ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

DEPARTMENT OF PROJECT MANAGEMENT

ASSESSMENT OF PROJECT RISK MANAGEMENT IN SELECTED MINING COMPANIES IN ETHIOPIA

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Addis Ababa, Ethiopia

A research project submitted to Addis Ababa University, College of Business and Economics, School of Commerce in partial fulfillment of the requirements for the Degree of Masters of Arts in project management

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June 2023

Addis Ababa, Ethiopia

DECLARATION

I, Kaleb Jia, declare that this research project entitled “Assessment of Project Risk Management in Selected Mining Companies in Ethiopia” is the outcome of my own effort and study. All sources of materials used for the study have been duly acknowledged. This study has not been presented for a degree in any university.

Kaleb Jia

Signature: _____

Date: _____

LETTER OF CERTIFICATION

This is to certify that Kaleb Jia has conducted this research project entitled “Assessment of Project Risk Management in Selected Mining Companies in Ethiopia”. This project work is original and suitable for the submission in partial fulfillment of the requirements for the award of Master of Arts Degree in Project Management.

Bahran Asrat (PhD) _____

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This is to certify that the research project presented by Kaleb Jia entitled: "ASSESSMENT OF PROJECT RISK MANAGEMENT IN SELECTED MINING COMPANIES IN ETHIOPIA" and submitted in partial fulfillment of the requirements for the degree of Masters of Art in Project Management complies with the regulation of the University and meets the accepted standards with respects to originality and quality.

Approval Board Committee:

Examiner (Internal)…….. Signature …… Date……..

Examiner (External)……. Signature …… Date…….

Advisor……. Signature …… Date……..

Chair of Department or Graduate Program Coordinator _____

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TABLE OF CONTENTS

List of Figures

List of Tables

ABSTRACT

The purpose of this research project is to assess project risk management practices of selected mining companies in Ethiopia namely– BEAEKA General Business, Tulu Kapi Mining Share Company, Oromia Mining Share Company, and El Net Technology. The study was descriptive by its type and data was obtained using purposive sampling methods; the sample size of the study was determined to be 41 respondents working actively on the mining projects from contractors, client and regulators side. Closed-ended questions were administered to respondents via questionnaire while interviews with two project managers and one general manager was conducted. The questionnaires covered main aspects of risk management including the overall project risk management, risk planning, risk identification, risk analysis and risk monitoring and controlling practices of the surveyed projects. The finding of the study indicated absence of systematic risk management policy or guidelines, and no organized standard risk management processes. Moreover, risk is primarily managed by the project managers with support from their team. In relation to risk identification, risk analysis and risk monitoring and controlling processes, they aren't undertaken in a way to mitigate project risks proactively. However, risks are handled upon their occurrence by relying on expert subjective judgments of project individuals especially of the project managers.

One international company was part of the survey with a very good risk management knowledge and practice but their experience in the survey has been overshadowed by the findings from the other local mining companies.

Recommendations have also been forwarded to companies to build their risk management knowledge through trainings and exposures to international practices. This will slowly build systematic approach in risk management practices in local settings. The topic also needs more researches in the future as there are few papers published in mining risks globally and none in Ethiopia's context.

***Key words**: Project risk management practice, mining companies, risk management processes*

ABBREVIATIONS/ACRONYMS

OHS: Occupational Health and Safety

FDRE: Federal Democratic Republic of Ethiopia

MoM: Ministry of Mines

PPE: Personal Protective Equipments

TKGM: Tulu Kapi Gold Mine Share Company

PMBOK: Project Management Body of Knowledge

PMI: Project Management Institute

RMP: Risk Management Process

PRM: Project Risk Management

NPV: Net Present Value

CHAPTER 1: INTRODUCTION

In any sector, project risk management is a crucial step, but mining projects require it much more. Complex mining projects come with a variety of hazards, including technical/operational, legal, financial, environmental, occupational health and safety, and social concerns. The success of mining projects depend on effective risk management, which entails identifying, assessing, managing, monitoring, and controlling risks throughout the project lifespan.

A mining project primarily comprises of four major phases where multiple tasks are undertaken in each phase. The first phase is the exploration phase where searching for valuable minerals are undertaken with the help of maps and other field tools. This is proceeded by pre-feasibility and feasibility studies to validate the project onto the next phase. The second phase is the development phase where the mining company hires consultants and contractors to put in place the different infrastructures, process plants, logistical and human resource requirements to transition the project into operation. The third phase is the operational phase where the extraction of the mineral for economic return takes place. This is the phase in which mining companies ensure real cash flows for their shareholders. The final phase is closure and reclamation phase, where a graceful exit is expected of mining companies from the environment where they have been operating for decades. As mining operations have high environmental footprint during their exploration and operation phase, they need to adopt a good closure and reclamation plan prior to closing out their operation. In this phase, companies plan and implement strategies to reclaim the disturbed environment and biotic species that they have been operating on while extracting their target mineral.

All project phases involve the use of tools and means that have risk sources and uncertain components; in other words, risks associated with the use of exploitation equipment (deep drilling, scraping with power shovels or explosives, etc.). Poor project planning is caused by estimation uncertainties for the quantity or quality of mineral reserves, which are present from the exploration phase on. The operating phase also carries risks, such as the presence of numerous OHS hazards that have been listed by both researchers and practitioners. These risks are connected to the utilization of large machinery and interactions between various energy sources. It is crucial to keep in mind that the mining sector is vulnerable to a number of external factors that could affect

operations and production, including shifts in commodity prices, regulatory changes, labor disputes, and unforeseen geological events. Any of these elements might cause the mine to be shut down early if they are substantial enough. In a nutshell, there are many hazards that vary in frequency and seriousness based on the project phase in issue. The management of these risks is influenced by a number of variables, including as corporate responsibility policies, preventative culture, and employee and company risk tolerance levels.

1.1 Background of the study

Risk is defined as "a chance or possibility of danger, loss, injury, or other adverse consequences" by the Oxford English Dictionary. Risk in this context refers to unfavorable outcomes. However, taking a risk might also have a good effect. The third possibility is that risk and result uncertainty are connected. Risk is defined as the "effect of uncertainty on objectives" in ISO Guide 73, the international standard for risk-related definitions. It is difficult to apply this term to daily life and it seems to require a certain level of expertise about risk management. A previous edition of Guide 73 (2002) also mentions the possibility of a good, negative, or unexpected outcome. These three types of events can be related to risks as opportunity, hazard or uncertainty.

Project risk management is a topic of major current interest. It is being actively addressed by many government agencies and most of the professional project management associations around the world, and many relevant standards are being developed. The standards and the guides from the professional associations provide only an outline of the topics that are essential for managing project risk, and they offer few insights into how the risk management process works in practice. In most projects, risk management overlaps with other management processes and procedures, in that many of the steps are undertaken as part of normal project management. This provides the basis for integrating risk management and project management activities (Dale F. Cooper, 2005, p. 8).

Project teams or organizations can utilize the risk management process (RMP), which is a phased procedure, to methodically manage their risks. The procedures consist of:
The first step in the risk management process, risk identification, is typically informal and is carried out in a variety of methods depending on the organization and project team. Identification

of risks is primarily based on analysis of similar completed projects and historical experience. The hazards in any project can be identified at this early stage using a variety of tools and methodologies. In the second stage of the risk management process, known as risk assessment/analysis, gathered data is examined for potential dangers. Out of all the threats indicated in the identification phase, risk assessment is defined as the short listing of hazards, beginning from low impact to maximum impact on the project. Both qualitative and quantitative risk assessments are used in risk management. The third stage, the risk response, will take the shape of risk mitigation by implementing the requisite risk avoidance, risk transfer, risk reduction, and risk acceptance techniques with regard to both positive and negative risks. The project will move forward to the fulfilment of project deliverables with the help of the risk monitoring and controlling stage, which uses a variety of tools to inform, guide, and monitor the risk management process. It employs the following methods and tools: risk audit, earned value analysis, risk reassessment, technical performance measurement, reserve analysis and status meeting.

Studies and surveys have shown that project failure is the rule, not the exception. One study across industrial sectors, including mining, showed that 65% of capital megaprojects fail to achieve their cost and schedule estimates (Merrow, 2011), while another demonstrated that 45% of large engineering projects fail to meet objectives (Miller & Lessard, 2001). Mining projects seem to align with the broad studies of industrial projects (Bertisen & Davis, 2008; Ernst and Young, 2017b; Kuvshinikov et al., 2017). Poor knowledge and practices of managing risks in projects are among the main contributors to project failure in the mining industry, according to a subset of these variables. The life cycle of a mining project frequently includes unaddressed risks and uncertainties that can result in poor decision-making, just like any industrial project (whether it be in the petrochemical, manufacturing, nuclear, or building sectors).

The following example can be used to demonstrate the importance and advantages of excellent risk management procedures with adequate and prompt risk response when unexpected hazards arise. In May 2011, Copper Mountain Mining Company constructed and opened the brand-new processing facility at Princeton, British Columbia's Copper Mountain Mine. A continuous production deficiency was seen soon after the mine was commissioned and ramped up, and the processing unit was unable to operate at design capacity. According to Rose et al. (2015), the issue

was identified as a SAG Mill that was unable to reach the intended production throughput and grind size despite operating at nearly full motor power. Copper Mountain conducted further hardness testing on a variety of ore types, added SAG Mill throughput models, and evaluated various operational improvements without noticeably changing the results. To increase the throughput of the SAG Mill, they installed a new permanent crusher in December 2014. It took Copper Mountain more than 2.5 years to put a solution to this issue into action. The protracted period of decreased output resulted in a considerable loss of value, even though they took a longer resolution path to ensure the technical precision of the decision-making process and control expenses. A quicker risk resolution may have been achieved by using a flexible and adaptable approach to risk management that acknowledges the uncertainty around the efficacy of risk responses. The simultaneous pursuit of various resolution options and the projection of systemic risk identification technique may have resulted in faster risk resolution and less loss in value.

In general, mining project activity is subject to high risks because of its size, uncertainty, complexity, and high costs. Since minerals are present beneath the surface of the earth, their presence to an economic value is estimated using geological knowledge yet to be known certainly during the operational phase. The development and operation phase also requires a huge capital outlay which poses financial risks to financers and mining companies. The operational phase alone consists of multidisciplinary activities interwoven together geared towards a common objective. This poses planning, environmental, OHS, geotechnical, and other risks that needs to be managed optimally if a company ought to achieve its strategic objectives. The political and regulatory risks also pose another risk threat to a country that is endowed with mineral resources. Hence, risk studies in mining industry is an ideal subject for academic researchers and their findings could be of paramount importance to the industry and the larger economy in general.

This research focuses on mining activities of active mining projects in Ethiopia which had recently been engaged on exploration and extraction of valuable minerals in different parts of the country. The researcher has identified four mining companies (Contractors/Clients) working on different mineral commodities, and the ministry of mines (regulator) for this research purpose, namely:

1. BEAEKA General Business Marble and Granite

2. Oromia Mining Share Company Gold
3. Tulu Kapi Gold Mine Share Company Gold
4. El Net Technology PLC Gold

BEAEKA General Business is engaged on the mining of dimension stones (marble and granite) in its five active quarry mine sites in Bullen Wereda, Metekel Zone, Benshangul Gumuz regional state, and Bure Wereda, West Gojjam Zone, Amhara regional state respectively. It is currently on the operation phase of the projects and is producing blocks and chips with a $500m^3$ per month mine capacity each for the past five years. It has its marble and granite processing plant at Bahirdar city where it produces finished products to be used on finishing phase of the building construction industry.

Tulu Kapi Gold Mine Share Company is an industrial scale mining firm working under the parent company of KEFI Minerals which is a registered firm in London stock market. The company has undertaken more than 10 years of exploration activity and is currently working on the development phase of its Tulu Kapi gold mine project at West Wollega Zone, Oromia regional state and is expected to transition to operation within the coming 2-3 years. When operational, the project is expected to produce 4000 kg of gold with 250-300 million USD revenue annually. This is going to mark as the largest gold mine project opened in Ethiopia over the past three decades.

El Net Technology and Oromia Mining Share Company are emerging new mining firms in Ethiopia's mining industry. They have only joined the country's mining industry in the past two years with a limited capital expenditure on active projects. El Net is currently working on mining of placer gold deposits with erection of small scale gold washing plant at Assosa zone, Benshangul Gumuz regional state. Oromia Mining Share Company is also working on mining of placer gold deposits at Guji zone, Oromia regional state with installation of three small scale gold washing plants.

1.2 Statement of the problem

The clear statement of the problem for this research purpose is assessing project risk management practices of mining companies in Ethiopia with a focus on their risk analysis practices. Because of the multifaceted nature of the mining industry and vulnerability of each project phase to multiple risk factors, risk management in the mining industry is a subject of utmost priority. It is very crucial not only to achieve operational efficiency but also goes beyond in determining the fate of projects as failure or success. For example, the pace and scale of current developments in Australia's mineral resources sector is worldwide known as unprecedented. A study of eighteen mining projects covering period of 1965 to 1981 showed an average cost overrun of 33 percent compared to their feasibility study estimates (Castle, 1985). A study of sixty mining projects covering the period from 1980 to 2001 showed average cost overruns of 22 percent with almost half of the projects reporting overruns of more than 20 percent (Gypton, 2002). A review of sixteen mining projects carried out in the 1990s showed an average cost overrun of 25 percent, attributed to overly optimistic feasibility studies and poor cost estimation (Anon, 2000, as sited in Noort & Adams, 2006). Thus, the motivation for this research stems from the realization of the need for project risk management knowledge and systems that concentrate on adopting systematic risk analysis tools to assist project teams in managing surprises that happen during the many phases of the mining project life cycle.

Risks in mining projects has a number of significant effects, including: Project Delays or Cancellations: risk occurrences, such as machinery breakdowns, unforeseen geological conditions, or labor disputes, can cause project delays or cancellations in the mining industry. The mining firm may suffer large financial losses as a result, in addition to missing out on chances for development and growth. Risk occurrences can result in safety mishaps, including injuries and fatalities, as mining is a high-risk business. As a result, the mining corporation may face legal and reputational problems in addition to enormous human expenses for the miners and their families. Environmental Damage: Mining operations can have a negative influence on the environment, causing habitat loss, water pollution, and soil erosion. Events that pose a risk, including chemical spills or tailings dams.

These all impacts are potential consequences a mining project team needs to deal with when managing risks and turning their outcomes into possible benefits of the project.

The researcher, a mining professional who has been employed in the field for over 6 years since November 2016, believes that mining companies in Ethiopia lack a thorough risk management system to direct them through the various stages of their mining projects. The researcher has conducted informal interviews with senior professionals in the industry regarding the research subject under study. By incorporating project risk analysis practices into every activity they execute throughout the project life cycle, the researcher further claims that a study on this topic will considerably aid these businesses in optimizing and enhancing their project management performance.

1.3 Research questions

This research intends to address these research questions in due course of the research process:

I. What are the most common risks associated with mining projects? What are the major factors/causes of these risks?
II. What systems and practices do the mining companies adopt to identify and assess risks?
III. What system and practices do the mining companies adopt to mitigate and monitor risks (geological, environmental, financial, operational and regulatory risks)?
IV. How is the experience of mining companies in Ethiopia with regards to using a scientific and systematic risk management system in their mining projects?

1.4 Research objectives – general and specific

The general objective of this research project is to study the risk management knowledge and practices of active mining projects in Ethiopia.

