e.g., donkeys). A minority 3.6% practice exploration and testing, and 1.8% apply sophisticated techniques such as geological and geophysical mapping. Additionally, a few respondents (1.8% additional administrative e.g., mining license authorities and representatives of the regulatory agency or society). Mining industries, including construction mining and gem mining, are practiced by 3.6% of respondents. Seasonal changes significantly affect operations, with 10.9% unable to work during the rainy season due to slippery conditions. Active operations are underway, with 3.6% of companies operating in the early stage, and 3.6% operating in wet conditions to extract sand from water. This will highlight the importance of adapted strategies to assist different mining activities and improve efficiency and safety in the industry.

This table prioritizes the significant role of small-scale and labor-intensive extraction in the sector. It also underscores the need for interventions and support mechanisms that can maximize the effectiveness and safety of these procedures while accounting for their similarities, differences, and special considerations.

Table 4.2.7: The data of organizations that implement mining technologies (1)

Have you implemented any innovative mining technologies in your operations?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	52	94.5	94.5	94.5
	Yes	3	5.5	5.5	100.0
	Total	**55**	**100.0**	**100.0**	

Source: Researcher's computation with SPSS 25

The tables reveal that 94.5% of the respondents have not yet introduced advanced mining technologies in their operations, revealing a large technology adoption gap of the new technologies within the sector. Only 5.5 of the respondents reported adoption of innovative technologies. Only a handful of people have sought to do so, e.g., by deploying an excavator with a jacamar and dam truck, and by employing equipment from the mines department.

Table 4.2.8: The data of organizations who implement mining technologies (2)

If yes, please specify					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		52	94.5	94.5	94.5
	Excavator with jacamar, truck.	1	1.8	1.8	96.4
	Improved productivity, enhanced safety, and substantial cost savings are benefits technology brings to the mining industry. In the next few years, mining companies will need to adopt this technology into their processes to stay competitive and meet the growing demands for sustainability and efficiency	1	1.8	1.8	98.2
	using mine department equipment	1	1.8	1.8	100.0
	Total	**55**	**100.0**	**100.0**	

Source: Researcher's computation with SPSS 25

Supporting the QUAN + qual data, one of the respondents reflected on his idea regarding mining technologies as follows:

> *"Improved productivity, enhanced safety, and substantial cost savings are benefits technology brings to the mining industry. In the next few years, mining companies will need to adopt this technology into their processes to stay competitive and meet the growing demands for sustainability and efficiency (researcher's computation with participant C, 2024)."*

This all underscores the necessity for broader adoption and integration of innovative technologies to bring both the efficiency and competitiveness of the mining industry to a new level.

4.3 Impact of Innovative Mining Techniques on Performance

Table 4.3.9: Organizations overall roles of innovative mining practices

In your opinion, what have the overall roles of innovative mining practices been in local communities?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-	1	1.8	1.8	1.8
	Misunderstandings in mining arise due to a lack of knowledge about its value and types. This leads to improper storage of valuable materials like steam coal and quartz. Mining associations often lack skills and struggle financially since the government does not provide startup funds. Consequently, they face difficulties and may halt their work. Essential support includes providing shade, equipment, and daily expenses for laborers.	1	1.8	1.8	3.6
	I do not know	1	1.8	1.8	5.5
	Innovative mining practices can create jobs, improve infrastructure, and provide materials for construction. For example, portable drilling rigs can be transported to remote areas, which can provide jobs for locals and reduce the need for truck transportation.	1	1.8	1.8	7.3
	Innovative mining practices have mixed effects on local communities, with both positive and negative effects. Positive effects include increased employment and income, environmental improvements, community development, and skill development. Negative effects include displacement, social disruption, economic inequality, ecological risks, and dependence on mining. Large-scale technologies can reduce manual labor, limit job opportunities, and increase wealth gaps. Additionally, accidental failures can have catastrophic effects on local environments.	1	1.8	1.8	9.1
	It did not have any effect.	2	3.6	3.6	12.7
	Mining processes can also harm the surrounding environment by destroying land and biodiversity, creating toxic chemicals, and polluting water and air.	1	1.8	1.8	14.5
	We do not use any machinery but It has destroyed nearby postage and deforestation.	47	85.5	85.5	100.0
	Total	**55**	**100.0**	**100.0**	

Source: Researcher's computation with SPSS 25

Table 4.3.9 shows a descriptive analysis of the assessed overall role of innovative mining practices in local communities. The findings reveal a broad range of views, highlighting positive and negative effects. Supporting the QUAN + qual data, one respondent highlighted the role of innovative mining practices for the communities as follows:

> *"We do not use any machinery but it has destroyed nearby postage and deforestation (researchers' computation with participant H, 2024)."*

The respondent points to a diverse range of views on the role of innovative mining practices in local communities. Significant concerns about environmental degradation and the lack of support for artisanal miners, alongside potential benefits, including job creation and infrastructure improvements, are highlighted. All this underscores a careful consideration of the best way to introduce innovative mining practices, taking advantage of the positive and negative roles of nearby populations.

Table 4.3.10: Observed socio-economic benefits in the society.

Please provide examples of socio-economic benefits observed in local communities due to your organization's practices.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Hiring local workers boosts employment, along with partnerships with local businesses, enhances economic activity, and strengthens supply chains. Training programs and scholarships equip locals with valuable skills and improve access to education; enhancing employability and helping youth enter the digital economy.	1	1.8	1.8	1.8
	Since I began working here, we have been fortunate that the agate mines are located on soft earth, saving labor and energy. When mining begins, I provide advance payments to cover initial needs, which are later deducted from sales. Associations typically last 6 months to a year, during which they profit and establish their business. Additionally, I pay a 6% royalty fee to the woreda.	1	1.8	1.8	3.6
	A living wage shapes opportunities for housing, education, childcare, food, and medical care.	3	5.5	5.5	9.1
	Organized youths will change themselves; they will get job opportunities, they will not spend their time in bad habits, and they will pay royalties to the government.	46	83.6	83.6	92.7
	People have the experience of working together in association and the knowledge and wealth of mineral resources.	3	5.5	5.5	98.2
	There is not that much effect on the ground	1	1.8	1.8	100.0
	Total	**55**	**100.0**	**100.0**	

Source: Researcher's computation with SPSS 25

Table 4.3.10 highlights various socio-economic benefits observed in local communities due to organizational practices: Job creation and economic growth, education, and skill development, economic opportunities for small miners, a living wage, and youth empowerment. Supporting the QUAL + quan data, the majority of respondents stated about socio-economic benefits as follows:

> *"Organized youths will change themselves; they will get job opportunities, they will not spend their time in bad habits, and they will pay royalties to the government (Researchers computation with participant D, 2024)."*

In brief, the table shows that the majority of socio-economic benefits originate from jobs (creating, activating youth, and establishing community) and youth empowerment. These benefits are of great economic and social value in its local community, although a minority of respondents reported limited impacts of these practices.

