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OCCUPATIONAL HEALTH AND SAFETY PRACTICES AMONG SMALL-SCALE MINING WORKERS IN GHANA; A CASE STUDY OF WASSA AMENFI (WEST, EAST AND CENTRAL) MUNICIPALS

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MASTER OF PHILOSOPHY

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OCCUPATIONAL HEALTH AND SAFETY PRACTICES AMONG SMALL-SCALE MINING WORKERS IN GHANA; A CASE STUDY OF WASSA AMENFI (WEST, EAST AND CENTRAL) MUNICIPALS

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Faculty of Environment and Health Education submitted to the School of Graduate Studies in partial fulfilment

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DECLARATION

CANDIDATE'S DECLARATION

I, Sabastian Samuel Kwesi, hereby declare that except references to other people's works which have been duly acknowledged, this thesis is my own original work towards the award of a Master of Philosophy in Environmental and Occupational Health Education and that this thesis or part has not been accepted for the award of a degree in this university, or elsewhere.

SIGNATURE……………………………………………….

DATE:……………………………………………………

SUPERVISORS' DECLARATION

We hereby declare that the preparation and presentation of this thesis was supervised in accordance with the guidelines of the University of Education Winneba on thesis work for the award of Master of Philosophy in Environmental and Occupational Health Education.

Dr. Richard Amankwah Kuffour (Principal Supervisor)

Signature…………………………..

Date:……………………………….

Professor Emmanuel Dartey (Co-Supervisor)

Signature……………………………

Date:………………………………..

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DEDICATION

This research work is dedicated to my mother, Jacquiline Damamu for her prayers, love, and unflinching support at all stages of my academic life.

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TABLE OF CONTENTS

University of Education,Winneba http://ir.uew.edu.gh

University of Education,Winneba http://ir.uew.edu.gh

University of Education,Winneba http://ir.uew.edu.gh

University of Education,Winneba http://ir.uew.edu.gh

University of Education,Winneba http://ir.uew.edu.gh

LIST OF TABLES

University of Education,Winneba http://ir.uew.edu.gh

LIST OF FIGURES

University of Education,Winneba http://ir.uew.edu.gh

ABSTRACT

Small-scale mining is perceived as a benchmark for poverty reduction in developing countries. It contributes immensely to national income for countries with minerals reserves and mining activities. Despite the contribution of small-scale mining to Ghana, the industry pays little attention to health and safety practices among miners. This study investigated occupational health and safety practices among small-scale miners using a descriptive cross-sectional survey design. A total of 295 participants were selected from small-scale mining firms in the Wassa Amenfi (West, East, and Central) Districts, Environmental Protection Agency, and the Minerals Commission. Data were gathered from the study participants using structured questionnaires and interview guides whereas levels of heavy metals (mercury and arsenic) concentrations in water and water sediments, were determined by laboratory analysis. Results of the study revealed that 78.98% (233) of the respondents were aware of available regulations regarding workers' safety. Safety measures adopted by the various mining companies were; safety training (35.00%), the use of PPE (33.00%), regular monitoring (28.00%), and prompt reporting of incidents (4.00%). Miners were exposed to various types of hazards and injuries sustained among miners included cuts, fractures, sprain, broken arms, and entrapment. The commonly used PPE was safety boots (37.00%) whilst the overall coat was the least (8.00%) used among miners. The use of technology was identified as the main factor affecting the implementation of health and safety practices. The mercury in water sediments and water was above the WHO Maximum Permissible Limit (MPL) whereas values of arsenic were below the WHO MPL. The study concluded that occupational health and safety were a priority in the small-scale mining companies within the study area.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Mining's contribution to the economy of many countries is colossal. The mining industry is made up of both large-scale mining and artisanal and small-scale mining (Agyarko *et al.,* 2014, G'afurovich et a., 2020; Pedersen et al., 2019). It is the world's second oldest and most important industry after agriculture (Bagah *et al.,* 2016). It is currently the fifth largest industry in the world and it plays a crucial role in the world's economic development. The trade of mineral commodities represents a substantial part of international trade. There are two kinds of mining; surface and underground mining (Bagah *et al.,* 2016, Ofosu et al., 2020). Surface mining, also called open-pit mining or strip mining is undertaken if the mineral deposit lies on the surface of the earth. This method is usually more cost-effective and requires fewer workers to produce the same quantity of more than underground mining does. Underground mining on the other hand is used when the mineral deposit lies deep below the surface of the earth. Mining investment, irrespective of the type or kind of mining being undertaken is capital intensive. The mining industry remains a vital contributor to the global economy (Stemn, 2018). It is a high-risk as well as a high-rewarding business for mining companies and communities because the mining business is a hazardous operation and consists of considerable environmental, health, and safety risks to miners (Chu *et al.,* 2017).