The specific objectives of this research project in this regard will be:

- To discover the most common risks in mining projects, and the major factors causing these risks

- To study how these risks in mining projects are identified and assessed
- To study how these risks in mining projects are mitigated and monitored
- To investigate the experience of mining companies in using a scientific and systematic risk management system in their mining projects

1.5 Significance of the study

Research on risk management in mining projects would be very beneficial to the mining industry because it can be used to identify and mitigate any risks that could negatively affect a project's success. Research in this area will be essential in systematically identifying, assessing, and mitigating risks at each stage of the project due to the inherent risk in the mining business. Effective risk management can ensure that the project is completed on time, on budget, and in compliance with all relevant standards by reducing the impact of these risks on it.

Additionally, by attempting to adapt international techniques to a local setting, this research will give information on the risk management procedures used by mining enterprises in Ethiopia. Improved knowledge and comprehension about risks in mining projects can help companies to better manage their resources and improve overall operational efficiency.

The results of this study can also help regulators and company executives create efficient company policies and rules for the mining industry, which will enhance sustainability and safety standards in the sector.

Since there are few or no studies on mining risks in local context, this study could theoretically inspire other academics to do comparable but more in-depth studies on the topic.

Overall, the findings of this study could be used to attract attention to risk management practices of mining businesses in Ethiopia and in further strengthening their effort towards adopting a comprehensive approach in project risk management.

1.6 Scope of the study

The general scope of this research project will be limited to mining projects in Ethiopia. As there are multiple minerals of economic value to be extracted for human benefit, this research project will only be limited to the most prominently extracted mineral commodities in Ethiopia recently – Gold, and Dimension stones (Marble and Granite).

The researcher clarifies that, except for the commercial production, closure and reclamation phase of mining projects, all phases of the mining project, exploration through to operation (Pre-production), will be within the study scope of this research project.

The researcher acknowledges that Ethiopia has one of the growing mineral industries in the world, and that its mineral resources remain untapped beneath the surface of the earth for ages. In light of this, there are few mining projects which had passed through to the operation phase. Hence, this research project will try to incorporate risk management practices of these mining projects within the last 10-15 years. This time period is selected because the researcher plans to interrelate and critically evaluate local practices to contemporary practices of project risk management in international standards.

1.7 Limitations of the study

This research project has faced the following limitations in the different phases of conducting the study:

Methodological limitations: A research study's methodology may have drawbacks that affect the validity and reliability of the findings, such as measurement error or a lack of control over auxiliary variables.

Sampling Restrictions: The size and make-up of this study's sample may not be representative of the overall population, which could contribute to bias and restrict the generalizability of the results.

Data Restrictions: Unnoticed measurement mistakes, missing data, or unreliable sources could all have an impact on the quality and accuracy of the data utilized in the study.

Limitations on Scope: The research study's scope is constrained by the place and time period it is focused on, which may limit the applicability of its findings in other situations.

1.8 Organization of the study

Five chapters will make up this research endeavor. The study subject and the thematic area it focuses on will be introduced in the first chapter. The researcher has attempted to give literature reviews in the second chapter to draw readers' attention to pertinent studies and publications published on the topic. The third chapter will describe the procedures, tactics, strategies, and plans the researcher employed while carrying out this study. The data analysis and interpretations of the research study will be discussed in detail in the fourth chapter. The key findings of the entire study and conclusions drawn will be covered in the fifth chapter, which will serve as a conclusion chapter. This is precisely done in a manner that is well aligned with the objectives of the research that were stated at the outset of this research project. A recommendation has also been forwarded in this chapter which boosts the significance of this research work both conceptually and empirically.

1.9 Definition of key terms

- **Risk**- is an uncertain event that if occurs, has a positive or negative effect on the project objectives (PMO, 2017).
- **Project Risk** - an uncertain event or condition that, if it occurs, has a positive or a negative effect on at least one project objective (PMO, 2017).
- **Risk Identification** - determining which risks might affect the project and documenting their characteristics (PMO, 2017).
- **Risk Analysis** - prioritizing risks for further analysis or action by assessing and combining their probability of occurrence and magnitude of impact (PMO, 2017).
- **Risk Monitoring and Control** - tracking identified risks, monitoring residual risks, identifying new risks, executing risk response action plans and evaluating their effectiveness throughout the project life cycle (PMO, 2017).
- **Mining/Exploitation** - is the extraction of minerals from the surface of the earth or beneath (JORC Code, 2013).

- **Mineral Exploration** - is the activity to find economic mineral deposits that will appreciably increase the value of a mining company's stock to the shareholders on a continuing basis, or to yield a profit to the explorer (JORC Code, 2013).
- **Mineral Resource**: - a concentration or occurrence of solid material of economic interest in or on the Earth's crust, which is estimated to have reasonable prospects for eventual economic extraction (JORC Code, 2013).
- **Mineral Reserve**: - that portion of the identified resource from which a usable mineral and energy commodity can be economically and legally extracted at the time of determination (JORC Code, 2013).
- **Ore**: - is a naturally occurring mineral or rock that contains a valuable substance that can be mined and processed to extract the desired commodity. The valuable substance in the ore is typically a metal, such as gold, silver, copper, or iron, although it can also be a non-metallic mineral, such as coal, phosphate, or salt (JORC Code, 2013).

CHAPTER 2: REVIEW OF RELATED LITERATURE

The researcher has tried to review relevant literatures pertaining to the research subject under study. A review of the existing literature reveals that very few research have been exclusively focused on mining project risks, with the exception of the many studies on construction Project Risk Management (PRM) in different nations. There have been numerous risk analysis studies on oil fields and petroleum exploration. However, based on the regional peculiarities of the mining industry, only a small number of research pertinent to PRM had been discovered.

The researcher in this regard has covered available literatures on risk management and its basic elements in projects. Hence, the concept of risk is defined in a manner that clearly paves a way to the research project. The fundamental risk management process, tools and techniques and factors that contributed to risks are reviewed in a scope that is defined for this research purpose in theoretical literature review framework. Empirical studies have also been reviewed to substantiate findings of this research and literatures of the mining industry in Ethiopia's context have also been covered to the extent possible by their availability.

2.1 Project Risk Management

Risk in projects is inherently attached to every phase of the project life-cycle. Their planning along with other aspects of the project at project conception stage leads to a better handling and an optimal output to project deliverables. Mining, as the riskiest business of all industrial endeavors requires a careful handling of risks in its project endeavors.

A blog on the internet by the name 'ProjectManager' defines Project risk management as the process of identifying, analyzing and responding to any risk that arises over the life cycle of a project to help the project remain on track and meet its goal (*https://www.projectmanager.com/blog/risk-management-process-steps*). Risk management shouldn't just be reactive; it should also be a part of the planning process to identify potential risks to the project and determine how to manage them if they do arise.

Project risk management techniques have become integral components of major project development, shown by inclusion in major bodies or knowledge, standards, and specialty guidelines (AACEI, 2015; PMI, 2017) and professional certifications in project risk management from these same organizations. Despite the growth and maturity of project risk management strategies, there are still serious problems with the prevalent methods. These flaws can be divided into two categories: the insufficiency of the available instruments and the restrictions of the risk management procedure as it is now used.

There are multiple tools available in the industry that are used in managing project risks. A risk register and a risk matrix are two of the most popular methods for managing project risks. These tools combine two dimensions—probability of occurrence and impact—to assess and analyze risks. A risk score is created by combining probability and impact; this risk score can be analyzed qualitatively or statistically. To produce a qualitative risk score, qualitative evaluations use ordinal scales (low/medium/high) for probability and impact. Alternately, you may multiply the numerical estimates of chance and impact to calculate the estimated loss from the risks. A ranked list of risks will be produced using either approach. Although these strategies are prevalent, there are numerous objections. Some academics contend that combining two dimensions into a single risk score or metric is an abstraction that could be deceptive as risks with considerably different probabilities and impacts (and likely vastly different approaches to mitigation and control) can receive equal risk scores (T. Williams, 1996). Other criticisms are that probability and impact are insufficient as they do not consider feasibility or timing of risk response (Ward, 1999) or do not rank the manageability of risks (Aven et al., 2007). Risk matrices have even been described as "worse than useless" by prominent risk researchers as they provide misleading information on the ranking and characterization of risks (Cox, 2008). Qualitative assessments of risks that use ordinal scales (low, medium, high) for risk probability and impact assessments also have several criticisms and limitations based on the quality of decision support insight they provide (Chapman & Ward, 2011; Cox et al., 2005). These criticisms are not recent, yet these tools remain popular.

2.2 The Risk Management Framework

An optimal risk management often requires a systematic process and a comprehensive tool that adopts project specific standards. Risk management framework which fundamentally comprises of the risk management process, is the major tool used by projects in all industries to better handle project risks.

The manager and members of the project team at different levels identify and manage risks in various forms (Lavanya & Malarvizhi, 2008). Without a structured risk management framework, however, this will be ineffective as it results in an incomplete impact assessment, which results in the loss of the following: Knowledge of the overall impact on the project objectives, including scope, time, cost, and quality; identification of secondary or new risks arising from the risks already identified; Lack of transparency and a communication gap within and outside the team.

Any project organization must build an efficient structure for risk management. The adoption of such a practice as the project team's culture ensures that:

- Risk is identified and managed consciously and intensively;
- The project proceeds as planned, with the fewest surprises or deviations, and in line with the goals of the organization and the project;
- Early and effective communication of project concerns with project organizations and stakeholders; and
- An effective team-building tool, as the learning and acceptance of new skills;

Since risk management is an iterative process, every aspect of it should be planned for and implemented during every stage of the project. At the beginning of the project, the risk management framework for the organization is examined and modified to develop the project risk management plan. The following recommendations are part of the risk management plan:

List of possible sources and categories of risk;

- Impact and probability matrix;
- Risk reduction and action plan;
- Intervention plan;
- Threshold and risk values;

The process in risk management framework comprises four steps: **risk identification, risks analysis or assessment, risks management/response, and risk monitoring & control.**

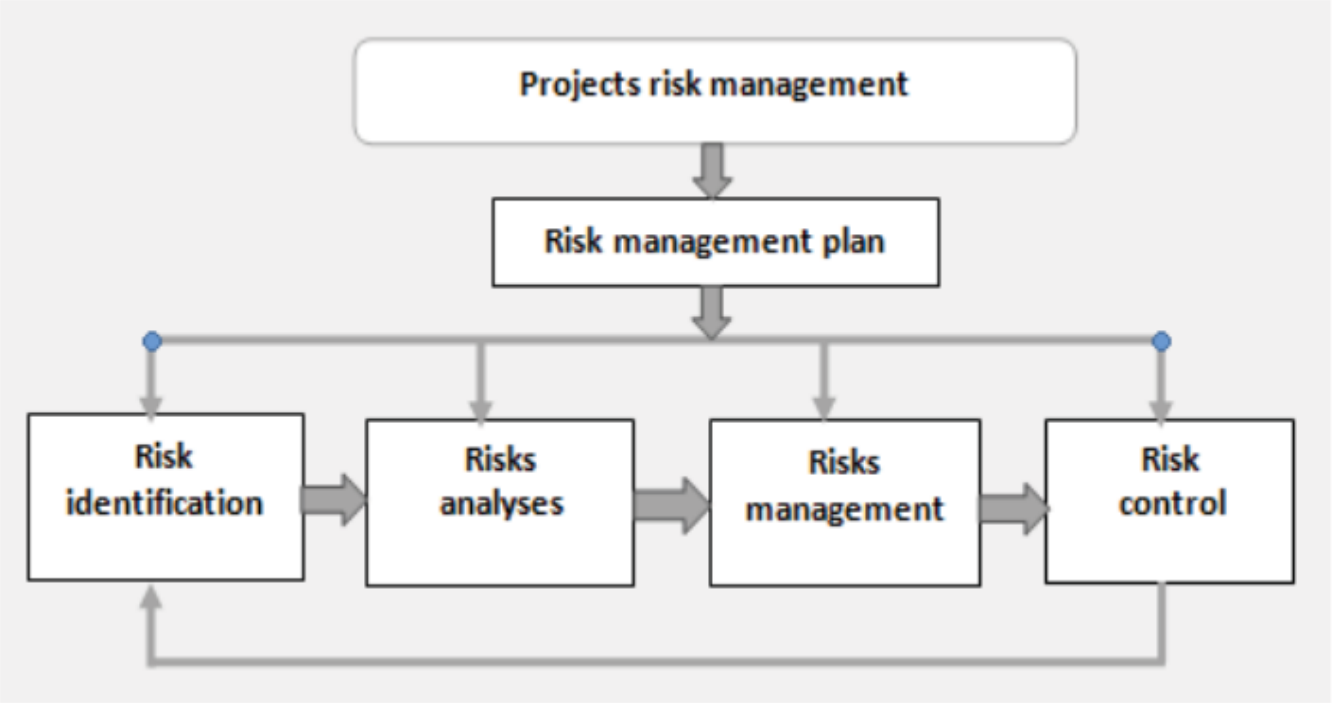

Figure 2.1 Project risk management framework (Lavanya & Malarvizhi, 2008)

2.3.1 Identification of Risks

Identifying and addressing risks as early as possible in the project is recommended. Throughout the course of the project, risks are identified, with a special emphasis on the crucial phases. One of the important issues in both reporting sessions and the usual state of the project is risk identification. Some dangers might be immediately obvious to the project team (known risks); others will require more investigation but are still avoidable. The risk register, which is kept on the project's main server, is the instrument for keeping track of all the risks found during the project. In order to identify risks in a structured and methodical way that assures that no substantial potential risks are overlooked, the following methods and recommendations are employed:

Risk identification tools and methods	Risk repertoire (risk history)
	Risk register
	Expert judgment (brain storming)
	Progress reports
	Risk categories
	Document review

Table 2.1 Risk identification tools and methods

A list of areas vulnerable to risk events is provided by the risk category. The organization suggests high-level standard categories that should be expanded based on the project's kind, such as technical, organizational, project management, and external elements.

2.3.2 Risk Analyses

Examining the impact of the risk event on the project's results and objectives is a component of risk analysis or assessment. In order to take the necessary steps to reduce the risks, they are first identified and then examined to determine their qualitative and quantitative impact on the project. The possibility of the risk occurring, the impact of the risk, the exposure to risk or risk score, and the duration of the risk's occurrence are the criteria used to analyze risks.

1. Likelihood of risk occurrence
    a. High probability: ($80\% \leq x \leq 100\%$)
    b. Medium-high probability: ($60\% \leq x < 80\%$)
    c. Medium-low probability: ($30\% \leq x < 60\%$)
    d. Low probability: ($0\% < x < 30\%$)
2. The impact of the risk
    a. High – Catastrophic (rating A – 100)
    b. Medium – Critical (rating B – 50)
    c. Low – marginal (rating C – 10)
3. Exposure to risk or risk score

The result of multiplying the impact rating by the risk probability is the risk exposure, often known as the risk score. Different colors can be used to indicate the urgency of risk response planning, which also establishes the degrees of reporting. The score represents the lower cutoffs for categorizing risks under "normal" circumstances.

According to the nature of the risk, it is required to characterize the impact on cost, schedule, scope, and quality in as much detail as possible in addition to classifying risks in accordance with the aforementioned standards.

Impact/Probability	**1 = high**	**2 = medium-high**	**3 = medium-low**	**4 = low**
A = 100	Very high exposure	Very high exposure	High exposure	Moderate exposure
B = 50	High exposure	Moderate exposure	Moderate exposure	Low exposure
C = 10	Low exposure	Low exposure	Low exposure	Low exposure

Table 2.2 Risk analysis tabulation (Lavanya & Malarvizhi, 2008)

2.3.3 Risk Response

Planning the risk response, determining the risk triggers, and assigning responsibility for risk resolution are all part of risk response and management.