Table 4.3.11: Measures taken to enhance environmental sustainability.

What measures has your organization taken to enhance environmental sustainability in its mining operations?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		1	1.8	1.8	1.8
	Implementing certified environmental management systems like ISO 14001 helps track, manage, and mitigate environmental impacts. We use advanced planning and technology to minimize land disturbance, and we implement progressive reclamation to restore ecosystems during ongoing mining operations, rather than waiting until mining ceases.	1	1.8	1.8	3.6
	Actions will be taken to make sustainable improvements to the area by supporting road works and education projects in the development sector.	4	7.3	7.3	10.9
	Environmental impact assessment procedures have been taken on	1	1.8	1.8	12.7
	Improving the health and well-being of workers, prioritizing the needs of local people, and increasing the overall efficiency of day-to-day processes.	1	1.8	1.8	14.5
	It has a gap we see on the ground	1	1.8	1.8	16.4
	Nothing	13	23.6	23.6	40.0
	The industrial minerals industry is striving to use the world's resources as efficiently and responsibly as possible by employing smarter production methods, optimizing the use of mineral deposits, reducing water consumption, and exploring ways to create a more sustainable and circular value chain.	1	1.8	1.8	41.8
	We are paying 6% of the royalty fee for the woreda.	1	1.8	1.8	43.6
	We have controlled illegal mining transfers, prevented soil erosion, and done post-mining terrace work.	26	47.3	47.3	90.9
	When the existing association contract time is over, we will reorganize the new association. The old one will start another business.	5	9.1	9.1	100.0
	Total	**55**	**100.0**	**100.0**	

Source: Researcher's computation with SPSS 25

Table 4.3.11 provides information on the actions being undertaken by organizations to foster environmental sustainability within their mining activities. Such as:- Certified environmental management systems, sustainable improvement actions, environmental impact assessment, worker health and improving efficiency, identified gaps, sustainable resource use, illegal mining control, and soil erosion prevention.

Supporting the QUAN + qual data, a group of respondents reflected on their ideas regarding environmental sustainability as follows:

> *"We have controlled illegal mining transfers, prevented soil erosion, and done post-mining terrace work (researchers' computation with participant J, 2024)."* A substantial portion reported that *"No special actions toward increasing environmental sustainability in their organizations have been undertaken (researchers' computation with Participant G, 2024)."*

The table generally captures a wide range of measures companies take to improve environmental sustainability, including certified management systems and impact assessments, as well as worker health and productivity. Nevertheless, many organizations have not implemented any actions or recognized the gaps in their action, which suggests the need for more comprehensive and standardized environmental sustainability practices across the mines sector. The table highlights various socio-economic benefits observed in local communities due to organizational practices.

4.3.1 Safety Improvement

The use of artisanal mining techniques can be dangerous and result in mishaps, injuries, and even death. Supporting the QUAN + qual data, one of the respondents reflected on his idea about safety in Table 4.4.16 as follows:

> *'Accidents, from simple to serious injuries to death".*

Table 4.3.12: Observed improved safety practices after implementing innovative mining technologies (1)

Have you observed improvements in safety practices since introducing innovative mining technologies?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	50	90.9	90.9	90.9
	Yes	5	9.1	9.1	100.0
	Total	**55**	**100.0**	**100.0**	

Source: Researcher's computation with SPSS 25

A majority (90.9%) of respondents have not seen improved safety practices since introducing innovative mining technologies. This indicates that technologies may not have been widely implemented or effective yet. 9.1% of respondents who did observe improvements.

In summary, while there are some positive signs, the overall effectiveness of innovative mining technologies in improving safety practices has not been widely observed, pointing to challenges in adoption and implementation.

Table 4.3.13:Observed improved safety practices after implementing innovative mining technologies (2)

If yes, Please explain.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	N.B: refer to table 18	41	74.5	74.5	74.5
	No new technology has been introduced, so there is no change in quality or quantity	10	18.2	18.2	92.7
	Technologies used for mineral exploration have assisted us in knowing the location of the product in a short period, it was possible to get a better quality product	2	3.6	3.6	96.4
	With the introduction of advanced technology, different aspects such as communication, minerals handling and transportation, and responses to emergence, safety, production, and environmental protection in mining operations have improved.	2	3.6	3.6	100.0
	Total	**55**	**100.0**	**100.0**	

Source: Researcher's computation with SPSS 25

It has been pointed out that applications developed for mineral exploration enabled the more accurate and effective selection of products, which resulted in higher quality products.

> *"With the introduction of advanced technology, different aspects such as communication, minerals handling and transportation, and responses to*

emergence, safety, production, and environmental protection in mining operations have improved (researchers' computation with participant D, 2024)."

The respondent highlights the positive impact that advanced technology has had on mining operations. With the introduction of modern technology, various crucial aspects of mining have seen significant improvements. Communication within mining teams has become more efficient, allowing for better coordination and information sharing. The handling and transportation of minerals have become more streamlined and effective. Additionally, the ability to respond to emergencies has been enhanced, ensuring quicker and more effective actions during critical situations. Safety measures for workers have been improved, reducing the risk of accidents and ensuring a safer working environment. Production processes have become more efficient, leading to increased output and productivity. Finally, environmental protection practices have been enhanced, reducing the negative impact of mining activities on the environment. Overall, advanced technology has brought about notable advancements in communication, safety, production, and environmental sustainability in the mining industry.