The activities of small-scale mining operators pose a great threat to the environment (Asiedu, 2013) and this has heightened interest from the public and many researchers.

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Although it has been a source of employment for some sects of the youth (Amponsah-Tawiah and Dartey-Baah, 2011), and also contributes to the overall gold production annually, its environmental consequences are myriad and very critical. Across Africa, in countries with rich mineral reserves and barren economies, thousands of the unemployed dig for fortunes operating illegally and unregulated. Small-scale mining which is usually characterized as informal, illegal, and unregulated by the government, is an important source of livelihood for many poor families and is characterized by poor technological practices with significant environmental, social, and health costs (Lu, 2012, Stemn, 2018). Small-scale mining is defined as a single-unit mining operation with an annual production of unprocessed material of 50,000 tons or less (Ofosu et al., 2020). It makes use of simple tools and lacks technology, and is hazardous under labor-intensive conditions. It involves the exploitation of mineral deposits using rudimentary tools and primitive mining and processing techniques (Owusu-Boateng and Kumi-Aboagye, 2013). It often employs unskilled elaborate stark illiterates who for diverse reasons, have little or no sensitization to the consequences of their actions, on their health and safety and the environment (Antoci *et al.,* 2019; Mudyazhezha and Kanhukamwe, 2014). Small-scale miners use primitive extraction techniques, with dynamite, pick axes, mercury, and the strength of their arms. In Ghana where the small-scale/artisanal sector employs about 300,000 people, most of whom are stark illiterates and employ very primitive methods in mining at the expense of their lives (Bagah *et al.,* 2016).

Occupational hazards in the mining sector can be divided into health hazards and safety hazards. Health hazards are those hazards that result in the development of illnesses or diseases. However, safety hazards are those hazards that cause accidents at workplaces

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that result in physical harm to the workers (Abbasi, 2018). These two hazards are further spread into various types and these can be physical, chemical, biological, ergonomic, and psychosocial. The physical hazards of mining include but are not limited to falls from dust, noise, heat (Abbasi, 2018), height, rock falls, fire and other explosions, submerging of underground mined area, release from collapsed bulkheads, and air blast from block caving failure. These physical hazards are hurtful injuries and stretch from slight to deadly. Chemical hazards are related to chemicals and these include arsenic (Santra *et al.,* 2017), mercury, silica, coal dust, asbestos, nickel compounds, hydrofluoric acid, hydrogen sulphide gas, explosive (Abbasi, 2018) xanthate reagent, etc. These chemicals have a range of fatal effects on miners which include respiratory disease, gastrointestinal disorder, liver malfunction, hematological diseases like anemia, leucopenia and thrombocytopenia, diabetes and severe cardiovascular malfunction, etc., (Lesser and Habyarimana, 2019). The constant exposure to chemicals especially mercury undermines the health of miners and increases medical costs, which further raises the need for and dependency on mercury to extract more gold (UNEP, 2019). Several studies have observed elevated levels of mercury in the hair, urine, blood, and nail samples of people residing in artisanal gold mining areas (Casey, 2019, Bnamericas, 2017).

The production of minerals brings income and foreign exchange. Biological hazards are associated with living things or organisms. These include snake bites, diseases from bacteria, viruses, fungi, and blood-borne pathogens in secluded mining areas (Abbasi, 2018). Mining involves the use of heavy machines yet many miners do the activity without machines or use physical strength.

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In addition to the above, high humidity and heat stress are part of ergonomic hazards (Wen Yi *et al.,* 2016). Most miners resort to the use of stimulant substances to boost their strength to increase their performance. This makes miners use drugs and alcohol thus causing psychosocial hazards. In 2012, an online search of Ghanaian newspaper articles resulted in 19 articles reporting 23 separate incidents of accidents and injuries among small-scale miners occurring between 2007–2012 (Brewster, 2013, Inan *et al.,* 2017). Eight main incident types were described, with the most common being collapses trapping miners (30%), followed by drowning (17%), and violent incidents and falls into mine pits (13% each). Crushing, burns, suffocation, and firearms injuries were among the other types of incidents reported. Most of the incidents (70%) took place in illegal mines, and the vast majority (87%) of the reported injuries resulted in fatalities. Seventy-six fatalities were recorded in total, with a range of 1–18 fatalities per incident. While these data have potentially substantial reporting biases, this study does provide some insight into the nature of injuries in Ghanaian small-scale mining sites (Long *et al.,* 2015, Stemn, 2018).