Planning the risk response

It can be impossible to find rapid fixes to all of the hazards that a project confronts. It can be necessary to strategically manage some hazards for longer periods of time. Action plans should be created to lower these risks as a result. These action plans should include a description of the risk, a risk assessment, a description of the risk reduction action, the owner of the risk action, and a committed completion date for the risk action.

Each risk action plan should be assigned to the appropriate party, who will be in charge of carrying it out. In agreement with the stakeholders, a risk response must be noted for each risk in the risk register. The project manager should present this. The following goals are the focus of the risk response plans: Elimination of risk, reduction in risk's likelihood of happening, and lessening risk's influence on the project's goals.

Plans for responding to risks typically affect both time and money. Therefore, it is essential that the established response plan's duration and cost be estimated as precisely as feasible.

Risk triggers

The risk register must contain a trigger for each danger. The risk symptoms or warning indications are known as the trigger. This suggests that there is a risk of anything bad happening. The risk trigger also indicates when a certain risk is anticipated to materialize. Following consultation with stakeholders and the effective execution of a set of response strategies, the risk score can be decreased.

Risk responsibility

The project manager is in charge of handling all project risks, according to the fundamental rule. A Risk Owner (who need not be the project manager) must be chosen and identified in the Risk Register based on this fundamental criterion. The risk owner is typically the one who can best handle the defined measurement measures, but they can also be the one who can best monitor the risk trigger. The risk owner is in charge of carrying out the specified countermeasures and reporting any changes in the status of the risk trigger immediately.

2.3.4 Risk Monitoring and Control

Risk monitoring and risk control or review is an iterative process that uses progress, and delivery status reports to monitor and control risks. This is activated by various status reports, such as quality reports, progress reports, tracking reports, etc. Risk reviews are a compulsory element of landmark meetings and or regular project meetings, but can also be carried out at risk assessments scheduled separately. These risk analyses should be performed on a regular basis. The frequency could also be determined based on the overall risk level of a project. Therefore, the risks of a

project must be anticipated, identified, and recorded. The risks that may arise are anticipated during the project design and planning phase. During the project course, the anticipated risks are verified and recorded, having the aim of reducing or resolving them (Doval, 2019).

2.3 Risk in the Mining Industry

The mining industry interchangeably known as the extractive industry, is well known for one of the primitive human occupations in early human civilizations. It has later become the back bone of industries in many countries. Its scope covers minerals, oil & gas, geothermal and etc. depending on specific scenarios in countries' conditions. The output from this industry has geared up developments and expedited structural transformations in macro-economies of most European, Middle East and North American countries. However, the infamous challenge to this industry, Risk, is posing a threat to its development and old standards. With the rapidly changing world standards specially in terms of resource management, environmental conservation, human welfare, social capital, and political economy, the mining industry is continuously being challenged by risks emanating from this new world order. Accordingly, the industry is striving best to keep up, evolve and adapt to this new order.

The life cycle of a mining project is principally divided into four phases and is briefly explained here. The first phase of 'Exploration' which ranges from 7–15 years encompasses research activities surrounding the resource or mineral to be extracted. These activities are completed using quantitative and qualitative analyses of mineral reserves. This phase involves several teams and specialists, including mining engineers, geologists, metallurgists, and environmental experts. This phase also involves simultaneous participation of several organizations. The exploration phase enables confirmation of the profitability of a mining project. It also includes creation of all documentation necessary for the establishment of the business plan and the engagement of subcontracted consultants and other social actors with a view to launch the new operation. During this phase, various methods and technologies are used to complete the exploration (e.g. drilling, map-making, and geostatic simulations). The second phase of 'Development' between 0.5-5 years begins with the planning of the various phases that follow exploration and the actions needed in order to set the deposit into commercial production. During this phase, the organization begins by setting up its teams and advancing in parallel infrastructure construction and installation activities. This phase is characterized by the start of interactions between teams of subcontractors and those

of the mine, the use of equipment and heavy machinery, and employment of a number of industrial disciplines all on the same site (e.g. civil engineers, mechanical engineers, electrical engineers, and geologists). This phase requires considerable investments and constitutes most of the project costs. Sometimes this phase is accompanied by preparation of urban infrastructure, such as roads, living accommodations, and services. Once construction is complete and all installations are operational and set to standard requirements, the project moves into the third phase of 'Operation' ranging from 2-20 years. This third phase comprises primarily the commercial production stage and marks the beginning of profitability. This stage involves the mine teams taking over control of all mining operations. The operational teams, in particular those involved in production and maintenance, become the most sought-after entities. The final phase of a project is normally a long one (between 2-10 years). This phase includes the dismantling stage and the reallocation of installations and equipment. The project 'Closeout' phase also includes a stage involving definitive project closure and rehabilitation of lands used and pits exploited (A. BADRI, 2012).

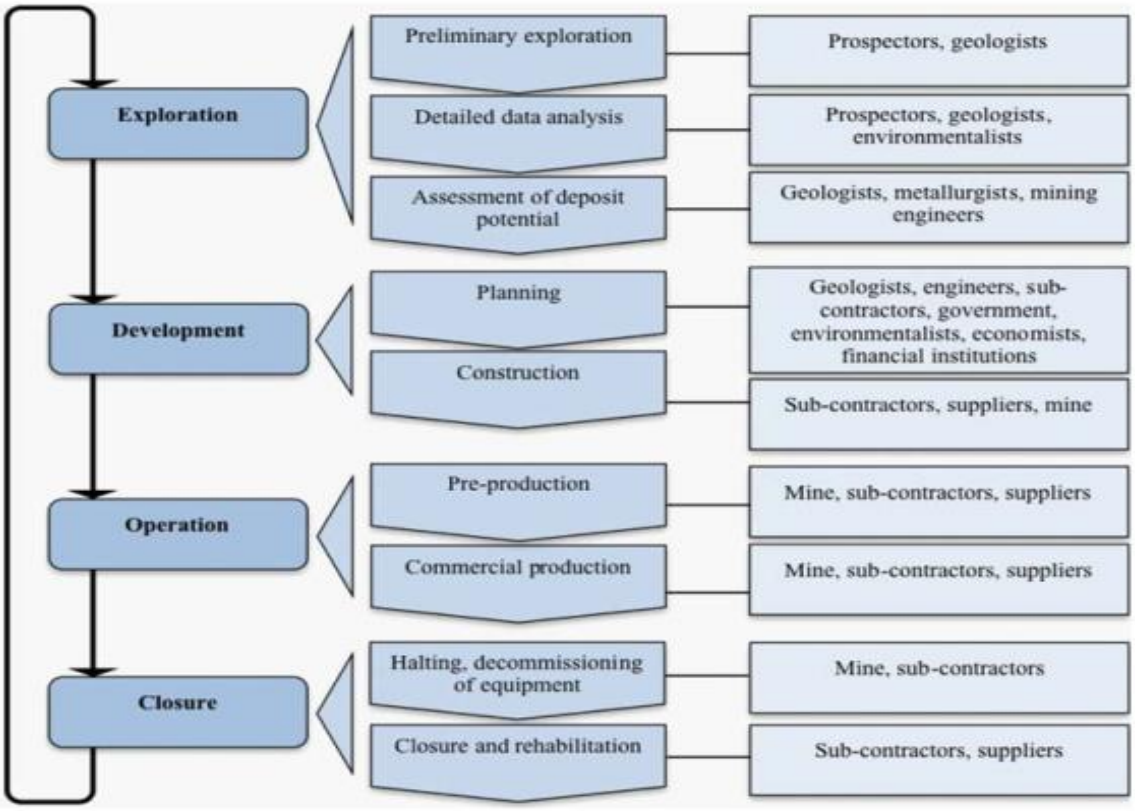

Figure 2.2 Mining project life-cycle (A. Badri et. al., 2012)

There is little published research on project risk management in the mining industry. A literature review of risk assessment methods in the mining industry over ten years from 2010-2020 identified 94 articles on risk analysis, risk assessment, and risk management, but only a single article was focused on project risk management (Tubis et al., 2020). Chinbat (2009) identifies some of the most significant risks faced by mining projects in Mongolia and documents the use of project risk management tools through a survey. An early study on project risk management methods in mining discusses the lack of reliable input data for quantitative risk techniques and suggests that the resultant analyses could be improved through access to higher quality information from previous projects (Atkinson et al., 1996). A comprehensive collection and classification of risks in the design and construction stage of mining projects document many risks in the different project stages that could be used as a guideline to complete a risk assessment in new mining projects (Badri et al., 2012). A new approach for health and safety hazard and risk management has been proposed for underground mine projects using an Analytic Hierarchy Process to improve ranking and prioritization of health and safety risks (Badri et al., 2013). There are no publications in the literature that describe controls, treatments, or responses as techniques for managing risks. Although this relationship has never been formally stated or demonstrated, it can be inferred that mining projects are substantively equal to other industrial infrastructure projects, such as those in the energy and hydrocarbon extraction industries.

Despite its economic success, the mining industry is nonetheless constrained by a number of issues and challenges that hinder its growth and harm its reputation. Many projects that have attracted tremendous attention have been shelved after a number of years for a variety of reasons (such as economic, geological, geotechnical, financial, etc.). For instance, Agnico-Eagle Mines recently opted to shut down the Goldex Mine in Val d'Or, Quebec, despite it being in full commercial production, due to unanticipated problems with geological stability. The corporation will suffer a loss of $190 million as a result of this early shutdown. The mining sector is frequently blamed for a wide range of environmental issues and a high rate of workplace accidents. Mines are a major contributor to a number of occupational ailments all around the world. Significantly poor working conditions affect a large number of miners, and some mines are corrupt. In summary, there is still a long way to go until the mining business is no longer seen as a risky and unpredictable endeavor because of its issues and ability to deal with unknown amounts. To handle risks that are present

throughout the life cycle of a mining project, quick adaptation to changes in laws and regulations as well as advancements in technology, processes, and attitudes are required.

2.4.1 Mining Risk Factors

Mining ventures are inherently dangerous since the discovery, development, extraction, and processing of natural resources involve complexity and uncertainty. Below is a discussion of some of the primary contributing factors or causes of mining project risks; researchers and practitioners will benefit from the systematic identification and study of each risk aspect made possible by the identification of these factors and causes.

Geology and mineralogy: The ore body's attributes, including its location, size, grade, and mineralogy, can have a big impact on how expensive and feasible a mining operation is. Unexpected changes in the deposit's geology or mineralogy may need alterations to the mining strategy or processing techniques, which could result in higher costs and longer processing times.

Technical and operational factors: Mining projects call for the employment of sophisticated, expensive technology, which is susceptible to malfunctions and failures. Equipment failure, inefficient processing, and poor maintenance are examples of technical and operational problems that can cause delays, downtime, and higher expenses.

Environmental and regulatory requirements: Mining projects must adhere to a wide range of environmental and regulatory standards, which might differ by jurisdiction and be challenging to negotiate. If you don't follow these rules, you risk fines, legal issues, and delays in getting permits or approvals.

Market and economic factors: The profitability of a mining operation can be affected by the volatility and unpredictability of the demand for and price of mineral commodities. The economics and funding of a project may vary as a result of modifications to market conditions, such as variations in consumer demand or price fluctuations for commodities.

Health and safety factors: Mining is a high-risk business with a high likelihood of mishaps, injuries, and fatalities. A mining project's success depends on ensuring the health and safety of the workers, and failing to do so can lead to legal liabilities, reputational harm, and project delays.

Social and community factors: Mining operations may have a big influence on the neighborhood, including environmental harm, evictions, and loss of livelihoods. Social unrest, riots, and project delays can occur if local stakeholders are not involved and their concerns are not addressed.

2.4.2 Risk Categories in the Mining Industry

Numerous risks and uncertainties of various types, such as those related to occupational health and safety (OHS), the environment, operations, legislation, politics, finance, and the economy, continually pose a threat to mining projects. A mining business is a socio-technical system that exhibits intricate relationships between people and different technical procedures. These interactions make it more difficult to put up a risk management policy, especially when it comes to identifying and evaluating hazards.

The risks in mining projects are highly related to their causes; and often the risks and causes are pronounced interchangeably in multiple literatures. The major mining project risks are categorized and briefly discussed as follows:

A. Operational Risks

Breakdowns in internal processes (methods and work procedures), systems (technical, management, and organizational), and people (inside the organization or externally in connection with the organization) are brought on by operational hazards. According to Zhang *et al., (2009),* we can classify operational risks into several categories: safety risks, planning risks, engineering risks, production risks, and technological risks. We might also include social risks that affect how the socio-technical system of the organization operates. Engineering and technological risks (new equipment, equipment selection criteria, communication networks, assessment of quantity and quality of reserves, design, mechanical sizing, data analysis, etc.) can be combined into a single category analyzed as technical risks. (Zhang *et al., 2009)* classify risks of injury and mortality related to equipment hazards and energy-source use, in the category of safety risks, as operational risks. It is important to note that (Zhang *et al.* 2009) do not distinguish work accidents as OHS risks. Injury and death in their circumstances may have detrimental effects on the operation of the organization. Operational risks can also be increased by issues with subcontracting and

partnerships between different businesses. The use of subcontractors poses a serious threat to worker health and installation safety.

B. Financial and economic risks

Mine development has economic advantages for workers and the community. Accounting for financial and economic parameters will have a direct influence on choice of technologies and work methods in mines. Profitability requires a choice of technical solutions (equipment, processes, technologies, etc.) and indicators (efficiency, productivity, profitability, etc.) that often conceals risks and constraints of different natures. For example, focusing solely on productivity can slant choice of equipment and technologies to the detriment of other considerations, such as those of OHS. Mine mechanization has led to a number of hazards, including intoxication and respiratory impairment, fires, mechanical failure, slips or falls while accessing workstations, vibration, ergonomic problems, etc. (A. Badri et. al., 2012).

It's critical to draw attention to hazards associated with capital allocation and cost control in this area. A waste reduction and elimination plan is necessary for a project to have a high return on investment. Such a plan places restrictions on the resources allotted to a mining operation in favor of raising cost-effectiveness. Investments in training, communication, and sometimes-difficult-to-identify process optimization are necessary to increase cost effectiveness. Mining companies must constantly adjust their budgets, collaborate with other businesses, and prioritize subcontracting if they want to keep cost overruns under control. Mining project feasibility studies consider a number of financial and economic factors, including price, exchange rates, budgets, and other factors, to evaluate project profitability. The precision and availability of technical data (such as predicted productivity, the quantity and quality of mineral deposits, the dependability of equipment, etc.) determine the reliability of these investigations. Mining firms are extremely susceptible to changes in the price of extracted materials. These prices are indexed on several exchanges and are based on demand around the world. These factors make it extremely crucial to be dependent on (or vulnerable to) exchange rates and market volatility (caused by consumers and rivals).

According to Ernst and Young, (2010), access to capital is also a significant risk to be taken into consideration by mines. This access to financing permits the companies to explore new deposits, set up new projects, and improve and renew equipments and means on a consistent basis.

C. Political and legal risks

It is crucial to remember that for mining companies established throughout several nations to operate effectively, they frequently face political and legal challenges. The mining industry is harmed by the negative effects of globalization. Mines have operating issues in nations with a lot of heavy bureaucracy, unstable governments, and unstable societies. In many nations, political unrest is a deciding factor when selecting whether to invest in mining exploitation. Mining businesses must evaluate the voids and variations in the host region's and nation's laws and regulations that frame their operations. Regulation and legal changes might occasionally introduce new measures that could increase exploitation expenses and make managing a business more difficult. As an illustration, changes to Polish water protection rules made in the 1980s resulted in exorbitant waste management and storage expenditures that copper companies were not prepared for. These unavoidable cost increases have the potential to cause losses and the closure of mining companies.