Current technology adoption in mining

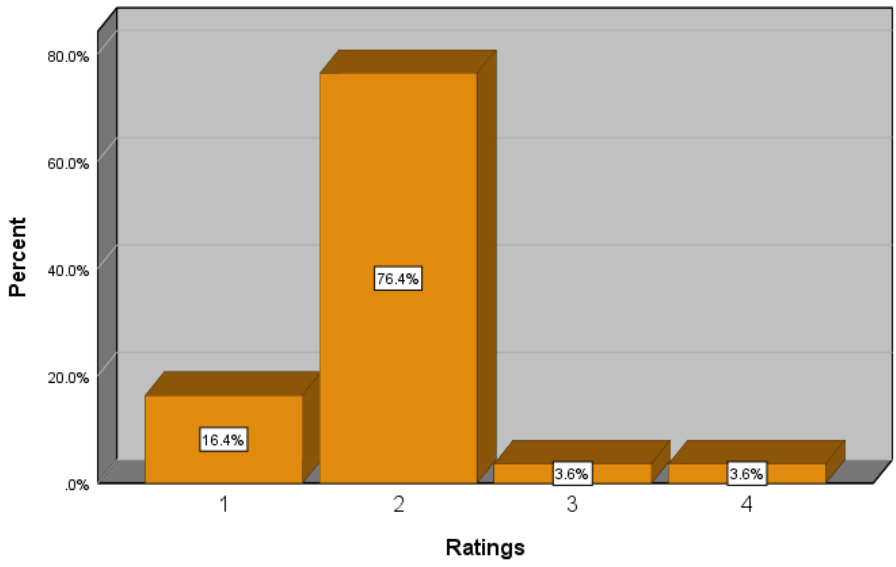

Figure 4.3.6: Respondent's current technology adoption in mining.

Figure 4.3.6 illustrates that the majority of respondents (76.4%) rated their organization's current technology adoption in mining low, and 16.4% considered it very low. This shows that 93% of organizations are at a low or very low stage of technological integration. Only

3.6% of respondents rated their technology adoption as normal, and another 3.6% rated it as high, with no respondents indicating a very high level of adoption.

These findings suggest maximum evidence of the major challenges experienced by adopting modern technologies such as but not limited to, funding shortages, insufficient training, resistance to change, and outdated equipment. The analysis shows the need for actions promoting technological diffusion, e.g., training modules, financial support, and the creation of favorable regulatory frameworks. Despite low uptake rates, there exist some organizations within the sector with medium-high levels of technology uptake that offer a learning and replication opportunity to successful models, disseminate best practices and success stories to overcome obstacles, and increase uptake within the sector.

4.4 Factors Influencing the Adoption of Innovative Mining Techniques

4.4.1 Financial Incentives &Training and Development

Table 4.4.14: Main barriers to adopting innovative mining technologies (1).

What are the main barriers to adopting innovative mining technologies in your organization? (Check all that apply.)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Insufficient training	3	5.5	5.5	5.5
	Insufficient Training, Resistance to Change, Technology limitations, Lack of Funding	1	1.8	1.8	7.3
	Insufficient Training, Technology limitation, Lack of Funding	33	60.0	60.0	67.3
	Lack of Funding	6	10.9	10.9	78.2
	Lack of Funding, Insufficient training	4	7.3	7.3	85.5
	Lack of Funding, Material supply	1	1.8	1.8	87.3
	Lack of Funding, Technology limitation	1	1.8	1.8	89.1
	Lack of Funding, Supply, and government support	1	1.8	1.8	90.9
	Technology Limitation	5	9.1	9.1	100.0
	Total	**55**	**100.0**	**100.0**	

Source: Researcher's computation with SPSS 25

Table 4.4.14 below describes a set of obstacles to the adoption of innovative mining technology by organizations. The above table indicates that most respondents (60.0% consider insufficient training, limitation of technology, and lack of funding as the most discouraging aspects of innovation in mining technologies. This demonstrates the need to be able to cover it fully in these areas. In addition, 10.9% identify lack of funding as a barrier while 5.5% mention insufficient training. Technology limitations are consistently reported, either alone (9.1%, or combined with other obstacles, representing the problems in the context of technological advances. Further barriers include resistance to change, shortage of material supply, and the need for governmental support, respectively.

Table 4.4.15: Main barriers to adopting innovative mining technologies (2).

Other Please specify					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Foreign currency remittance shortages, customs procedures for importing machinery, and poor communication between the Ministry of Mining and other offices.	1	1.8	1.8	1.8
	Insufficient laboratories	1	1.8	1.8	3.6
	Lack of awareness about mining policy	1	1.8	1.8	5.5
	Poor leadership, poor IT use or development, etc.	1	1.8	1.8	7.3
	Supply	1	1.8	1.8	9.1
	Total	**5**	**9.1**	**9.1**	

Source: Researcher's computation with SPSS 25

Other barriers observed are a lack of foreign currency remittance, customs procedures for importing machinery, and lack of communication between the Ministry of Mining and other ministry officers (1.8%). Additional barriers include insufficient laboratories, lack of awareness about the country's mining policy, poor leadership, and inadequate IT use or development, each cited by 1.8% of respondents. Supply issues are mentioned.

Overall, these findings underscore the need for a collaborative effort to address all existing barriers to using new mining technologies, including but not limited to those related to financial constraints, training deficit, technological disadvantage, and individual operational/policy limitations in the context of enhancing the role of innovative mining technologies.

Evaluation plan for adopting innovative mining techniques.