In addition to these exposures, hazardous physical conditions and activities throughout the process raise concerns about occupational injuries. Even in high-income countries with strong and well-enforced occupational health and safety regulations, mining is a hazardous activity. However, the statistics on major accident events such as fatalities and reportable incidents have not shown the corresponding levels of improvement (Abbasi, 2018). The lack of safety regulations and enforcement, education and training, and functional infrastructure and equipment may lead to elevated injury rates in low- and middle-income countries, particularly in small-scale mining. It has been reported that small-scale miners may have 6–7 times more non-fatal accidents than large-scale

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operations, but only a few studies have documented occupational safety measures by workers (Casey, 2019).

1.2 Problem Statement

According to the Ghana Mineral Commission, the overall workplace injury in the mining sector has increased from 9,664 cases in 2017 to 18,070 cases in 2018 (Ghana Mineral Commission, 2019). Among the factors is the lack of knowledge of occupational health safety among workers and the dangers associated with their work. Fatigue, inattentiveness, and most importantly lack of adherence to safety rules at workplaces are major contributing factors. The small-scale mining sector within the Wassa Amenfi West Municipalities had many fatalities and injuries and this could be due to inadequate knowledge of occupational health and safety practices among miners or failure to adhere to safety rules at workplaces (Ghana Minerals Commissions, 2018). Even though adherence to occupational safety has become an important mechanism for improving work output, little research has been done in the study area. Thus, little attention is given to policy considerations in the absence of empirical data to reduce the toll of workplace hazards and injuries. This study sought to bridge these gaps by Investigating the occupational health and safety practice among small-scale miners in the study area.

1.3 Objectives of the Study

The main objective of the study was to investigate occupational health safety practices among small-scale miners in Wassa Amenfi West Municipalities of Ghana.

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1.3.1 Specific Objectives

Specifically, the study sought to;

1. Determine the types and sources of occupational hazards encountered in small-scale mining.
2. Determine the safety practices of small-scale miners.
3. Investigate factors that influence the implementation of safety practices among small-scale miners.
4. Determine heavy metals (Hg and As) present in water and water sediments within the small-scale mining area.

1.4 Research Questions

The study was guided by the following questions;

1. What are the causes and types of hazards encountered in small-scale mining?
2. What occupational health and safety practices are in place among small-scale miners?
3. What factors influenced the implementation of occupational safety and health management systems in small-scale mining?
4. What are the concentration levels of heavy metals (Hg and As) in water and water sediments in the operations areas of small-scale miners?

1.5 Justification

The desire to achieve safety and health practices in workplaces has made many companies resort to effective and efficient health and safety practices that are capable of addressing and minimizing to its lowest ebb industrial accidents that result in injuries and deaths of workers. This desire should therefore stimulate research interest in effective ways in which efficient health and safety practices promote employees' well-being. However, contributions to the ongoing debate, on the effectiveness of health and safety practices have attracted only very little attention from these practitioners and academia alike. The level of Occupational Health and Safety compliance and implementation in Africa is generally low compared with the other continents of the world (Regional Committee for Africa Report, 2014). The World Health Organization (2018) stated that, when Occupational Health and Safety are not properly observed, it drastically has a toll on the work output of the worker and this may in turn affect the economic turnout by significant proportions and subsequently will affect a nation's Gross National Product. Takala (2002) estimates that Occupational deaths, diseases, and illnesses constitute roughly 4% loss of the Gross Domestic Product globally.

Studies have been done to establish that management commitment is negatively related to occupational health and safety practices. Further studies reveal the lack of understanding in mining site management on safety and health and the non-existence of site occupational and safety models are attributable factors to high accident rates (Alhajeri, 2014). Efforts therefore must be made by both the employees and the managers to prevent these accidents in mining firms. Shikdar (2003) is of the view that poor occupational health and safety practices increase the risk of incidence of an accident at the workplace and ultimately affect job performance, therefore, institutions that have made provisions for issues of health and safety usually have little or minimal records of injuries and accidents. Considering the long-term implications of injuries related to the mining industry, emphasizing the need for workers to strictly adhere to safety measures is of utmost importance. The study, therefore, serves as a timely reminder of the dangers associated with mining and will be useful to miners, employers,

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policymakers, and advocates in that it will provide data that will inform policy-making on the safety of mine workers.