D. Environmental risks

In operational phases (pollution of water reserves, excessive noise, mineral ore wastes, atmospheric pollution, dust, radiation, etc.) or closure phases (long-term effects of radiation, chemical products, and mineral ore wastes, etc.), it is significant to note that researchers are preoccupied with environmental issues. Even in the nations with the strictest regulations in this area, the detrimental effects of mineral exploitation on the neighborhood and the ecosystem are constantly felt.

The majority of work involves mining, processing, and using mineral ores, which has an adverse effect on the environment. Mines use procedures for ore processing that involve a variety of chemical compounds during the operational phase. The most recent technology allows for the recovery of the greatest quantity of these products as well as the evacuation of sterile residue. Because miners all over the world lack access to the new equipment generation, the issue of chemical contamination caused by earlier methods is still up for discussion.

E. Occupational Health and Safety (OHS) risks

Recent statistics indicate a decline in occupational diseases and accidents in the mining industry in several industrialized nations, including those of the United States and Canada. The mining

industry's and governments' efforts to protect miners' safety are widely attributed to this fall. Despite these efforts, this progress falls short of what lawmakers, employees, or researchers had hoped for. OHS risks are the root cause of numerous hazards with various characteristics. We can highlight the mechanical factors (equipment, vehicles, cleaning, and maintenance), the electrical factors (electrical energy sources and electrical equipment), the physical environments (thermal stresses, humidity, dust, noise, and vibration), the human and social factors (risky behavior, fatigue, and competence), and the work methods (team management, work organization, planning, and execution of work) among the hazards identified.

2.4 Empirical Studies on Mining Project Risk Management

Empirical studies in risk management should notably be discussed in this chapter to review how other researchers have assessed the research subject under their respective scenarios. Thus, the following recent articles released in risk management under different frameworks are reviewed and discussed.

A study conducted by Izabela Jonek Kowalska in May 2014 about Risk management in the hard coal mining industry: Social and environmental aspects of collieries' liquidation, is summarized as follows: Despite an undoubtedly significant role of the mining enterprises in meeting the energy needs for human welfare, their operations are subject to risk of an extraordinary scale and extent. Among the sources of specific risk that do not occur in other manufacturing enterprises, natural hazards should be mentioned: gas, dust, rock burst, water, seismic, climatic, radioactive, and microbiologic (Wodarski and Popczyk, 2011). The enhanced risk of accidents at work and occupational diseases among the crew of the collieries is also related to these occurrences. This causes an intensification of social and environmental sources of risk (Ściążko and Zuwała, 2007). All of the aforementioned factors cause the mining operations to be regulated by separate, specific legal provisions, which are related to the increased scale and extent of legal risk. It is also worth adding that the realization of the aforementioned risk sources as well as their associated occurrence causes, above average, financial losses in the operations of the enterprise and in its environment, which also means an enhanced level of financial risk (Michalak, 2011).

The paper examines only a part of the extensive problem of risk management in a colliery, particularly the liquidation stage with its accompanying natural and social hazards (Brzychczy, 2011). In this article, the problem of social and environmental risk management is raised in the stage of colliery liquidation. The main objective of the article was to identify and assess the social and environmental hazards accompanying the collieries' liquidation and to indicate the tools necessary for taking actions aimed at reducing the effects of these hazards.

The researchers in this article concluded that, risk identification should be conducted at the level of the mining enterprise building. Furthermore, all the enterprise stakeholders who may be influenced by the possible effects of environmental and social risk should participate in this activity: employees, ecologists, and representatives of local, regional, and national authorities (Buysse and Verbeke, 2003; Delmas and Toffel, 2004). Only such sustainable cooperation enables construction of complete risk lists. At a pre-liquidation and liquidation level, such a list should be verified and completed. In turn, the assessment of natural and ecological risk should be conducted with participation of external, impartial, interdisciplinary experts, taking into consideration a possibility of deliberate underestimation of liquidation effects by the enterprise. Specialization of the experts should reflect the particular segments of the enterprise's environment, which means ecological, social, technological, and legal segments. The selection of instruments of environmental and social risk assessment in a stage of liquidation should include contemporary conceptions according to a new management paradigm. The superior and broadest conception in this area is of sustainable development (SD), which highlights the fact that the enterprise cannot create value without a permanent engagement of all the environmental participants (Boiral and Gendron, 2010). The second conception that may be used by the mining enterprises is Corporate Social Responsibility (CSR), elaborated as a result of intensive development of economies, globalization, intensification, and international expansion of large corporations (Pater and Van Lierop, 2006; Van Marrewijk, 2003; Unerman et al., 2007; Kotler and Lee, 2005). The instruments presented above support risk management especially in the stage of risk identification and assessment. In the integrated implementation of environmental and social risk management, complex standards of risk management should be applied, among which the following should be mentioned: ISO 31000 Risk Management—Guidelines for principles and implementation of risk management (2009); IEC Guide 73:2009 Risk Management—Vocabulary – Guidelines for use in standards (2009); or IEC/ISO 31010 Risk Management—Risk Assessment Techniques (2009).

Another study conducted by Charles Teye Amoatey, Samuel Famiyeh and Peter Andoh at GIMPA Business School about risk assessment of mining projects in Ghana has revealed valuable findings relevant to the research subject under study here. The fact that there is very limited sector-specific risk assessment model for the mining sector is a serious problem. This is because there are specific factors which could influence project success in this sector. Evidently, academic debate on the subject of project risk assessment in the mining sector is quite weak, especially in a Ghanaian context. The main purpose of the study therefore was to assess the critical risk factors affecting the mining projects in Ghana. In this regard, the paper has investigated the risks factors associated with mining projects in Ghana by examining the contribution of various risk factors to project failure. The study identified the five most critical risk factors in mining projects to be unstable commodity prices, inflation/exchange rate, land degradation, high cost of living and government bureaucracy for obtaining licenses. Though, the study aimed at identifying mining sector-specific risk factors, we observed that the five risk factors listed above were unique to the mining industry. Earlier studies have identified these risk factors in other sectors of the entire construction industry. Furthermore, the study found that risk assessment in the mining sector has a direct link with mining project sustainability. This implies that risk assessment helps to eliminate certain obstacles that may become a hindrance to the effective operation of mining activities. Mitigation measures for addressing the identified risk factors were discussed. The key findings emphasize the need for a comprehensive risk management culture in the entire mining sector of the country. The results show that most mining companies had risk mitigation plans in place which are aimed at addressing the most significant risk factors. Consistent with findings by Shen (1997) and Lyons and Skitmores (2004), most companies use qualitative approaches, such as brainstorming, in risk identification and development of risk mitigation measures. Additionally, there is a need to create strategies and processes for risk management that are distinctive to each nation and are guided by analytical research on how the sector operates. Government should promote the development of data collecting, analysis, and reporting systems as well as a platform for exchanging risk information among industry participants in order to lessen the exposure of mining corporations to hazards.

2.5 The Mining Industry in Ethiopia and Associated Risks

Africa as a whole is a "Minerals Economy" with extractives comprising about two-thirds of the continent's exports. Following the AMV (Africa Mining Vision) the key driver is realizing the enormous mineral backward linkages, or mining supply chains into capital goods, consumables and services. "Procurement by a mining operation is the single largest potential economic impact in a host country, more than payments in taxes, wages and community investment combined" (Geipel, 2017).

According to literatures reviewed from the Ministry of Mines (MoM), geological exploration activities in Ethiopia dates back to 1839 when a French researcher named Rupeel conducted researches on geology of the country. However, mineral exploration activities by government at institution level started late at 1928. According to a proclamation enacted in 1944 during the reign of Emperor Haileselassie, it legislates any mineral commodity found in and on the surface of the earth in Ethiopia will require the permission of the emperor for investigation, development and production activities.

An organized and planned exploration activities by the government with the support of UN agencies started in 1968. This has necessitated the establishment of geological survey of Ethiopia in 1969 and mineral regulatory office of Ethiopia in 1970 under the ministry. Nonetheless, the ministry of mines had undergone frequent merger and differentiations since its establishment in 1966. Later in 1983, with an intent to tackle challenges in the mineral sector, the geological survey was upgraded to 'Ethiopian Geological Study Institute' and 'Ethiopian Mineral Development Corporation' was established with a mandate to develop, produce, sell and purchase mineral resources in the country.

During the FDRE era, the ministry of mines has been re-established in 2002 with a mandate:

- To expand mineral development
- To organize and obtain mining cadaster, retain information related to minerals, producing and distribution of mineral reports
- To prepare policies, laws and regulations, that will secure and protect the mineral wealth of the country

- To give license to local and international investors that show interest in exploration and production of mineral wealth in the country
- **To regulate activities of licensed companies in exploration and mining portfolio and to check their compliance against the contract they agreed with the ministry**
- To establish research and training institutions that will help boost the mineral sector in the country

These have primarily remained the mandates of the ministry to this time ruling government with a few modifications thereto.

In light of these mandates, one can easily understand that the ministry is delegated to strictly regulate and monitor the general activities of mining companies in the country in every phase of their project life cycle. Monitoring of risks in mining projects is embedded in the regulatory framework of the ministry though it is not explicitly written in their documents. As mining is a global endeavor and the industry is highly regulated due to its sensitivity and complexity, risk challenges seen in other parts of the globe are evident in Ethiopia's mining sector as well. These risks are mainly operational, financial, social, environmental and political/legal in nature. In recent times, due to political turmoil in the country, risks associated with security concerns and changes in political landscape of the country are posing serious challenges to investors to swiftly transform their projects into revenue generating ventures. On the other hand, the current government's policy which takes the mining sector as one of the five pillars of the macro economy and revision of some of the legislations thereto is attracting the attention of multi-national mining enterprises as active players in the industry.

2.6 Conceptual Framework of the Study

This research work revolves around five variables in the risk management process in mining projects. Hence, based on the theoretical and empirical reviews in the literature reviews above; the following conceptual model for the research is developed.

Figure 2.3 Conceptual Model of the Study

CHAPTER 3: RESEARCH METHODOLOGIES

There are several research methods that could be adopted for researching project risk management in mining projects depending on the objectives, scope and significance of the research work. The researcher for this research project intends to conduct a descriptive type of research which involves gathering of primary and secondary data to fully describe the phenomena of the research under study. Furthermore, it employs survey methods to analyze the topic under study as case study of active mining projects in Ethiopia to overview practices in the country at large.

3.1 Research Design

Descriptive research type is adopted for this research purpose because the research basically is concerned with characterizing risk management knowledge and practices of mining projects operating in Ethiopia. In light of this, the researcher has defined five research variables measured in due course of conducting this research in mixed (both qualitative and quantitative) research approach. The research design in this regard is rigid in terms of the research objectives set out, data collection methods, sampling methods selected and the processing of data and reporting of findings.

Since the research objective is to assess risk management knowledge and practices of mining companies in Ethiopia, a multiple case study approach for active mining projects was selected to fit into the descriptive type of research. The researcher believes this method will ensure access to representative and relevant information pertaining to the research topic under study. Secondary data on the research subject had been collected through documents including books, manuals, policies, standards and guidelines from the internet and other sources. The literatures reviewed has been developed in a way to give insight on risk management knowledge and practices within the process related to local mining projects context.

Questionnaires and interviews were devised as data collection techniques to collect primary data from the sources that will be outlined below. Structured format is adopted for the questionnaire and unstructured format is used for interviews to ease and minimize the cost of data collection and

processing efforts. These methods and format are believed fit and convenient to the research purpose being undertaken here.

3.2 Description of Study Variables

This research project has identified the following study variables that had been considered for the study of 'Project risk management in mining projects' in Ethiopia's mining industry context:

1. **Risk Planning**: this variable examines the risk knowledge of mining companies and their prior preparedness and planning for anticipated project risks (PMO, 2017).
2. **Risk identification techniques**: This variable examines the methods used to identify risks in mining projects, such as brainstorming, risk checklists, historical data analysis, and other approaches (PMO, 2017).
3. **Risk assessment methods**: This variable looks at the ways in which risks are evaluated, such as probability and impact analysis, risk matrix, or other methods (PMO, 2017).
4. **Risk response strategies**: This variable investigates the strategies used to address identified risks, such as avoidance, mitigation, transfer, or acceptance (PMO, 2017).
5. **Risk monitoring and control**: This variable examines the techniques and tools used to track and control risks during the project's execution phase, such as regular risk review meetings, risk reporting, and contingency planning (PMO, 2017).

3.3 Description of Study Area and Target Population

The mining industry is one of the sectors that exhibits high risks in its activities. This research focuses on mining activities of active mining projects in Ethiopia which had recently been engaged on exploration and extraction of valuable minerals in different parts of the country. The researcher has identified four mining companies (Contractors/Client) working on different mineral commodities, and the Ministry of mines (regulator) for this research purpose, namely:

1. BEAEKA General Business — Marble and Granite
2. Oromia Mining Share Company — Gold

3. Tulu Kapi Gold Mine Share Company Gold
4. El Net Technology PLC Gold

BEAEKA General Business is engaged on the mining of dimension stones (marble and granite) in its five active quarry mine sites in Bullen Wereda, Metekel Zone, Benshangul Gumuz regional state, and Bure Wereda, West Gojjam Zone, Amhara regional state respectively. It is currently on the operation phase of the projects and is producing blocks and chips with a 500m^3 per month mine capacity each for the past five years. It has its marble and granite processing plant at Bahirdar city where it produces finished products to be used on finishing phase of the building construction industry. Depending on their production capacity the mining projects could comprise of 100-150 project team members consisting of professionals and labors.

Tulu Kapi Gold Mine Share Company is an industrial scale mining firm working under the parent company of KEFI Minerals which is a registered firm in London stock market. The company has undertaken more than 10 years of exploration activity and is currently working on the development phase of its Tulu Kapi gold mine project at West Wollega Zone, Oromia regional state and is expected to transition to operation within the coming 2-3 years. When operational, the project is expected to produce 4000 kg of gold with 250-300 million USD revenue annually. This is going to mark as the largest gold mine project opened in Ethiopia over the past three decades. The project currently employs about 60 permanent and temporary work force but when operational it will have more than 900 permanent employees.

El Net Technology and Oromia Mining Share Company are emerging new mining firms in Ethiopia's mining industry. They have only joined the country's mining industry in the past two years with a limited capital expenditure on active projects. El Net is currently working on mining of placer gold deposits with erection of small scale gold washing plant at Assosa zone, Benshangul Gumuz regional state. Oromia Mining Share Company is also working on mining of placer gold deposits at Guji zone, Oromia regional state with installation of three small scale gold washing plants. El Net Technology currently consists of about 20-30 work force working on the mining project and Oromia Mining Share Company has about 60 work force working on its three small scale gold mining projects.

Thus, summing up the population in the different company groups, a total of about 270 population size is considered for this research purpose.

3.4 Sampling Technique and Sampling Size

Non-probability purposive sampling technique is used for this research study. The purpose of this sampling technique here is to concentrate on a small group of respondents that the researcher carefully chooses so that their in-depth knowledge of the field and the topic under investigation will provide the best possible insight into issues that need in-depth explanation. In this case, the Ministry of Mines (MoM) had been crucial in providing information about the active mining firms that are currently operating in the nation, this has easily informed the research population. Moreover, this has made it easier for the researcher to choose the size and type of his target projects, allowing the effort to focus on coming to the best conclusion possible regarding the initially specified research objectives.