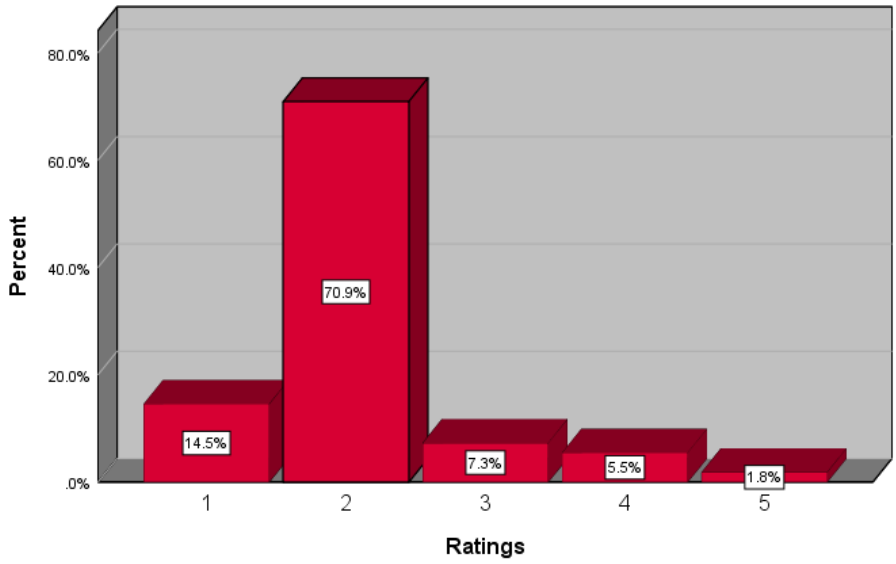

Figure 4.4.7: Respondents' evaluation plan for adopting innovative mining techniques in the future.

Figure 4.4.7 shows the evaluation of the organizations' plans for adopting innovative mining techniques in the next few years providing insight into their future outlook: The majority of respondents (70.9%) rated their organizations' plans for adopting innovative mining techniques as low (rating 2). This suggests a general pessimism and/or unpreparedness for high-level technological innovations shortly. In addition, 14.5% of subjects (rating 1) rated their plan as very low. This, therefore, points to organizational and structural barriers that organizations anticipate, irrespective of which particular innovations are attempted.

In general, these responses indicate that most institutions have low to very low plans for implementing innovative mining technologies soon. This highlights the necessity of greater attention and strategic planning better to harness the implementation of best practices in the field to achieve greater efficiency and sustainability.

Table 4.4.16: Challenges the Mining Sector Faces in Adopting Innovative Practices.

What challenges does the mining sector face in adopting innovative practices?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-	1	1.8	1.8	1.8
	Innovative mining technologies face high initial costs, infrastructure challenges, and complex implementation. There are issues with integrating new technologies with existing systems and ensuring scalability. Additionally, resistance to change and workforce adaptation pose significant barriers.	1	1.8	1.8	3.6
	Accidents, from simple to serious injuries to death.	1	1.8	1.8	5.5
	I don't know	1	1.8	1.8	7.3
	I don't think there will be a worse problem unless it is done with determination	5	9.1	9.1	16.4
	It will be much better.	1	1.8	1.8	18.2
	Lack of enough training, financial shortage and infrastructure, labor exploitation	24	43.6	43.6	61.8
	Road, lack of technology labor exploitation	1	1.8	1.8	63.6
	Technological innovations are particularly relevant in the mining industry, which faces challenges such as lower and more difficult-to-access grade deposits, environmental footprint concerns, health hazards, and depleting access to resources such as water and energy needed for mining operations.	1	1.8	1.8	65.5
	The mining industry worldwide faces complex challenges, including environmental and climate change pressures, trade wars and geopolitics, changing and uncertain demand, technology changes, and a global maintenance skills shortage. Addressing these challenges is a priority for the long-term sustainability of mining.	1	1.8	1.8	67.3
	The problem is related to adopting innovation.	1	1.8	1.8	69.1
	We haven't used any machines yet	17	30.9	30.9	100.0
	Total	**55**	**100.0**	**100.0**	

Source: Researcher's computation with SPSS 25

When discussing the challenges faced by the mining sector in adopting innovative practices, several key issues stand out. One of the most significant challenges is articulated in the following response:

> *"Lack of enough training, financial shortage, infrastructure, labor exploitation (researchers computation with Participant G, 2024)."*

The mining sector faces several significant challenges when adopting innovative practices. One of the primary obstacles is the lack of adequate training for workers, which means they may not have the necessary skills to effectively use new technologies. Additionally, there is a financial shortage, which indicates that there may not be enough funds to invest in innovative technologies and their implementation. The infrastructure required to support these technologies may also be insufficient, hindering their adoption. Lastly, labor exploitation remains a critical issue, highlighting the unfair and unsafe working conditions that still exist in the mining industry.

Table 4.4.17: Solved challenges that occur during implementing innovative practices.

How does your organization navigate these challenges while implementing innovative practices?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-	1	1.8	1.8	1.8
	Identifying challenges involves conducting stakeholder analysis to understand who will be impacted by the innovation and their concerns, and performing a risk assessment to evaluate potential obstacles such as regulatory compliance, cultural resistance, and technological feasibility. Building a strong innovation culture includes encouraging open communication where team members feel safe sharing ideas and challenges, and rewarding creativity by recognizing and incentivizing contributions to innovative efforts.	1	1.8	1.8	3.6
	By creating feasible alternatives that can address the root causes and desired outcomes of a problem	1	1.8	1.8	5.5
	Continuous Learning: Embrace a mindset of lifelong learning, staying updated on industry trends, and acquiring new skills to adapt to evolving challenges.	1	1.8	1.8	7.3
	It helps me focus and utilize the production space I am given.	1	1.8	1.8	9.1
	Observing the mining techniques on-site	1	1.8	1.8	10.9
	The sector is not that much in our case	1	1.8	1.8	12.7
	We haven't used any machines yet	47	85.5	85.5	98.2
	Working again and again	1	1.8	1.8	100.0
	Total	**55**	**100.0**	**100.0**	

Source: Researcher's computation with SPSS 25

Most respondents (85.5% indicated that they have not used machines yet. This highlights important barriers or lack of resources for implementing new approaches.

Other responses, although limited in frequency, indicate a range of strategies such as creating feasible alternatives, continuous learning, effective utilization of production space, and site observation (1.8% each). A few respondents have mentioned a lack of expansion in the sector, highlighting broader challenges that may affect adopting innovative practices (1.8% each).

Table 4.4.18: Required support from the government.