1.6 Significance of the Study

This study sought to establish the trends of small-scale mining activities over the past decade and also the safety practices observed by small-scale miners and recommendations for future policies. Since not much or very little research has been done concerning the topic in Ghana, the study will serve as an insight into safety practices in small-scale mining firms. The results from this are expected to contribute immensely to a better understanding of the issue of occupational safety and the findings will serve as a channel for improvement of occupational health and safety practices of workers and employers. The findings of this study will serve as a basis for offering purposeful suggestions to stakeholders in the mining and also be useful in improving and preventing occupational accidents in the future through sustainable measures such as planning and control, workers participation, and monitoring. Another significance of the study is that the findings can be used to examine the relationship between methods of operation by small-scale miners over the past decade and safety practices and further suggest ways for effective usage of protective equipment and provide policymakers in mining with literature on appraising activities and programs associated with the prevention of occupational accident in the country and the world at large. Additionally, the study will serve as resource material for students/researchers who may make a related study in the future.

1.7 Limitations and Delimitations of the Study

The study focuses on occupational safety at small-scale mining sites due to the contribution toward job creation and poverty reduction. Reviewing of literature consist

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of occupational accidents, health and safety practices, activities at small-scale mining sites, and many others. Also, traces of reported cases of occupational accidents in small-scale mining sites will be captured. Problems encountered in the research was the inability to trace medical reports suffered from the occupational accident. This was because most workers do not keep good accounts of medical reports. Limited time and financial constraints were limiting factors. Despite these limitations, analyses from the data which were obtainable were sufficient to provide meaningful conclusions to the research questions.

1.8 Organization of the Study

Chapter one introduces the study and provides the outline of the study which is to investigate the trends of small-scale mining and occupational safety practice by small-scale miners. It also captures the background information, problem statement, objective of the study, research questions, significance of the study, the scope of the research, limitations, and delimitations of the study. Chapter two deals with the review of literature related to the subject of study. The review involves in-depth studies related to the problem under study. The third chapter describes the methodology used in the study. Specifically, the research design, the research instrument, sample and sampling technique, the procedures for data collection, and the data analysis are discussed. The analysis, results, and discussion are presented in chapter four. This chapter captures the interpretation of all the interview responses and content analysis of the data collected in the field of study. In chapter five, the main focus is the summary, conclusions, and recommendations. This chapter provides a summary of all the chapters in the study. In addition, the chapter also made a few recommendations on alternative development approaches before concluding the study.

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CHAPTER TWO

LITERATURE REVIEW

2.1 Mining

Mining is the removal of minerals from the earth's crust in the service of man. Mining is the process of digging into the earth to extract naturally occurring minerals (Hilson and Laing, 2017). Mining has also been defined as the extraction of valuable minerals or other geological materials from the earth, usually (but not always) from an ore body, vein, or (coal) seam. There are two kinds of mining; surface and underground mining. Surface mining, also called open-pit mining or strip mining is undertaken if the mineral deposit lies on the surface of the earth. This method is usually more cost-effective and requires fewer workers to produce the same quantity of more than underground mining does. Underground mining on the other hand is used when the mineral deposit lies deep below the surface of the earth. Surface mining is a broad category of mining in which soil and rocks overlying the mineral deposit are removed. This practice which includes open-pit mining, strip mining, and mountaintop removal mining requires a large area of land to carry out (Arah, 2014) It involves the exploitation of mineral deposits using rudimentary tools and primitive mining and processing techniques (Owusu-Boateng and Kumi-Aboagye, 2013) and often employs unskilled and stark illiterates who for diverse reasons, have little or no sensitization for the consequences of their actions on the environment (Buadee et al 2014; Mudyazhezha and Kanhukamwe, 2014). Materials recovered by mining include bauxite, coal, diamonds, iron, precious metals, lead, limestone, nickel, phosphate, rock salt, tin, uranium, and molybdenum. Any material that cannot be grown from agricultural processes must be mined. Mining in a wider sense can also include the extraction of petroleum, natural gas, and even water.

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Available literature indicates that basically, there are eight steps to the mining process. These are as follows:

1. Prospecting to locate ore.
2. Exploration to define the extent and value of ore where it was located.
3. Conduct resource estimate to mathematically estimate the extent and grade of the deposit.
4. Conduct mine planning to evaluate the economically recoverable portion of the deposit.
5. Conduct a feasibility study to evaluate the total project and make a decision as to whether to develop or walk away from a proposed mine project. This includes cradle-to-grave analysis of the possible mine, from the initial excavation through to reclamation.
6. Development to create access to an ore body.
7. Exploitation to extract ore on a large scale.
8. Reclamation to make land where a mine had been suitable for future use.