Hence, the researcher has collected primary data from 41 respondents via questionnaire and also interviewed 3 senior managers; 2 from clients/contractors and 1 from the regulator.

3.5 Data Collection

After choosing the target projects, the researcher has gathered information about mining contractors'/clients' knowledge, strategy, and practices related to risk management in mining projects through interviews and questionnaires. Key project professionals who had defined roles in their projects has been approached as sources of trustworthy data using the suggested research approach.

Questionnaires amounting in number to 12 has been distributed to respondents working at BEAEKA General Business. The respondents were from the project quarry sites (7), corporate supervisory team at head office (2) and from the manufacturing plants (3). Oromia Share Company's respondents had also been approached the same way. 13 questionnaires were filled out and returned back from them. The respondents consists of employees from the gold mine site (9) and the supervisory team at head office (4). 6 senior project development professionals with multiple years of experience locally and abroad were approached at Tulu Kapi Gold Mine Project.

4 project employees at El Net Technology including the project manager had been approached via questionnaire.

The researcher had interviewed the general manager of Oromia Mining Share Company, the Project Manager of Tulu Kapi Gold Mine Project, and a senior desk officer at Ministry of Mines to collect data pertaining to the research work under study.

The researcher has also tried to gather first-hand information about risk management audit findings of mining projects in the country from the concerned department of the Ministry of Mines (MoM), a regulatory body that oversees and regulates both the technical and national regulatory compliance of mining projects in the country, through interviewing of a senior officer at the department. Questionnaires had also been dispatched to professionals (6) who are directly delegated with the supervisory role of regulating mining companies' activities in the country.

Finally, the researcher has paid a visit to one of Oromia Mining Share Company's project site (Bersisa Gold Mine) to observe working conditions of Mine projects on site as in relation to risk management practices.

3.6 Data Analysis

Microsoft excel version 2013 application software was used for analysis of primary data in this research endeavor. The research employed a descriptive data analysis technique using frequency, percentage, mean and standard deviation parameters. The findings of this research are presented with tables and narrative summaries along with descriptive statistics results.

3.7 Reliability and Validity Analysis

Reliability is measures of internal consistency that is concerned with item's responses consistent across constructs and indicates scores are stable over time when the instrument is administered (Creswell, 2009). To measure the reliability of the instrument for this research purpose, a 0.70 Cronbach's coefficient alpha was conducted. George and Mallery (2003) provide the following rules of thumb:

> .9	Excellent	> .6	Questionable
> .8	Good	> .5	Poor
> .7	Acceptable	< .5	Unacceptable

Table 3.1 Reliability Test Rule of Thumb (George and Mallery, 2003)

Using Microsoft excel application software, the test was conducted and the overall **Cronbach's Alpha coefficient results in 0.716** which is acceptable according to the above table. Hence, the results from the questionnaires are reliable.

Item	Number of Items	Cronbach's Alpha coefficient
Risk planning	5	0.742
Risk Identification	6	0.765
Risk Analysis	4	0.761
Risk Response	3	0.782
Risk monitoring & Control	4	0.738

Source: Own survey, 2023

Table 3.2 Cronbach's Alpha Coefficient Test

Cronbach's alpha coefficient for each variables also shows values greater than 0.70 mark, thus all are acceptable and reliable.

Any sort of reliable and accurate assessment can be thought of as having validity at its heart. The degree to which a measurement tool adequately covers the subject being studied is known as content validity. In order to ensure that the instruments weren't unclear or confusing for the respondents, a pilot test of the instruments was conducted with 10% (5) of the sampled respondents.

3.8 Ethical Considerations

The researcher has used all the research instruments with full consent of the respondents. The four organizations and the regulator (MoM) which have been selected for this research purpose was formally approached through a letter written from Addis Ababa University. The letter clearly depicted the purpose of their engagement in the research and requested their consent to cooperate in the process.

The respondents likewise have been oriented the purpose of the research and also told the confidentiality of their responses to the research instruments. Moreover, they have also been communicated to respond to the questionnaires with full honesty, since that will add depth and breadth to the research findings.

CHAPTER 4: DATA PRESENTATION AND ANALYSIS

This chapter presents the analysis and interpretation of data obtained through 41 questionnaires and 3 interviews conducted to assess the risk management knowledge and practice of mining companies in local settings. To assess this, the researcher has approached 4 active mining companies working on gold, and dimension stones projects. Moreover, the researcher has also conducted an interview and distributed questionnaires to experts at FDRE Ministry of Mines (MoM) – the legal entity which regulates and controls activities of mining firms in Ethiopia, as an approach to cross check and verify the responses given by respondents at the mining companies.

4.1 Response Rate

The researcher has distributed 49 questionnaires to potential respondents in the selected four mining companies and 41 questionnaires have been filled out and returned back to the researcher on time.

Out of the 28 questions presented to the respondents in Likert scale, about 3.7% respondents didn't respond to one of the questions in the questionnaire. All the demographic and multiple questions are responded to with 100% rate. With regards to questions the researcher presented to respondents about scaling of major risk factors in mining projects, about 9.4% of the respondents didn't scale one of the risk factors in the questionnaire.

4.2 Demographic Information of Respondents

This section presents the respondent's general background information such as their level of education, area of discipline, level of experience in mining industry, and phase of the project life cycle they are most experienced with.

Demographic Items	Count	Percent
Area of Profession/Technical training		
Engineering	9	22.0%
Geology	25	61.0%
Environment	1	2.4%
Business/Finance/Economics	4	9.8%
Sociology/Management	2	4.9%
Level of Education		
Secondary School	0	0.0%
Vocational School	0	0.0%
Bachelor's degree	28	71.8%
Master's degree	11	28.2%
Ph.D. holder	0	0.0%
Level of Experience/Position		
Junior professional	2	5.1%
Skilled technician	1	2.6%
Senior professional	30	76.9%
Management	6	15.4%
Years of Experience in Mining Industry		
0-5	8	20.0%
6-10	6	15.0%
11-15	17	42.5%
16-20	5	12.5%

> 21	4	10.0%
Nature of Company of the Respondents' Employer		
Contractor	24	37.5%
Consultant	0	0.0%
Client	34	53.1%
Regulator (Federal or regional level)	6	9.4%
Project Phase Respondents Involved		
Exploration	16	32.7%
Project development	11	22.4%
Operations	22	44.9%
Project Experience of Respondents		
0-5	24	60.0%
6-10	6	15.0%
11-15	10	25.0%
16-20	0	0.0%
> 21	0	0.0%
Total Number of Respondents	**41**	**100%**

Source: Own Survey, 2023

Table 4.1 Respondents' demographic information summary

As presented in the table above, about 61% (25) of the total respondents are professionals with geology or earth science discipline and about 22% (9) of the total respondents are engineers with different specialties. The third highest proportion of 9.8% (4) respondents are professionals with business, finance and economics background and the remaining 4.9% (2) are professionals with management or sociology background. Since mining project risks are multifaceted and invades areas of multiple disciplines, the professional mix is a good input to portray the real characteristics of risks in mining projects. Moreover, the highest percentage of geologists and engineers among

the respondents is a good indication to get reliable results from the questionnaires since the two professions are the major key players in mining projects both in impact and number.

As per the demographic table above, 71.8% (28) of the total respondents are professionals with bachelor's degree and the remaining 28.2% (11) are professionals with master's degree. This shows that all respondents are with good literacy level that are able to read, understand and respond to questions on the questionnaires appropriately. Since risk management knowledge and practice requires a certain level of literacy to understand and integrate knowledge with practices, the respondents' good level of literacy is of significant input to this research purpose.

The table above also shows about 76.9% (30) of the total respondents in senior professional level, 15.4% (6) as management staff, 5.1% (2) are junior professionals and 2.6% (1) are skilled technicians. In terms of year of experience, about 42.5% (17) of the total respondents have experience between 11-15 years, 20% (8) have between 0-5 years, 15% (6) have 6-10 years and the remaining 22.5% (9) have above 16 years of total experience in the mining industry. The higher percentage of senior professionals and management staff in the respondents' mix with more than 11 years total experience is a good implication to obtain a reliable responses from the questionnaires based on their good knowledge and longer on job experience. Professionals with longer years of service are believed to be all rounded and may have read few literatures about risk management in their respective work contexts.

As presented in the table above, about 53.1% (34) of the total respondents' employers are mining clients (mineral licensees), 37.5% (24) are mining contractors and 9.4% (6) regulators at federal level. Clients in mining projects are companies which are granted mining or exploration licenses in certain mineral localities, whereas mining contractors are specialist contractors which are hired by mining companies (licensees) to undertake mining exploitation and/or exploration activities on behalf of the licensee client. However, often times mining clients are themselves specialized mining contractors which undertake every mining activities on their concession area hence labeled as clients and contractors simultaneously. Thus, the percentage mix from the respondents clearly show that all the major stakeholders in mining projects which deals with mining risks are included in the research survey.

Statistical figures in the above table show about 44.9% (22) of the total respondents are involved in the operation phase of the project, 32.7% (16) are involved in exploration phase and 22.4% (11) are involved in the project development phase of the project. Since respondents are from the different phases of the project life cycle, this shows that risks in all phases of mining projects are covered in this research endeavor.

As clearly depicted in the above table, about 60% (24) of the total respondents have 0-5 years of project experience, 25% (10) have 11-15 years and the remaining 15% (6) have 6-10 years of project experience. This shows that respondents are chosen from active projects which have spanned less than 15 years as initially intended by the researcher and their project experience shown in the survey is a clear indication of their awareness about risks in mining projects.

4.3 Descriptive Statistics

The researchers has tried to show findings of the research endeavor with descriptive statistics method. This section presents findings of the research regarding the research variables outlined in chapter 3 then summarizes the results in descriptive statistics tables.

4.3.1 General Risk Management Practices

This research has tried to cover the overall risk management practices of mining companies in Ethiopia. Needless to say, in the risk management framework the fundamental elements in the process namely risk planning, risk identification, risk analysis, risk response and risk monitoring & control are thoroughly studied in this research endeavor. As mining projects are the riskiest industrial businesses among its contenders in terms of contributions to national macro-economies, but as such enough attention is not given to the subject. There is little published research on project risk management in the mining industry. A literature review of risk assessment methods in the mining industry over ten years from 2010-2020 identified 94 articles on risk analysis, risk assessment, and risk management, but only a single article was focused on project risk management (Tubis et al., 2020). Practitioners in the industry also face gaps on the ground in availability of comprehensive risk management guide documents specific to the extractive industry which would assist them in optimal handling of risks in their respective projects.

The fact that there is very limited sector-specific risk assessment model for the mining sector is a serious problem. This is because there are specific factors which could influence project success in this sector (Charles Teye Amoatey, 2017). Hence, the researcher believes this research would contribute its part in filling gaps pertaining to the subject.

	General Risk Management Questions	**1**	**2**	**3**	**4**	**5**	
		Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Total**
1	There is good knowledge about risk management in the project team.	1	5	11	19	3	**41**
2	Project team members receive training or have enough knowledge about how to handle uncertainties/risks.	2	10	11	13	3	**41**
3	The project team members are well experienced.	0	4	8	21	7	**41**
4	There is adequate top management support for risk management.	1	3	9	20	6	**41**
5	The organizational environment is stable.	1	5	15	16	3	**41**
6	Adequate resources are allocated for the project team.	0	7	9	20	3	**41**
7	The project has a standard risk management process.	2	9	9	17	1	**41**
8	There is responsible person or department to handle risks.	3	5	8	20	4	**41**
9	There is a policy and procedure that guide the project team to go through a disciplined risk management process.	1	6	7	22	4	**41**
10	Project team have in-depth experience in risk management.	1	13	9	14	3	**41**
	Total **%**	**12** **3.05%**	**67** **17%**	**96** **24.4%**	**182** **46.2%**	**37** **9.4%**	**410** **100%**

Source: Own Survey, 2023

Table 4.2 General risk management practice

Scale	SD	D	N	A	SA	Total	Mean	SD
Code	**1**	**2**	**3**	**4**	**5**			
There is good knowledge about risk management in the project team.	1	5	11	19	3	**41**	**3.46**	**3.06**
The project has a standard risk management process.	2	9	9	17	1	**41**	**3.16**	**2.79**
There is a policy and procedure that guide the project team to go through a disciplined risk management process.	1	6	7	22	4	**41**	**3.55**	**3.15**
Project team have in-depth experience in risk management.	1	13	9	14	3	**41**	**3.13**	**2.77**

Source: Own Survey, 2023

Table 4.3 Risk management policy and experience

As presented in the table above, about 10 questions were presented to respondents in Likert scale to assess the overall risk management knowledge and practice of their company - about existence of policies and other relevant documents to guide their risk management process in the projects, and about management support and availability of resource for risk management process. Thus, about 46.2% (182) of the total 394 responses have 'Agreed' to the statements forwarded in general context of risk management practice in their respective projects, 24.4% (96) responses were 'Neutral' to the statements, and 17% (67) responses 'Disagreed' to the statements forwarded in general risk management practice in mining projects. However, the 3 interviews conducted and observations by the researcher revealed the absence of documents for risk management practice, absence of standard risk management process, and lack of in-depth experience in risk management at project level. Project risk management techniques have become integral components of major project development, shown by inclusion in major bodies or knowledge, standards, and specialty guidelines (AACEI, 2015; PMI, 2017) and professional certifications in project risk management from these same organizations. Despite the growth and maturity of project risk management strategies, there are still serious problems with the prevalent methods.

Exception to the responses in this study's survey was the responses by the international mining company TKGM which has a standard risk management process, policy and guidelines to guide its risk management practice and in-depth experience of their project team in risk management process that is extracted from their long years of experience in the industry.

Responses obtained from the interview with the regulator institution inferred that industrial scale mining companies have a good understanding of risk management and adopts a standard process in managing uncertainties in their project activities however, small scale mining companies which gets their license from regional offices lack to adopt good risk management practices. The interviewee went on to claim that their overall project management practice is unsatisfactory and they lack the necessary professionals and tools to handle risks emerging in their project endeavors.

Uncertainties that occur in the project are mostly handled by	**Code**	**Count**	**Percent**
Project manager	1	19	42.2%
Senior management	2	8	17.8%
Consultant	3	2	4.4%
Project team	4	16	35.6%
Special Risk management (RM) team	5	0	0.0%
Total		**45**	**100.0%**
Mean		**2.33**	
Standard Deviation (SD)		**10.06**	

Source: Own Survey, 2023

Table 4.4 Responsible party for project risk handling

As presented in the table above, 42.2% (19) of the total respondents said that uncertainties in the projects are handled by the project manager, 35.6% (16) believes that uncertainties are handled by engaging of the whole project team, 17.8% (8) believes that some high rank uncertainties are handled by the senior management staff and the remaining 4.4% (2) responded that consultants are hired to handled uncertainties in their project. Literatures dictate that all the enterprise stakeholders who may be influenced by the possible effects of environmental and social risk should participate in this activity: employees, ecologists, and representatives of local, regional, and national

authorities (Buysse and Verbeke, 2003; Delmas and Toffel, 2004). Only such sustainable cooperation enables construction of complete risk lists.