What support would be most beneficial for your organization in adopting innovative mining technologies? (Check all that apply.)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Financial Support,	2	3.6	3.6	3.6
	Financial Support, Training and Capacity Building, Technological Resources, Policy and Regulatory Support.	48	87.3	87.3	90.9
	Training and Capacity Building,	5	9.1	9.1	100.0
	Total	**55**	**100.0**	**100.0**	

Source: Researcher's computation with SPSS 25

When considering the types of support that would be most beneficial for organizations in adopting innovative mining technologies, the following response stands out:

"Financial Support, Training and Capacity Building, Technological Resources, Policy and Regulatory Support (researchers' computation with Participant B, 2024)."

The adoption of innovative mining technologies can be significantly enhanced by providing comprehensive support in several key areas. Financial support is crucial to cover the high costs associated with acquiring and implementing new technologies. Training and capacity building are essential to equip the workforce with the necessary skills and knowledge to effectively utilize advanced technologies. Access to technological resources ensures the tools and equipment to adopt and integrate new technologies seamlessly. Finally, policy and regulatory support help create a favorable environment by establishing guidelines and frameworks that facilitate the adoption of innovative practices.

Table 4.4.19: Roles of government in addressing challenges faced by mining sectors.

In your opinion, what role should the government play in addressing the challenges faced by the mining sector?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Establish clear and predictable regulatory frameworks that promote investment while safeguarding environmental and social concerns. Streamline permitting processes to ensure transparency and efficiency, attracting investment without compromising oversight. Enforce strict environmental standards to mitigate the ecological impact of mining activities.	1	1.8	1.8	1.8
	Establish consistent pricing, provide adequate skill training to professionals, and strictly control illegal traders.	4	7.3	7.3	9.1
	Financial Support, Training and Capacity Building, Technological Resources, Policy and Regulatory Support	8	14.5	14.5	23.6
	Governments can collaborate with local communities and the mining industry to protect the environment and people while realizing mining's benefits. Additionally, addressing political and legal issues is crucial for sustainable development.	7	12.7	12.7	36.4
	The government should be able to solve problems beyond our power, such as infrastructure and safety. Furthermore, the government should give full attention to the mining sector.	35	63.6	63.6	100.0
	Total	**55**	**100.0**	**100.0**	

Source: Researcher's computation with SPSS 25

When considering the role of the government in addressing the challenges faced by the mining sector, the following response highlights an essential perspective:

> *The majority of respondents articulated the need for government intervention, stating, "The government should be able to solve problems beyond our power, such as infrastructure and safety. Furthermore, the government should give full attention to the mining sector"(researchers' computation with participant E, 2024).*

The respondent believes that certain challenges, specifically related to infrastructure and safety, are beyond the capacity of individuals or private entities to address. They assert that it is the government's responsibility to solve these problems. Furthermore, the respondent emphasizes that the mining sector requires the government's full attention and support to address these issues effectively.

Table 4.4.20: Additional comments, insights, or recommendations.

What additional comments, insights, or recommendations do you have regarding adopting innovative mining technologies in Southern Ethiopia?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		32	58.2	58.2	58.2
	Engaging local communities in planning and decision-making fosters trust and ensures technologies meet local needs. Investing in training programs builds capacity, enabling locals to operate advanced technologies. Focusing on environmentally sustainable technologies, such as waste recycling, water conservation, and reduced energy consumption, minimizes ecological damage. Solutions for land reclamation and biodiversity conservation post-mining activities are essential. Starting with economically feasible technologies that demonstrate quick returns can build investor confidence. Encouraging public-private partnerships and providing subsidies or tax incentives promotes the adoption of environmentally friendly mining innovations.	1	1.8	1.8	60.0
	address political and legal issues with local communities, and incentivize miners to invest in local	1	1.8	1.8	61.8
	Give awareness about mineral value by providing proper training.	18	32.7	32.7	94.5
	He should pay attention and work. So far, there have been no complaints on the part of the government	1	1.8	1.8	96.4
	In our region mining techniques and technologies are poor, so the government supports mining sectors to get more benefit	1	1.8	1.8	98.2
	The southern part of Ethiopia needs Transportation Management Systems (TMS) to empower shippers, enhance efficiency and safety, address environmental concerns, and optimize resource utilization. Integrating IoT with AI creates more autonomous and connected mining ecosystems.	1	1.8	1.8	100.0
	Total	**55**	**100.0**	**100.0**	

Source: Researcher's computation with SPSS 25

In Table 4.4.20, a significant portion of respondents (32.7%) pointed out the need to educate people on minerals, making training more prevalent. Others reported that 1.8% each socialized the need to include political and legal considerations, better mining practices, and greater emphasis on government support practices. It was further noted that there is a need for a complex transport logistics system and the use of technologies in mining. 1.8% emphasized the need for local communities' involvement in planning and decision-making to build trust and the technologies that address local needs. This includes capacity building through training programs to help workers and local stakeholders gain the skills needed to operate and maintain advanced technologies.

4.5 Discussion

The study shows a significant interest in embracing new technologies in the Ethiopian mining economy. However, various factors, including a lack of resources and limited education availability, as well as reduced government support, among other factors, tend to constrict this growth (Musingwini, 2014; Hilson, 2002). Furthermore, the data indicates gender inequality with a high number of male respondents, though youth are adequately represented, the association primarily consists of laborers, resulting in fewer female participants. Mining activities, such as digging and transporting, pose challenges for women (Lahiri-Dutt, 2015; Hinton, Veiga, & Beinhoff, 2003).

The association primarily consists of laborers, so the number of females is lower than that of males. It is challenging women to engage in activities such as digging and transporting the product. Understandably, mining is the backbone of the country's economy, particularly other industries. However, according to the survey results, innovative practices and job creation are limited in Kamba Woreda. The community is not utilizing natural resources effectively due to a shortage of expertise and financial resources; they tend to view mining only as a means of generating survival income.

The socio-economic and environmental implications of mining operations are important to targeting specific policies and approaches and working closely with communities. These two aspects work together to ensure that the anticipated benefits of mining activities are maximized while minimizing the negative impacts to the greatest extent possible. These findings point toward a need for strategic interventions to address these barriers and promote sustainable development within the sector (Kitula, 2006; Tsecha S. 2007).

CHAPTER FIVE

SUMMARY, RECOMMENDATIONS, AND CONCLUSION

INTRODUCTION

This final chapter briefly restated the research outcomes on the role of innovative mining techniques and their impact on the overall performance of the mining sector in Southern Ethiopia, focusing on the activities of Gamo Zone, Kamba Woreda. Furthermore, challenges encountered during the research work are discussed, suggestions for the study of the mining sector are provided, and the study contributions concluded with ideas about the value of further work and innovations in the mining sector.

5.1 Summary

The study conducted in southern Ethiopia Kamba Woreda, has brought several findings regarding the role of innovative mining methods and practices in affecting mining performance. In this study, Qual + quan design was employed, and data were collated from 55 key stakeholders through questionnaires among miners, government officials, and industrial experts. It points out that a low rate exists in assimilating current mining technologies: 76.4% argued there is not been appropriate assimilation into the operations concerned. Key drivers hindering proper implementation of the innovative practices under discussion were linked to insufficient training, limited availability of financial credit and minimal government support fact pointed to by 60.0%. Finally, although innovative mining has the potential to improve socioeconomic conditions and infrastructure development, the study showed very significant environmental problems, primarily deforestation and loss of biodiversity, as reported by 85.5% of the participants.

This study has employed a concurrent mixed method, and its primary means of data collection will involve administering structured questionnaires to stakeholders within the Gamo Zone, Kamba Woreda. The population includes mining associations, government representatives, and industry specialists. A purposive non-probability sampling methodology is used to select the sample in this study because it can ensure that these participants have relevant knowledge and experience in the mining industry. The descriptive statistics of the collected data show major trends and patterns in the adoption of innovative mining technologies for their effects on productivity and environmental sustainability. This work also highlights the challenges faced by the mining sector in integrating innovative practices and adapting to newer technologies.

Major findings from this research have brought forth both potential benefits and challenges associated with adopting innovative mining practices in Southern Ethiopia. Low training and education levels among the miners are significant hindrances to the effective use of modern technologies. In addition, financial complications toward integrating innovative practices are observed since most of the stakeholders indicated the need for more support from the government in terms of funding. It was also established that even though innovative practices may be synonymous with increased employment and community development, such must be balanced against environmental stewardship so as not to lead to adverse impacts on local ecosystems. Deforestation and biodiversity loss are critical concerns that arise from the necessity of embracing sustainable mining practices. Overall, the results indicate a larger need for firmer policies and investment strategies for the adoption of innovative technologies and the protection of social and environmental interests.

Generally, this study highlights the critical role of innovative practices in enhancing the performance of the Ethiopian mining sector. It reveals that substantial opportunities for economic growth exist through the adoption of modern mining technologies. Yet, significant barriers, including inadequate training, limited financial resources, and insufficient government support, impede progress. These challenges call for a collective effort among stakeholders: the government, local communities, and mining associations. Besides, there is a need to address gender disparities for inclusive development that will ensure full participation in the sector, for the benefit of local communities and the contribution of the sector to national economic growth. Future research should, therefore, identify what specific barriers to technology adoption exist and investigate ways through which local capacities can be built in a manner consistent with the goal of sustainable development in the mining sector. The study provides valuable insights for policymakers, industry practitioners, and academic researchers while emphasizing the urgency of addressing existing gaps to enhance the mining sector's overall efficiency and sustainability in Ethiopia.

5.2 Conclusion

In conclusion, this study has proven that the mining sectors in the southern part of Ethiopia have significant potential to enhance economic growth. By addressing barriers such as lack of financial workforce assistance, inadequate training, and government sponsorship, they will develop the sector to be more innovative, with the key purpose of ensuring a more inclusive and economic system that benefits the local people and the country. Continued research and focus on the advancement of technology will be essential for mining in Ethiopia in the future.

All this calls for addressing issues at the level of funding, training, and community involvement to integrate innovative practices into the operational levels within the mining units. It is in these areas that there is a need for insights to inform stakeholders about strategies for overcoming challenges and leveraging innovation for sustainable growth in the mining sector.

The remaining future research avenues relate to investigations on specific sub-segments of the sector and policy interventions that shall favor technology dissemination towards sustainable means of production. To this extent, stakeholders' interventions in both realms will serve a dual objective of a more mature as well as durable mining industry.

5.3 Recommendations

Based on the finding of the conclusions of the study, several means can be suggested:

I. Enhance Training Programs: Create comprehensive training and capacity-building programs targeted at miners to enable them to adopt innovative techniques. Collaboration with educational institutions and Non-Governmental Organizations is beneficial.
II. Increase Government Support: The government must increase its role by offering financial rewards and resources to mining industry participants to encourage them to embrace new technologies and practices. A favorable policy environment that encourages investment in sustainable mining operations is necessary.
III. Community Engagement: Establish two-way communication with local stakeholders and provide appropriate structures for their participation in mining activities and their outcomes so that local communities can become involved in the mining process.
IV. Research on Best Practices: Undertake further studies to identify and report models of innovative mining technologies that have improved productivity and mitigated negative environmental impacts in other regions.

V. Focus on Gender Inclusive: Encourage policies and strategies to facilitate women's inclusion in the mining industry and promote gender equality in employment and decision-making in mining associations.

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APPENDIX-A: Study Questionnaire in English

Dear Respondents

This study aims to gather data for the "Role of Innovative Mining on Performance: The Case of the Ethiopian Mining Sector." Your responses are crucial for achieving the study's objectives and will contribute significantly to reliable findings. Please note that your answers will only be used for academic purposes, and confidentiality will be ensured. We kindly ask you to share your thoughts openly regarding the issues being investigated. Thank you in advance for your cooperation.

General Instructions

There is no need to write your name.

Answer all items unless you encounter one that is not applicable.

Use '√' or '×' to indicate your responses to objective items.

Provide elaborations for the open-ended or subjective items.