The responses from the interviewees and researcher's observation revealed similar results as the questionnaires, that is the project manager is fundamentally responsible for handling any uncertainties and routine activities of the project with the support from his/her team. The manager and members of the project team at different levels identify and manage risks in various forms (Lavanya & Malarvizhi, 2008). Moreover, interviewees disclosed that some strategic and high profile risks with significant financial implications on the project are handled by the senior management at corporate level. Furthermore, it is also indicated in the interview that some international companies hire external risk management specialist consultants to handle any uncertainties in their projects.

Risk management is thought and implemented at which stage of the project?	**Code**	**Count**	**Percent**
Conceptual stage	1	11	12.6%
Planning stage	2	32	36.8%
Implementation stage	3	22	25.3%
Monitor & Control stage	4	15	17.2%
Closure	5	7	8.0%
Total		**87**	100.0%
Mean		**2.71**	
Standard Deviation (SD)		**2.44**	

Source: Own Survey, 2023

Table 4.5 Risk implementation stages

As presented in the table above, 36.8% (32) of the total respondents responded that risk management is practiced starting from the planning stage of the project, 25.3% (22) responded that it is practiced at the implementation stage, 17.2% (15) responded that it is practiced at monitoring

& Controlling stage of the project, 12.6% (11) respondents responded that risks are thought and managed beginning from conceptual stages of projects and the remaining 8% (7) respondents believes that risk management practice goes all the way to closure stages of projects. A comprehensive collection and classification of risks in the design and construction stage of mining projects document many risks in the different project stages that could be used as a guideline to complete a risk assessment in new mining projects (Badri et al., 2012).

However, results from the interview revealed that apart from one international company surveyed, most companies practice risk management at the implementation stage of projects when the risks occur in real time. Observation on site however revealed that risk management is barely done to all risk factors, but only selected risks are managed. The remaining risks are handled at crisis stage upon their worst occurrence.

Summary of Descriptive Statistics on General Risk Management Practices

	Statements	**Total (N)**	**Mean**	**Standard Deviation**
1	There is good knowledge about risk management in the project team.	41	3.46	3.06
2	The project has a standard risk management process.	41	3.16	2.79
3	There is a policy and procedure that guide the project team to go through a disciplined risk management process.	41	3.55	3.15
4	Project team have in-depth experience in risk management.	41	3.13	2.77
5	Uncertainties that occur in the project are mostly handled by:	45	2.33	10.06
6	Risk management is thought and implemented at which stage of the project?	87	2.71	2.44
	Grand Summary	**48.2**	**3.1**	**4.0**

Source: Own Survey, 2023

Table 4.6 Summary of Descriptive Statistics on General Risk Management Practices

As depicted on the summary table above, the average of the responses obtained for the general risk management practice in their respective projects is around neutrality on the scale. This shows that most of the respondents are unaware of risk management knowledge and practices in their projects. The higher values of the standard deviations shows that the responses from the respondents are dispersed far from the average (mean) value of the response implying a different perception of events by the different respondents in similar project undertakings.

4.3.2 Risk Planning Responses

	SD	D	N	A	SA	Total	Mean	SD
Code	**1**	**2**	**3**	**4**	**5**			
There is systematic approach or careful planning.	2	7	10	17	4	**41**	**3.35**	**2.99**
Relevant stakeholders are involved in the risk planning.	0	7	9	19	5	**41**	**3.55**	**3.15**
Tools like expert judgment, meetings or others are considered for risk planning.	1	1	8	28	2	**41**	**3.73**	**3.26**
Environmental, social, and political factors are included as an input to plan for uncertainties.	0	3	2	29	6	**41**	**3.95**	**3.49**
Risk management plan is incorporated with the project plan.	0	5	4	23	7	**41**	**3.82**	**3.40**
Total	**3**	**23**	**33**	**116**	**24**	**205**		
Total %	**1.5%**	**11.6%**	**16.6%**	**58.3%**	**12.1%**	**100%**		
Mean Summary							**3.68**	**3.26**

Source: Own Survey, 2023

Table 4.7 Risk planning responses

As presented in the table above about responses of respondents regarding risk planning in their respective projects, about 58.3% (116) of the total responses given to five questions have ‘Agreed’

to systematic risk management planning, involvement of relevant stakeholders in planning, use of tools and consideration of important factors in risk planning process in their respective projects. 16.6% (33) of the responses were 'Neutral' to risk planning statements, 12.1% (24) of the responses have 'Strongly Agreed' to the existence such risk planning systems in their projects, and the remaining 13.1% (26) of the responses are in strong disagreement or disagreement of the existence of risk planning systems and practices in their projects.

Moreover, general observation from the summary statistics of the mean and standard deviation values infers that most of the responses to risk planning statements in the questionnaire were in between neutrality and agreement of the different aspects in the risk planning process in projects. The higher values of the standard deviations in the survey above show that the responses from the respondents are dispersed far from the average (mean) value of the response implying a different perception of events by the different respondents in similar project undertakings. Responses obtained via the interview are opposite to the results from the questionnaires that is, with the exception of the international company, most of the companies lack risk planning process and practices in their project management endeavor. This has a grave impact on the whole project management process and project deliverables. One study across industrial sectors, including mining, showed that 65% of capital megaprojects fail to achieve their cost and schedule estimates (Merrow, 2011), while another demonstrated that 45% of large engineering projects fail to meet objectives (Miller & Lessard, 2001). Mining projects seem to align with the broad studies of industrial projects (Bertisen & Davis, 2008; Ernst and Young, 2017b; Kuvshinikov et al., 2017). Since risk management is an iterative process, every aspect of it should be planned for and implemented during every stage of the project. At the beginning of the project, the risk management framework for the organization is examined and modified to develop the project risk management plan.

4.3.3 Risk Identification Responses

	SD	D	N	A	SA			
Code	**1**	**2**	**3**	**4**	**5**	**Total**	**Mean**	**SD**
Project team members play roles to identify risk.	0	2	4	28	6	**41**	**3.95**	**3.48**
Risk register is produced as an output in risk identification process	0	5	9	23	3	**41**	**3.60**	**3.16**
Documentation review conducted to identify risks.	0	5	4	28	2	**41**	**3.69**	**3.24**
Expert judgment or brainstorming is used to identify risks.	1	2	3	26	4	**41**	**3.83**	**3.39**
Total	**1**	**14**	**20**	**105**	**15**	**164**		
Total %	**0.65%**	**9%**	**12.9%**	**67.7%**	**9.7%**	**100%**		

Source: Own Survey, 2023

Table 4.8 Risk identification knowledge and strategies

As presented in the table above, about 67.7% (105) of the total respondents have 'Agreed' to the existence of risk identification process, use of tools in identifying risks and involvement of project team in the identification process. 12.9% (20) of the total responses have kept neutrality to risk identification statements of the questionnaire, the remaining about 9% (14) of the responses each have equally agreed and disagreed to statements forwarded regarding risk identification process in their respective projects.

Risk identification should be conducted at the level of the mining enterprise building (Kowalska, 2014). In this research's survey responses obtained via interview revealed the existence of risk identification practices, the level of which depends on the characteristics of the risks and the level of complexity of the company undertaking the project. Observations also entail lack of systematic risk identification strategies which would lead to many surprises and costly risk management responses given the risky nature of the industry. For instance, Agnico-Eagle Mines recently opted to shut down the Goldex Mine in Val d'Or, Quebec, despite it being in full commercial production,

due to unanticipated problems with geological stability. The corporation has suffered a loss of $190 million as a result of this early shutdown (Rice, 2021).

The following method is primarily used to identify risks within the project	**Code**	**Count**	**Percent**
Expert judgment	1	18	33.3%
Checklists	2	18	33.3%
Document review	3	9	16.7%
Assumption analysis	4	9	16.7%
Total		**54**	**100.0%**
Mean		**2.17**	
Standard Deviation (SD)		**1.91**	

Source: Own Survey, 2023

Table 4.9 Risk identification tools

As presented in the table above, equally each 33.3% (18) of the total responses believe tools used for risk identification process are expert judgment and risk checklists respectively. This implies that projects mostly rely on individual experts especially on project managers for their risk identification process or prepared checklists to identify potential risks. Document review and assumption analysis each have obtained 16.7% of response from the total respondents as a tool for the risk identification process.

Interviewees conducted with senior management have yielded results indicating lack of a specific tool identified by the organization. Any tools convenient by the project manager and his/her team mostly of ‘expert judgment’ are used at sole discretion of the project manager. The management only oversees the risks to be checked and mitigated optimally. The researcher upon observation also didn’t see any systematic tools adopted by the organizations with the exception of TKGM adopting risk register as its primary tool.

Who participates in the risk identification process?	Code	Count	Percent
Top management	1	16	23.5%
Project manager	2	20	29.4%
Project team members	3	23	33.8%
External consultant	4	9	13.2%
Total		**68**	**100.0%**
Mean		**2.37**	
Standard Deviation (SD)		**2.05**	

Source: Own Survey, 2023

Table 4.10 Responsible party in risk identification

As presented in the table above, 33.8% (23) of the responses admits the involvement of project team members in the risk identification process, 29.4% (20) of the total responses believes the project manager is the one responsible solely for the risk identification process, 23.5% (16) responses revealed the involvement of top management in the identification of some of the critical strategic risks in the project, the remaining 13.2 % (9) of the responses responded that external consultants are engaged in the identification process.

Moreover, the responses obtained from the interviews inferred similar results that is most of the risk identification tasks fall on the shoulders of the whole project team with a key role given to the project manager in coordinating and steering the process.

Summary of Descriptive Statistics on Risk Identification

Statements/Questions	Total (N)	Mean	SD
Project team members play roles to identify risk.	41	3.95	3.48
Risk register is produced as an output in risk identification process	41	3.60	3.16
Documentation review conducted to identify risks.	41	3.69	3.24
Expert judgment or brainstorming is used to identify risks.	41	3.83	3.39
The following method is primarily used to identify risks within the project	54	2.17	1.91
Who participates in the risk identification process?	68	2.37	2.05
Mean Summary	**46.17**	**3.27**	**2.87**

Source: Own Survey, 2023

Table 4.11 Summary of Descriptive Statistics on Risk Identification

As depicted on the summary table above, the average of the responses obtained for the risk identification system and practice in their respective projects is around neutrality on the scale. This shows that most of the respondents are not familiar with systematic risk identification process in their respective projects, however the use of common tools is evident in their practices. The higher values of the standard deviations shows that the responses from the respondents are dispersed far from the average (mean) value of the response implying a different perception of events by the different respondents in similar project undertakings.

4.3.4 Risk Analysis Responses

	SD	D	N	A	SA			
Code	**1**	**2**	**3**	**4**	**5**	**Total**	**Mean**	**SD**
Identified risks are characterized before being analyzed as environmental, technical, financial, social, OHS and political.	1	3	8	23	5	**40**	**3.70**	**3.28**
There is a measurement system to analyze the risk.	3	7	6	18	6	**40**	**3.43**	**3.11**
Project documents are updated after risk assessment.	5	7	9	15	4	**40**	**3.15**	**2.86**
Total	**9**	**17**	**23**	**56**	**15**	**120**		
Total %	**7.5%**	**14.2%**	**19.2%**	**46.7%**	**12.5%**	**100%**		

Source: Own Survey, 2023

Table 4.12 Risk analysis knowledge, and system

As presented in the table above, the risk analysis statements on the questionnaire have tried to evaluate the existence of measurement system to analyze risks, and characterization of risks in their respective category before being analyzed. Hence, 46.7% (56) of the total responses were in agreement with these statements forwarded regarding risk analysis in their projects, 19.2% (23) of the responses were neutral to opinion on risk analysis system. A good portion of 21.7% (26) of the responses obtained were in disagreement and strong disagreement to the risk analysis statements. An early study on project risk management methods in mining discusses the lack of reliable input data for quantitative risk techniques and suggests that the resultant analyses could be improved through access to higher quality information from previous projects (Atkinson et al., 1996)

Interview results from senior management infers lack of systematic risk assessment practices at project level. Empirical reviews suggest that the assessment of natural and ecological risk should be conducted with participation of external, impartial, interdisciplinary experts, taking into consideration a possibility of deliberate underestimation of liquidation effects by the enterprise. Specialization of the experts should reflect the particular segments of the enterprise's environment,

which means ecological, social, technological, and legal segments (Kowalska, 2014). Hence, contrary to suggestions by the industry scholars, the surveyed companies lacks to adopt a systematic risk assessment/analysis practice. Implications to the lacking of this risk management element is catastrophic to projects. Risk assessment in the mining sector has a direct link with mining project sustainability; this implies that risk assessment helps to eliminate certain obstacles that may become a hindrance to the effective operation of mining activities (Charles Teye Amoatey, 2017).

What tools are used to analyze identified risks in your project?	**Code**	**Count**	**Percent**
Probability and impact analysis	1	17	30.4%
Risk matrix	2	13	23.2%
Monte Carlo simulation	3	1	1.8%
Subjective assessment based on expert judgement	4	16	28.6%
Ranking based on past experience	5	8	14.3%
None	6	1	1.8%
Total		**56**	**100.0%**
Mean		**2.79**	
Standard Deviation (SD)		**2.72**	

Source: Own Survey, 2023

Table 4.13 Risk analysis tools

As presented in the table above, about 30.4% (17) of the responses obtained admitted the use of probability and impact analysis tool for the risk analysis process, 28.6% (16) of the total responses claimed the use of subjective assessment based on expert judgement for their project risk analysis, and the other 23.2% (13) of the responses voted for the use of risk matrix as their risk analysis tool, 14.3% (8) of the responses have chosen ranking based on past experience as an ideal tool for their analysis process. A very small percentage of 1.8% (1) responded to the use of Monte Carlo simulation tool for their risk analysis. A literature by Dale F. Cooper, (2005) suggest that risk register and a risk matrix are two of the most popular methods for managing project risks. These tools combine two dimensions—probability of occurrence and impact—to assess and analyze

risks. A risk score is created by combining probability and impact; this risk score can be analyzed qualitatively or statistically.

The responses obtained from the interviews have yielded similar results that the majority of the surveyed projects use probability and impact analysis, or their combination of risk matrix and expert judgment of subjective assessments. This goes in line with empirical reviews and the responses from the risk identification stage in this survey; that's surveyed projects are majorly dependent on the expert judgment of their project manager along with support of the team with adoption of probability and impact assessment tools with varying mix.

Summary of Descriptive Statistics on Risk Analysis

Statements/Questions	Total (N)	Mean	SD
Identified risks are characterized before being analyzed as environmental, technical, financial, social, OHS and political.	41	3.70	3.28
There is a measurement system to analyze the risk.	41	3.43	3.11
Project documents are updated after risk assessment	41	3.15	2.86
What tools are used to analyze identified risks in your project?	56	2.79	2.72
Mean Summary		**3.27**	**2.99**

Source: Own Survey, 2023

Table 4.14 Summary of Descriptive Statistics on Risk Analysis

As presented in the descriptive summary above, the mean value of the responses is a little above the average value which shows that there is agreement on the existence of risk analysis tools and practices in their projects. However, there lacks a systematic and comprehensive approach, with non-existence of standard documents, is evident in undertaking the risk analysis tasks in their respective projects.