Section 1: Demographic Information

1.1) Gender:

[ ] Male [ ] Female

1.2) Age:

[ ] 20-30 years [ ] 31-40 years [ ] 41-50 years [ ] above 50 years

1.3) Educational Level (Please specify your highest level of education attained):

[ ] Certificate [ ] Diploma [ ] BSc []; MSc []; PhD

[ ] Other (please specify _____)

1.4) Years of Experience in the Mining Industry:

[ ] Less than 1 year [ ] 1-5 years [ ] 6-10 years [ ] More than 10 years

Section 2: Organizational Information

2.1) Institution/Association: _____

2.2) Position/Title: _____

2.3) Type of Organization:

[ ] Mining Company [ ] Government Agency [ ] Association

[ ] Industry Expert

[ ] Other (please specify _____)

2.4) How many employees does your organization have?

[ ] Less than 50 [ ] 50-100 101-200 [ ] Over 200

2.5) please describe your organization's current mining operations and extraction practices:

_____

_____

_____

Section 3: Adoption of Innovative Technologies

3.1) How would you rate your organization's technology adoption in mining?

(1 = Very Low, 2 = Low, 3 = Normal, 4 = High, 5 = Very High)

1 [ ] 2 [ ] 3 [ ] 4 [ ] 5 [ ]

3.2) What are the main barriers to adopting innovative mining technologies in your organization? (Check all that apply.)

[ ] Lack of Funding [ ] Insufficient Training

[ ] Resistance to Change [ ] Technology Limitations

[ ] Other (please specify _____

3.3) How would you evaluate your organization's plans for adopting innovative mining technologies in the next few years?

(1 = Very Low, 2 = Low, 3 = Normal, 4 = High, 5 = Very High)

1 [ ] 2 [ ] 3 [ ] 4 [ ] 5 [ ]

3.4) Have you implemented any innovative mining technologies in your operations?

[ ] Yes [ ] No

If yes, please specify _____

_____

3.5) How do you perceive the role of government in facilitating the adoption of innovative mining practices? _____

_____

Section 4: Impact of Innovative Technologies on Performance

4.1) In your opinion, what have the overall roles of innovative mining practices been in local communities?

_____

_____

_____

4.2) please provide examples of socio-economic benefits observed in local communities due to your organization's practices. _____

_____

_____

4.3) What measures has your organization taken to enhance environmental sustainability in its mining operations? _____

_____

_____

4.4) Have you observed improved safety practices since introducing innovative mining technologies?

[ ] Yes [ ] No

If yes, please explain: _____

_____

_____

4.5) Has your organization received any training or support in adopting innovative mining techniques?

[ ] Yes [ ] No

If yes, please describe the training or support received_____

_____

_____

Section 5: Contextual Challenges and Additional Insights

5.1) What challenges does the mining sector face in adopting innovative practices?

_____

_____

_____

5.2) How does your organization navigate these challenges while implementing innovative practices?

_____

_____

_____

5.3) What support would be most beneficial for your organization in adopting innovative mining technologies? (Check all that apply.)

Financial Support

[ ] Training and Capacity Building

[ ] Technological Resources

[ ] Policy and Regulatory Support

[ ] Other (please specify _____

_____

_____

5.4) In your opinion, what role should the government play in addressing the challenges faced by the mining sector? _____

_____

_____

5.5) What additional comments, insights, or recommendations do you have regarding adopting innovative mining technologies in Southern Ethiopia?

_____

_____

APPENDIX-B: Study Questionnaire in Amharic

ቃለ-መጠይቅ

ውድ የዚህ ጥናታዊ ፅሁፍ ምላሽ ሰጪዎች ይህ ጥናት “ The Role of innovative Mining on performance : The case of Ethiopian Mining Sector.("የፈጠራ ማዕድን ቁፋሮ በአፈጻጸም ላይ ያለው ሚና፡ የኢትዮጵያ ማዕድን ዘርፍ ጉዳይ”) በሚል ርዕስ ላይ ተንተርሶ ለሚደረገው ጥናት መረጃ ለመብሰብ ያለመ ነው። የእናንተ ምላሽ የጥናቱን አላማዎችን ለማሳካት ወሳኝ እና ለአስተማማኝ ግኝቶች ጉልህ አስተዋፅኦ ያደርጋሉ።

ይህ ጥናት በ Project Management የትምህርት ዘርፍ የማስተርስ ዲግሪ መመረቂያ ፅሁፍ ግብአትነት ብቻ ጥቅም ላይ እንደሚውልና ምስጢራዊነታቸው የተጠበቀ እንደሆነ ተረድታችሁ ለቀረቡላችሁ ቃለ-መጠይቆች ላይ ሀሳባችሁን በግልፅ እንድታካፍሉን ስንል በትህትና እንጠይቃለን። ስለ ትብብርዎ በቅድሚያ እናመሰግናለን።

አጠቃላይ መመሪያዎች

- ስምዎን መጻፍ አያስፈልግም.
- የማይመለከቶት ካላጋጠመዎት በስተቀር ሁሉንም ጥያቄዎች ይመልሱ።
- ለተጨባጭ ጥያቄዎች ምላሾችዎን ለማመልከት '√' ወይም '●' ምልክቶችን ይጠቀሙ።
- ክፍት ለሆኑት ወይም ለተጨባጭ ነገሮች ማብራሪያዎችን ያቅርቡ።

ክፍል 1፡ የስነ ሕዝብ አወቃቀር መረጃ

1.1) ጾታ: [ ] ወንድ [ ] ሴት

1.2) ዕድሜ;

[] 20-30 ዓመት [] 31-40 ዓመት [] 41-50 ዓመት [] ከ50 ዓመት በላይ.

1.3) የትምህርት ደረጃ (እባክዎ ያገኙት ከፍተኛውን የትምህርት ደረጃ ይግለጹ)፡-

[ ] የምስክር ወረቀት [] ዲፕሎማ [] BSc [] MSc [] ፒኤችዲ

[] ሌላ እባክዎ ይግለጹ_____

1.4) በማዕድን ኢንዱስትሪ ውስጥ የዓመታት ልምድ፡-

[ ] ከ 1 ዓመት በታች [ ] 1-5 ዓመታት [] 6-10 ዓመታት [] ከ 10 ዓመት በላይ

ክፍል 2: ድርጅታዊ መረጃ

2.1) ተቋም/ማህበር፡ _____

2.2) የስራ መደብ/ ርዕስ፡ _____

2.3) የድርጅት አይነት፡-

[] የማዕድን ኩባንያ [] የመንግስት ኤጀንሲ [] ማህበር

[ ] የኢንዱስትሪ ባለሙይ

[] ሌላ ካለ እባክዎ ይግለጹ _____

2.4) ድርጅትዎ ስንት ሰራተኞች አሎት?