4.3.5 Responses on Risk Response Strategies

Risk Response	SD	D	N	A	SA	Total	Mean	SD
Code	**1**	**2**	**3**	**4**	**5**	**N**		
There is a well-developed strategy to respond to risk.	0	12	11	13	2	38	**3.13**	**2.74**
Factors such as budget, schedule, resources and scope are considered while responding to risk.	1	4	8	23	4	40	**3.63**	**3.21**
Total	**1**	**16**	**19**	**36**	**6**	**78**		
Total %	**1.28%**	**20.5%**	**24.4%**	**46.2%**	**7.7%**	**100%**		

Source: Own Survey, 2023

Table 4.15 Risk response knowledge and strategies

As presented in the table above, of the total responses given to statements regarding risk response strategies in Likert scale, about 46.2% (36) have agreed to the existence of risk response strategies and consideration of project resource, schedule, and scope factors in responding to risk appearing in their project. 24.4% (19) responses were neutral or unaware of the existence of such risk response strategies and procedures followed thereto, a good percentage of about 20.5% (16) of the total responses for the non-existence of risk response mechanisms and consideration of different factors in responding to risks appearing in the project.

An article by Charles Teye Amoatey, (2017), show that most mining companies had risk mitigation plans in place which are aimed at addressing the most significant risk factors. Risk registers are the primary tool that the use in this regard. The interviews with senior managements yielded similar results as to findings to the literatures but contrary to responses to the questionnaires. Most significant and high profile risks have a good risk management strategies at corporate level but other risk factors are dealt with upon their occurrence.

The risk response strategy used in the project:	Code	Count	Percent
Control/reduction	1	38	90.5%
Avoidance	2	2	4.8%

Transfer	3	2	4.8%
Acceptance	4	0	0.0%
Total		**42**	
Mean		**1.14**	
Standard Deviation (SD)		**0.62**	

Source: Own Survey, 2023

Table 4.16 Risk response tools

As presented in the table above, about 90.5% (38) of the total respondents have said that the major risk response strategy in their respective projects is risk control/reduction. This statistics goes in line with the responses obtained for the risk planning works. Since most of the surveyed companies lack a systematic risk planning strategy and procedures to deal with every type of risks and their respective response strategies, they only deal with mitigation or reducing the impact of risks upon occurrence. The remaining 4.8% each for avoidance and transfer risk response mechanisms shows that advanced mining companies which comply to international standards follow a very systematic risk response strategies incorporating all mechanisms where necessary.

Interviews and researcher's observation have also yielded similar results as the questionnaires, which is risk control/reduction method is the primary tool adopted at project and corporate level to manage risks immediately upon occurrence. Instances of lack of awareness about land degradation by mining activities in society was raised by one of the senior managers interviewed which had posed risks to sustainability of operation for some time but later they handled it by good communication and awareness works and land reclamation works after mining activities.

Summary of Descriptive Statistics on Risk Response Strategies

Risk Response	**Total**	**Mean**	**SD**
There is a well-developed strategy to respond to risk.	41	3.13	2.74
Factors such as budget, schedule, resources and scope are considered while responding to risk.	41	3.63	3.21
The risk response strategy used in the project:	41	1.14	0.62

Summary Mean	**41**	**2.63**	**2.19**

Source: Own Survey, 2023

Table 4.17 Summary of Descriptive Statistics on Risk Response Strategies

As presented in the table above, statements forwarded on risk responses strategies with Likert scale has shown an average response of agreement on the existence of the risk response system however, the system was only limited to control/reduction of impacts by incidents according to the majority of the respondents.

The lower value of standard deviation for the specific risk response strategy used shows that most of the respondents have responded closer to the average response obtained on the statement. However, for statements regarding existence of risk response system and consideration of factors for responding to risks have shown a relatively higher values of standard deviation implying dispersion of responses by respondents from the average response on the statements.

4.3.6 Responses on Risk Monitoring and Control

Risk Monitoring & Control	**SD**	**D**	**N**	**A**	**SA**	**Total**	**Mean**	**SD**
Code	**1**	**2**	**3**	**4**	**5**	**N**		
Risks are registered and communicated properly.	2	8	7	21	2	41	**3.33**	**2.96**
Risks are reviewed periodically.	1	11	7	19	3	41	**3.29**	**2.93**
Risk responses are audited.	2	6	7	21	4	41	**3.48**	**3.11**
Project performance is evaluated against risk.	4	5	10	17	3	41	**3.26**	**2.93**
Total	**9**	**30**	**31**	**78**	**12**	**164**		
Total %	**5.6%**	**18.8%**	**19.4%**	**48.8%**	**7.5%**	**100%**		

Source: Own Survey, 2023

Table 4.18 Risk monitoring and control practices

As presented in the table above, 48.8% (78) of the total respondents have 'Agreed' to the existence of general risk monitoring and control system, 19.4% (31) of the respondents are neutral to the existence of the system, and the third largest portion which is about 18.8% (30) of the respondents have disagreed to the existence of risk monitoring and control system.

However, the responses obtained from the interviews with senior management were in denial of the existence of such systems. The interviewees further claimed that due to a shorter period of stay in the mining industry, they're still figuring out how to monitor and control risks in their respective projects, hence implying absence of risk monitoring and control mechanisms in their active projects.

Summary of Descriptive Statistics on Risk Monitoring and Control Mechanisms

Risk Monitoring & Control	**Total**	**Mean**	**SD**
Code	**N**		
Risks are registered and communicated properly.	41	**3.33**	**2.96**
Risks are reviewed periodically.	41	**3.29**	**2.93**
Risk responses are audited.	41	**3.48**	**3.11**
Project performance is evaluated against risk.	41	**3.26**	**2.93**
Summary Mean	**41**	**3.34**	**2.98**

Source: Own Survey, 2023

Table 4.19 Summary of Descriptive Statistics on Risk Monitoring and Control Mechanisms

As presented in the table above, the mean value of the responses is close to the average value of the Likert scale which represents neutrality of opinion to the statements forwarded on risk monitoring and control. This signifies the responses from the interview were somehow closer to the realities of risk monitoring and control situations on the ground as the researcher had witnessed with lacking of any risk monitoring and controlling guidelines at all. Furthermore, measures of dispersion shown on the relatively higher values of the standard deviation infers the difference in opinions and perceptions by the respondents to the statements.

4.3.7 Responses on Scaling of Mining Risks

The researcher has presented scaling questions to respondents on his questionnaire. These questions request respondents to scale major mining risks sorted by the researcher, with reference of different literatures and information obtained from senior professionals in the industry, according to their probability of occurrence and impact on project deliverables.

Scale code for probability of occurrence:

1 - High Probability (HP) 3 - Medium Low Probability (MLP)

2 - Medium High Probability (MHP) 4 - Low Probability (LP)

Scale code for impact magnitude on project objectives:

1 - High Impact (HI) 2 - Medium Impact (MI) 3 - Low Impact (LI)

The results of the responses from the respondents is presented in the section below:

Potential Risks	**HP**	**MHP**	**MLP**	**LP**	**Total**	**Mean**
Code	**1**	**2**	**3**	**4**		
Environmental Risks						
Pollution of air and water bodies	29.3%	4.9%	22.0%	34.1%	**41**	**2.41**
Land degradation	29.3%	9.8%	26.8%	19.5%	**41**	**2.07**
Unpredicted environmental damage	19.5%	4.9%	36.6%	29.3%	**41**	**2.56**
Social Risks						
Displacement of communities	26.8%	9.8%	22.0%	31.7%	**41**	**2.39**
High cost of living	29.3%	24.4%	34.1%	0.0%	**41**	**1.80**
Lack of community acceptance	22.0%	26.8%	29.3%	9.8%	**41**	**2.02**
Occupational Health & Safety (OHS) Risks						
Accidents during construction and operation	17.1%	19.5%	34.1%	19.5%	**41**	**2.37**
Inadequate PPE for employees	12.2%	14.6%	31.7%	26.8%	**41**	**2.44**
Spread of diseases	12.2%	22.0%	12.2%	43.9%	**41**	**2.68**

Political and Legal Risks						
Political instability	63.4%	24.4%	2.4%	0.0%	**41**	**1.20**
Pressure from government inspectors	19.5%	43.9%	24.4%	2.4%	**41**	**1.90**
Government bureaucracy for obtaining licenses	24.4%	36.6%	19.5%	9.8%	**41**	**1.95**
Conflict/Volatile security	61.0%	24.4%	2.4%	2.4%	**41**	**1.27**
Change in laws and regulations	9.8%	41.5%	24.4%	14.6%	**41**	**2.24**
Financial Risks						
Price fluctuation of minerals	48.8%	26.8%	9.8%	9.8%	**41**	**1.71**
Foreign exchange rate fluctuations	56.1%	24.4%	7.3%	4.9%	**41**	**1.46**
Demand fall of the mineral	22.0%	24.4%	14.6%	34.1%	**41**	**2.51**
Increase of market competition	9.8%	29.3%	19.5%	34.1%	**41**	**2.63**
Owner's financial difficulties	29.3%	17.1%	19.5%	22.0%	**41**	**2.10**
Incorrect financial resource calculation (Incorrect costing)	24.4%	26.8%	19.5%	24.4%	**41**	**2.34**
Technical/ Operational Risks						
Poor management of operation	17.1%	29.3%	31.7%	17.1%	**41**	**2.39**
Shortage of skilled labor	14.6%	26.8%	36.6%	7.3%	**41**	**2.07**
Shortage of professional experts	22.0%	29.3%	26.8%	14.6%	**41**	**2.20**
Employee strike	12.2%	7.3%	34.1%	36.6%	**41**	**2.76**
Labor dispute	9.8%	14.6%	41.5%	26.8%	**41**	**2.71**
Incorrect mineral resource calculation	17.1%	12.2%	31.7%	26.8%	**41**	**2.44**
Shortage of machineries	14.6%	17.1%	34.1%	22.0%	**41**	**2.39**
Low productivity of labor and equipment	12.2%	36.6%	31.7%	9.8%	**41**	**2.20**
Shortage of material supply and availability	19.5%	34.1%	22.0%	17.1%	**41**	**2.22**
Diesel shortage in the country	29.3%	17.1%	29.3%	17.1%	**41**	**2.20**
Poor infrastructure	14.6%	26.8%	41.5%	9.8%	**41**	**2.32**

Poor internal communications	12.2%	14.6%	48.8%	19.5%	**41**	**2.66**

Source: Own Survey, 2023

Table 4.20 Mining Risks Scaling %, Probability of Occurrence

As presented in the table above, the five highest rated risks by the respondents according to their probability of occurrence are:

- Political instability (1.2),
- Volatile security (1.27),
- Foreign exchange rate fluctuations (1.46),
- Price fluctuation of mineral (1.71), and
- High cost of living (1.8)

These risks require a special attention by the management staff and the project team in order to minimize their probability of occurrence and associated impact on the project.

Potential Risks	**HI**	**MI**	**LI**	**Total**	**Mean**
	1	**2**	**3**		
Environmental Risks					
Pollution of air and water bodies	34.1%	19.5%	36.6%	**41**	**1.83**
Land degradation	36.6%	22.0%	31.7%	**41**	**1.76**
Unpredicted environmental damage	34.1%	26.8%	26.8%	**41**	**1.68**
Social Risks					
Displacement of communities	31.7%	26.8%	31.7%	**41**	**1.80**
High cost of living	36.6%	29.3%	24.4%	**41**	**1.68**
Lack of community acceptance	34.1%	36.6%	12.2%	**41**	**1.44**
Occupational Health & Safety (OHS) Risks					
Accidents during construction and operation	14.6%	51.2%	24.4%	**41**	**1.90**
Inadequate PPE for employees	22.0%	41.5%	26.8%	**41**	**1.85**
Spread of diseases	24.4%	34.1%	31.7%	**41**	**1.88**
Political and Legal Risks					

Political instability	78.0%	14.6%	0.0%	**41**	**1.07**
Pressure from government inspectors	19.5%	61.0%	9.8%	**41**	**1.71**
Government bureaucracy for obtaining licenses	24.4%	48.8%	17.1%	**41**	**1.73**
Conflict/Volatile security	75.6%	12.2%	2.4%	**41**	**1.07**
Change in laws and regulations	14.6%	51.2%	22.0%	**41**	**1.83**
Financial Risks					
Price fluctuation of minerals	56.1%	17.1%	17.1%	**41**	**1.41**
Foreign exchange rate fluctuations	65.9%	17.1%	9.8%	**41**	**1.29**
Demand fall of the mineral	34.1%	22.0%	31.7%	**41**	**1.73**
Increase of market competition	12.2%	34.1%	46.3%	**41**	**2.20**
Owner's financial difficulties	39.0%	26.8%	24.4%	**41**	**1.66**
Incorrect financial resource calculation (Incorrect costing)	31.7%	22.0%	36.6%	**41**	**1.85**
Technical/ Operational Risks					
Poor management of operation	43.9%	24.4%	24.4%	**41**	**1.66**
Shortage of skilled labor	39.0%	36.6%	17.1%	**41**	**1.63**
Shortage of professional experts	39.0%	31.7%	22.0%	**41**	**1.68**
Employee strike	22.0%	36.6%	31.7%	**41**	**1.90**
Labor dispute	17.1%	34.1%	41.5%	**41**	**2.10**
Incorrect mineral resource calculation	39.0%	31.7%	17.1%	**41**	**1.54**
Shortage of machineries	39.0%	26.8%	22.0%	**41**	**1.59**
Low productivity of labor and equipment	31.7%	29.3%	31.7%	**41**	**1.85**
Shortage of material supply and availability	41.5%	41.5%	7.3%	**41**	**1.46**
Diesel shortage in the country	51.2%	24.4%	17.1%	**41**	**1.51**
Poor infrastructure	29.3%	36.6%	26.8%	**41**	**1.83**
Poor internal communications	22.0%	31.7%	39.0%	**41**	**2.02**

Source: Own Survey, 2023

Table 4.21 Mining Risks Scaling %, Impact Magnitude

As presented in the table above, the five highest rated risks by the respondents according to their impact magnitude on the project are:

- Political instability (1.07),
- Volatile security (1.07),
- Foreign exchange rate fluctuations (1.29),
- Price fluctuation of mineral (1.41), and
- Lack of community acceptance (1.44)

Ratings by the respondents for both impact and probability of occurrence of mining project risks seems to go in the same order except for their fifth highest rated risks.

A study on Ghanaian mining industry has identified the five most critical risk factors in mining projects to be unstable commodity prices, inflation/exchange rate, land degradation, high cost of living and government bureaucracy for obtaining licenses. Though, the study aimed at identifying mining sector-specific risk factors, we observed that the five risk factors listed above were unique to the mining industry (Charles Teye Amoatey, 2017).

The survey results from this research here show that, the political and legal risk factor seem to overweigh among the enlisted risks presented for scaling; this is attributed to the rapidly changing and volatility of the country's political landscape. But, all in all these most rated risks require due attention by the respective senior management staff and every team members in the project. This is due to the fact that appearance of some of these risks may halt, delay or completely shut down activities of mining projects or may induce catastrophic impacts as evidenced by some of the surveyed companies in this research survey.

In summary, poor knowledge and practices of managing risks in projects are among the main contributors to project failure in the mining industry. The life cycle of a mining project frequently includes unaddressed risks and uncertainties that can result in poor decision-making, just like any industrial project (whether it be in the petrochemical, manufacturing, nuclear, or building sectors). The companies surveyed believe that managing risk and project success are married to each other. The better you manage your risks, the better your NPV (Net Present Value). However, it is the industries practice that to be able to have a unique project, sometimes projects come only in high risk categories. You need to be able to take chances, within limits, but that will create the company

a satisfied shareholder. In light of this, it is unfortunate that mining projects in Ethiopia lacks the necessary risk management knowledge and practice that fit standards of the industry requirements. Tools used unsystematically by the consent of project managers and other stakeholders may help in reducing the grave effects of risk impacts that may arise in project endeavors, but this still falls much short of what is required by the industry in international standards.