[] ከ50 በታች [] 50-100 [] 101-200 [] ከ200 በላይ

2.5) እባክዎን የድርጅትዎን ወቅታዊ የማዕድን ስራዎች እና የማውጣት ልምዶችን ያብራሩ፡

ክፍል 3 የፈጠራ ቴ ክኖሎጂዎችን መቀበል

3.1) በማዕድን ቁፋሮ ላይ የድርጅትዎን የቴክኖሎጂ ጉዲፈቻ ደረጃ እንዴት ይገመግማሉ?

(1 = በጣም ዝቅተኛ ፣ 2 = ዝቅተኛ ፣ 3 = መደበኛ ፣ 4 = ከፍተኛ ፣ 5 = በጣም ከፍተኛ)

1 [] 2 [] 3 [] 4 [] 5 []

3.2) በድርጅትዎ ውስጥ አዳዲስ የማዕድን ቴክኖሎጂዎችን ለመቀበል ዋና ዋና መሰናክሎች ምንድን ናቸው? (የሚመለከተውን ሁሉ አረጋግጥ)

[] የገንዘብ ድጋፍ እጥረት

[] በቂ ያልሆነ ስልጠና

[ ] የለውጥ ተቃውሞ

[] የቴክኖሎጂ ገደቦች

[] ሌላ (እባክዎ ይግለጹ)፡ _____

_____

3.3) በሚቀጥሉት ጥቂት ዓመታት ውስጥ ፈጠራ ያላቸው የማዕድን ቴክኖሎጂዎችን ለመውሰድ የድርጅትዎን እቅዶች እንዴት ይገመግማሉ?

(1 = በጣም ዝቅተኛ ፣ 2 = ዝቅተኛ ፣ 3 = መደበኛ ፣ 4 = ከፍተኛ ፣ 5 = በጣም ከፍተኛ)

1 [] 2 [] 3 [] 4 [] 5 []

3.4) በስራዎ ውስጥ ማንኛውንም የፈጠራ የማዕድን ቴክኖሎጂዎችን ተግባራዊ አድርገዋል?

[ ] አዎ [ ] አይ

አዎ ከሆነ፣ እባክዎን ይግለጹ_____

_____

_____

3.5) አዳዲስ የማዕድን አሰራሮችን በማመቻቸት ረገድ የመንግስትን ሚና እንዴት ይመለከቱታል?

_____

_____

ክፍል 4፡ የፈጠራ ቴክኖሎጂዎች በአፈጻጸም ላይ የሚያሳድሩት ተጽዕኖ

4.1) በእርስዎ አስተያየት፣ አዳዲስ የማዕድን ማውጣት ስራዎች በአካባቢ ማህበረሰቦች ላይ ያደረሱት አጠቃላይ ተጽእኖ ምንድ ነው?

_____

_____

_____

4.2) እባክዎን በድርጅትዎ አሰራር ምክንያት በአካባቢ ማህበረሰቦች ውስጥ የተስተዋሉ የማህበራዊ-ኢኮኖሚያዊ ጥቅማ ጥቅሞችን ያቅርቡ?

_____

_____

_____

4.3) ድርጅትዎ በማዕድን ቁፋሮው ውስጥ የአካባቢን ዘላቂነት ለማሻሻል ምን እርምጃዎችን ወስዷል?

_____

_____

_____

4.4) አዳዲስ የማዕድን ቴክኖሎጂዎችን መጠቀም ከጀመረ በኋላ በአካባቢ ደህንነት፣ በምርት ጥራት እና ብዛት ላይ መሻሻሎችን ተመልክተዋል?

[ ] አዎ [ ] አይ

አዎ ከሆነ፣ እባክዎን ያብራሩ፡- _____

_____

_____

_____

4.5) ድርጅትዎ አዳዲስ የማዕድን ቴክኒኮችን ለመጠቀም ስልጠና ወይም ድጋፍ አግኝቷል?

[ ] አዎ [ ] አይ

አዎ ከሆነ፣ እባክዎን የተቀበሉትን ስልጠና ወይም ድጋፍ ያብራሩ _____

_____

_____

ክፍል 5፡ አውዳዊ ተግዳሮቶች እና ተጨማሪ ግንዛቤዎች

5.1) የማዕድን ዘርፍ አዳዲስ የማዕድን አሰራሮችን በመከተል ረገድ ምን ችግሮች ያጋጥሟቸዋል?

_____

_____

5.2). አዳዲስ አሰራሮችን ሲተገብሩ የሚያጋጥሙ ችግሮችን ድርጅትዎ እንዴት ይዳስሳል?

_____

_____

_____

5.3) አዳዲስ የማዕድን ቴክኖሎጂዎችን በተግባር ለመጠቀም ድርጅትዎ ምን ድጋፍ ይኖረዋል? (የሚመለከተውን ሁሉ አረጋግጥ)

[] የገንዘብ ድጋፍ

[] የሥልጠና እና የአቅም ግንባታ

[] የቴክኖሎጂ ሀብቶች

[ ] ፖሊሲ እና የቁጥጥር ድጋፍ

[] ሌላ (እባክዎ ይግለጹ _____

_____

_____

_____

5.4) በእርስዎ አስተያየት በማዕድን ዘርፍ የሚስተዋሉ ችግሮችን ለመፍታት መንግሥት ምን ሚና ሊጫወት ይገባል?

_____

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5.5) በደቡብ ኢትዮጵያ ህዝቦችክልል አዳዲስ የማዕድን ቴክኖሎጂዎችን መቀበልን በተመለከተ ተጨማሪ አስተያየቶች፣ ግንዛቤዎች ወይም ምክሮች ካሎት እባኮት በነፃነት ይግለፁ

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Thank you for your time and patience!