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter have tried to discuss summary of key findings of this research project, conclusions drawn from the summary of findings and recommendations proposed for mining companies working in Ethiopia's context regarding risk management practice in their mining projects. This will in turn inform executives of mining companies to identify their gaps in risk management, and draw their focus onto the most strategic and impactful risks their project might entertain in due course of the project life cycle.

5.1 Summary of Key Findings

This research study has tried to examine the risk management processes of mining projects actively working in Ethiopia. The study has identified the five risk management processes for this research purpose namely – risk planning, risk identification, risk analysis, risk response and risk monitoring and control. Furthermore, the research has identified the major mining risks globally and presented their ratings in Ethiopia's mining industry context.

Based on literature reviews, and data processed, analyzed and interpreted in chapter four of this paper via questionnaire and interview data collection instruments, the researcher has reached on the following key findings:

- ➔ Regarding existence of risk management policy, and guidelines, the responses from the interviews have yielded the absence of such documents unlike majority of the respondents on the questionnaire which claimed existence of policy documents. Exception to the respondents were the responses by the international mining company of TKGM which have a standard risk management process, policy and guidelines to guide their risk management practice and in-depth experience of their project team in risk management process that is extracted from their long years of experience in the mining industry.
- ➔ Uncertainties and risks appearing in projects are handled primarily by the project manager with the support of the whole project team. Furthermore, it is also indicated in the results

that some international companies hire external risk specialist consultants or engage senior management at corporate level to handle any uncertainties in their projects.

- ➔ With regards to implementation of risk management process, most companies practice risk management at the implementation stage of projects when the risks occur in real time.
- ➔ In risk planning process, most companies lack a systematic risk planning process prepared ahead at the start of the project.
- ➔ Findings of this research have revealed the existence of risk identification practices, the level of which depends on the characteristics of the risks and the level of complexity of the company undertaking the project.
- ➔ Regarding tools used for risk identification process, projects mostly rely on individual experts' opinion especially of project managers' for their risk identification process or prepared checklists to identify potential risks.
- ➔ Most of the risk identification tasks fall on the shoulders of the whole project team, depending on the type of risks, with a key role given to the project manager in coordinating and steering the process. However, this is not documented and is not led with a systematic procedure.
- ➔ Regarding existence of risk measurement system, majority of the respondents believe the existence of one, however it is not of systematic and organized type.
- ➔ Concerning risk analysis tools, most of the respondents have claimed to use probability and impact analysis, or their combination of risk matrix and expert judgment of subjective assessments almost equally where necessary.
- ➔ In relation to risk response strategies, projects lack a systematic risk response mechanisms, risks are mostly managed upon their occurrence.
- ➔ The major risk response strategy in the surveyed projects is risk control/reduction. However, advanced mining companies like TKGM which comply with international standards follow a very systematic risk response strategies incorporating all response mechanisms wherever they are necessary.
- ➔ Unlike the responses obtained from the questionnaire, managers' interview yielded the absence of a systematic risk monitoring and control mechanism in their project. This is due to a shorter period of stay in the mining industry, they're still figuring out how to monitor and control risks in their respective projects.

- ➔ Regarding analysis of major mining risks, respondents unanimously agreed for the high occurrence rate of the two top political and financial risks on the scaling table - Political instability, Volatile security, Foreign exchange rate fluctuations, and Price fluctuation of mineral in their descending order.
- ➔ Concerning ratings of impact of risks on project objectives or deliverables, respondents unanimously agreed for the high impact magnitude of the two top political and financial risks on the scaling table - Political instability, Volatile security, Foreign exchange rate fluctuations, and Price fluctuation of mineral in their descending order.

5.2 Conclusions

As the major and general objective of this research project was to assess and investigate the risk management practice of mining companies actively working in Ethiopia's mining landscape in a descriptive research type, the following conclusion was forwarded based on the key findings drawn from the research after employing both primary and secondary data collection techniques.

The study revealed that mining companies didn't have any risk management policy, guideline or procedures which guide them through a systematic risk management practice. They also lack a systematic risk management process which complies with the standards and practices set in PMBOK. Furthermore, no specific person or department is assigned to manage risks in their project undertaking; hence the project manager is fundamentally responsible for handling risks with the support from the project team. And mostly risk handling is usually practiced at the implementation phase of projects.

The study has also revealed that the surveyed projects lack a systematic risk identification, analysis and response mechanisms which parallels the risky nature of the mining industry. However, tools which are fundamentally dependent on subjective judgment of individuals especially of the project manager are used in each step of the risk management process. It is worthwhile mentioning here that the project manage is primarily responsible for handling any risk appearing in the project. He/she does this by consulting senior management for high profile risks or with concerted effort of his project team for low profile and project specific risks.

The research has further unveiled absence of risk monitoring and control mechanism or tools in the surveyed projects. This was explained by the shorter stay of companies in the industry and their being on the learning curve on how to navigate through monitoring and control mechanisms to optimally manage their risks. This stage has been found to be the weakest spot for all the local mining firms among the researched stages of the risk management process.

This research inferred that political instability, volatile security, foreign exchange rate fluctuations, price fluctuation of mineral, lack of community acceptance and high cost of living are the major risks posing a threat to activities of mining companies in Ethiopia's context; these major risks in turn are fundamentally attributed to political, financial, environmental, environment and social factors. Though, other African countries experience attribute their major risks in mining projects to financial and environmental factors, it was also evident from this research finding that risks in the political and financial categories are believed to have posed a major hold back to the progress of projects and significant financial bleeding to corporates in general.

5.3 Recommendations

Mining project activities are subject to high risks because of their size, uncertainty, complexity, and involvement of high costs. In light of this fact, the findings from this research are unprecedented; that is mining companies in Ethiopia lack a systematic risk management practice at all.

As recommendation, the researcher believes the work on risk management should start from the regulatory institution at federal, and regional level. Experts at the regulatory institutions should be of high intellect and experience regarding risk management in the mining industry. Institutions should give continuous and rigorous trainings to its professionals in account of the dynamic nature of the industry to equip them well with their supervisory skills. Regulatory institutions further needs to develop risk management supervisory frameworks to help its professionals in objective assessment of operating mining companies regarding their risk management practices. By doing so, mining companies could be enforced to adopt and implement a good risk management framework.

The researcher also recommends that local mining companies should learn from international mining firms and start to use systematic approach in managing risks which fits their level of business venture. Initiatives which gives due consideration to risks in overall project management could be an encouraging move by the local mining firms as a startup step; this will later improve to a systematic and comprehensive approach, and finally will end up being an organized risk management policy document which guides risk management process in every project endeavors in the company.

A sample risk register format as shown below could also be adopted as a startup to build a good risk management practice, tools and techniques in mining projects.

Risk No	Description of Potential Risk	Description of Potential Impact	Risk Owner	Steps to Mitigate	Monitoring Frequency	Likelihood (1-5)	Impact (1-5)	Controls (1-3)	Risk Rating
F1	Dependency on a limited number of income/funding sources	Cash flow and budget impact of loss of income source	CEO	• Identify major funding/income source dependencies • Implement adequate reserves policy	Annual review of the risk by the Risk Committee reporting to the board. The review will assess; • Adequacy of reserves to sustain an income shock • Opportunities for income diversification or to develop additional income sources	3	4	2	24

5.4 Research Limitation and Areas of Further Research

In random selection of the mining companies for this research survey, one international company with good risk management practice and documents have been included. Though their practice was overshadowed in this research project by findings from the local mining firms, the researcher has tried to shed light on their good practices on every sections of this research project. The researcher believes this will give good insights for the local firms if they are willing to work on their project risk management practices.

Academically, the researcher recommends that researches in risk management in the mining industry are very minimal in number and substance; even non-existent in local context. This is understandably due to the infant nature of the industry in Ethiopia's setting. However, the current imminent blooming signals of the industry and the attention it is given by the government as one of the five pillars of the macro-economy demands more and more researches in risk management to help practitioners in the industry optimally handle risks in their project management endeavors.

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ANNEX

Survey Questionnaire

Section I: General Demographic Questions

		Count	%
1	In which stage of the project life cycle are you working in?		
	a. Exploration		
	b. Project development		
	c. Operations		
	Total		
2	What is the nature of the organization you're working in?		
	a. Contractor		
	b. Consultant		
	c. Client		
	d. Regulator (Federal or regional level)		
	Total		
3	What is the highest level of education you have completed?		
	a. Secondary School		
	b. Vocational School		
	c. Bachelor's degree		
	d. Master's degree		
	e. Ph.D. holder		
	Total		
4	What is the area of your profession or technical training?		
	a. Engineering		
	b. Geology		
	c. Environment		
	d. Business/Finance/Economics		
	e. Sociology/Management		
	Total		
5	Which of the following best describes your current or most recent position?		
	a. Junior professional		
	b. Skilled technician		
	c. Senior professional		
	d. Management		
	Total		
6	How many years of experience do you have in the mining industry?		
	a. 0-5		

b. 6-10
c. 11-15
d. 16-20
e. > 21

Total

7 How long have you worked in your current project?
a. 0-5
b. 6-10
c. 11-15
d. 16-20
e. > 21

Total

Section II: Project Risk Management Questions

		Count	%
8	Uncertainties that occur in the project are mostly handled by: a. Project manager b. Senior management c. Consultant d. Project team e. Special Risk management (RM) team		
	Total		
9	Risk management is thought and implemented at which stage of the project? a. Conceptual stage b. Planning stage c. Implementation stage d. Monitor & Control stage e. Closure		
	Total		

Risk Identification:

10	The following method is primarily used to identify risks within the project a. Expert judgment b. Checklists c. Document review d. Assumption analysis		
	Total		
11	Who participates in the risk identification process? a. Top management b. Project manager c. Project team members d. External consultant		

Total

Risk Analysis:

12 What tools are used to analyze identified risks in your project?

a. Probability and impact analysis
b. Risk matrix
c. Monte Carlo simulation
d. Subjective assessment based on expert judgement
e. Ranking based on past experience
f. None

Total

Risk Response:

13 The risk response strategy used in the project:

a. Control/reduction
b. Avoidance
c. Transfer
d. Acceptance

Total

14 Sources of risk that the project usually encounters:

a. Technical
b. Financial
c. Ecological
d. Social
e. OHS
f. Political and legal

Total

S.N	Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
		1	2	3	4	5	
GENERAL RISK MANAGEMENT QUESTIONS							
1	There is good knowledge about risk management in the project team.						

2	Project team members receive training or have enough knowledge about how to handle uncertainties/risks.						
3	The project team members are well experienced.						
4	There is adequate top management support for risk management.						
5	The organizational environment is stable.						
6	Adequate resources are allocated for the project team.						
7	The project has a standard risk management process.						
8	There is responsible person or department to handle risks.						
9	There is a policy and procedure that guide the project team to go through a disciplined risk management process.						
10	Project team have in-depth experience in risk management.						
RISK PLANNING							
11	There is systematic approach or careful planning.						
12	Relevant stakeholders are involved in the risk planning.						
13	Tools like expert judgment, meetings or others are considered for risk planning.						

14	Ecological, social, and political factors are included as an input to plan for uncertainties.						
15	Risk management plan is incorporated with the project plan.						
RISK IDENTIFICATION							
16	Project team members play roles to identify risk.						
17	Risk register is produced as an output in risk identification process						
18	Documentation review conducted to identify risks.						
19	Expert judgment or brainstorming is used to identify risks.						
RISK ANALYSIS							
20	Identified risks are characterized before being analyzed as ecological, technical, financial, social, OHS and political.						
21	There is a measurement system to analyze the risk.						
22	Project documents are updated after risk assessment.						
RISK RESPONSE							
23	There is a well-developed strategy to respond risk.						

24	Factors such as budget, schedule, resources and scope are considered while responding to risk.						
RISK MONITOR AND CONTROL							
25	Risks are registered and communicated properly.						
26	Risks are reviewed periodically.						
27	Risk responses are audited.						
28	Project performance is evaluated against risk.						

Section III: Mining Project Risk Analysis Questions

1. Scale the following major mining project risks with their probability of occurrence.

   1 - High Probability (HP) 3 - Medium Low Probability (MLP)

   2 - Medium High Probability (MHP) 4 - Low Probability (LP)

Potential Risks	**HP**	**MHP**	**MLP**	**LP**	**Total**
	1	**2**	**3**	**4**	
Environmental Risks					
Pollution of air and water bodies					
Land degradation					
Unpredicted environmental damage					
Social Risks					
Displacement of communities					

High cost of living					
Lack of community acceptance					
Occupational Health & Safety (OHS) Risks					
Accidents during construction and operation					
Inadequate PPE for employees					
Spread of diseases					
Political and Legal Risks					
Political instability					
Pressure from government inspectors					
Government bureaucracy for obtaining licenses					
Conflict/Volatile security					
Change in laws and regulations					
Financial Risks					
Price fluctuation of minerals					
Foreign exchange rate fluctuations					
Demand fall of the mineral					
Increase of market competition					
Owner's financial difficulties					
Incorrect financial resource calculation (Incorrect costing)					
Technical/ Operational Risks					
Poor management of operation					
Shortage of skilled labor					
Shortage of professional experts					
Employee strike					

Labor dispute					
Incorrect mineral resource calculation					
Shortage of machineries					
Low productivity of labor and equipment					
Shortage of material supply and availability					
Diesel shortage in the country					
Poor infrastructure					
Poor internal communications					

2. Scale the following major mining project risks with their impact magnitude on project objectives, if they occur.

1 - High Impact (HI) 2 - Medium Impact (MI) 3 - Low Impact (LI)

Potential Risks	**HI**	**MI**	**LI**	**Total**
	1	**2**	**3**	
Environmental Risks				
Pollution of air and water bodies				
Land degradation				
Unpredicted environmental damage				
Social Risks				
Displacement of communities				
High cost of living				
Lack of community acceptance				
Occupational Health & Safety (OHS) Risks				
Accidents during construction and operation				
Inadequate PPE for employees				
Spread of diseases				

Political and Legal Risks				
Political instability				
Pressure from government inspectors				
Government bureaucracy for obtaining licenses				
Conflict/Volatile security				
Change in laws and regulations				
Financial Risks				
Price fluctuation of minerals				
Foreign exchange rate fluctuations				
Demand fall of the mineral				
Increase of market competition				
Owner's financial difficulties				
Incorrect financial resource calculation (Incorrect costing)				
Technical/ Operational Risks				
Poor management of operation				
Shortage of skilled labor				
Shortage of professional experts				
Employee strike				
Labor dispute				
Incorrect mineral resource calculation				
Shortage of machineries				
Low productivity of labor and equipment				
Shortage of material supply and availability				
Diesel shortage in the country				
Poor infrastructure				

Poor internal communications				

Interview Questions

(Contractor or Client)

1. How do you describe the risk management knowledge and practice in your organization and projects?
2. Is there a standardized or formally documented process on how to manage risks in your project?
3. How does the overall risk planning practice look in your project?
4. How does the overall risk identification practice look in your project?
5. How does the overall risk analysis practice look in your project?
6. What is your risk response mechanism?
7. What challenges has the project faced so far due to unmanaged risks?
8. Do you think managing risks and project success are related? If yes, how?

Interview Questions

(Regulator)

1. How do you evaluate the risk management knowledge and practice of mining companies?
2. Do mining companies submit their risk management practice along with their performance reports?
3. Do mining companies have risk identification, analysis, response and management tools?
4. What is your audit findings regarding risk management in mining companies?
5. What do you think is the current impact in the industry in relation to the practice of risk management by mining companies? Positive and negative