Mining methods are of four basic types. Firstly, materials may be mined from surface mines, open pits, quarries, or other diggings open to the atmosphere. This group constitutes by far the greatest number of mines in the world. Secondly, there are underground mines, entered through shafts or tunnels. Thirdly, there is the recovery of minerals and fuels through boreholes. Finally, there is underwater mining or dredging, which is now extending to the potential mining of the deep oceans. The discovery, extraction, and processing of mineral resources are widely regarded as one of the most environmentally and socially disruptive activities undertaken by businesses. Many of the environmental disasters or human rights incidents that have contributed to the

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growing public concern about the actions of companies over the last 40 years have taken place in the extractive industries: the mining sector, therefore, is a key topic in debates about social and environmental responsibility. On the other hand, it is believed that mining operations present a lot of benefits for communities where such mining takes place and the country at large. In Ghana, three main classes of ores exploited for gold during small-scale mining operations are (1) subsurface alluvial deposits of about 3m depth; (2) Deeper level alluvial deposits occurring at about 7-12 m, and; (3) Hard rock material mostly from an underground source. All three categories of orebodies require varying degrees of input for gold recovery. Mining of the first and second ore types have been influenced by the increased use of sophisticated machinery such as bulldozer for digging and rock crushing machines for ore processing. The third ore type requires mechanical and chemical treatment of ores (Buadee *et al.,* 2018).

2.2 Positive and Negative Impacts of Mining

Mineral production generates income and foreign exchange through exports and can stimulate local economies through the local purchase of inputs. Mining companies employ workers who earn income, some of which they spend on domestically produced goods and services. Governments receive tax revenues from mineral products which are available to fund education, health care, roads, electricity supply, and other forms of infrastructure development. Most mining companies on their own accord provide some infrastructure development to the local communities within which they operate without recourse to their tax obligations. By creating jobs and economic growth, mining companies help catalyze other private investment at the local, regional and national levels, and they have a huge demonstration effect (Amponsah-Tawiah & Dartey-Baah, 2011).

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Data which underscore the economic importance of mining are critical to understanding how finances fuel the sector's production and growth, create linkages to other industries, and crucially, bolster the case for formalizing and supporting its activities. To explore how there are several data gaps relating to stimulating economic growth that need to be addressed. The first is the sector's contribution to GDP, although at times, due to limited data even this must be estimated (World Bank, 2020). Overall, there are only a small number of examples to draw from beginning with Guyana, where for a period of two decades (1996-2015), all gold was produced by indigenous small-scale miners. In 2012, at the peak of the country's gold boom, buoyed by a rise in the metal's international price and a spike in production, output from these operations accounted for more than 17 percent of national GDP (Hilson and Laing, 2017).

In Rwanda, where mining operations "are small as measured by investment," none of which "would be considered either medium-sized (cumulative investment of about US$250 million to US$750 million, though less for gold) or large (investment of more than US$750 million)" (World Bank, 2014), in 2018 the sector contributed 2.5 percent of GDP generating US$237 million in earnings (at 2014 prices) making mining a top export earner for the country (Government of Rwanda 2019; Lesser and Habyarimana, 2019). The key takeaway with Rwanda, however, is that the government is looking to provide support to miners, to accelerate the mining sector's contribution to exports to US$1.5 billion by 2024 (Government of Rwanda, 2019). Gathering GDP and complementary data from Rwanda and Guyana, where ASM has been supported more than most countries, illustrates the potential economic contribution the sector can make if its formalization is prioritized.

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In Ghana, fiscal income generated through taxes collected from mining operations forms a substantial part of the government's revenue which can be used to implement a lot of poverty reduction intervention strategies. According to a report from the World Bank on mining and development, Tax receipts from a single mining company can amount to 30% to 50% of a country's fiscal income. In Ghana taxes from the mining sector accounts for between 35% and 45% of revenue generated by the government. Following the 2010 National Mining Policy of Ghana, there has been a significant flow of external investment in the mining sector of Ghana (Ghana Mineral Commission, 2014). As a result, the mining industry contributed twenty-seven percent (27%) of the total tax revenue in 2012, with gold alone recording approximately $5.6 billion from 4.3 million ounces (Kyeremateng-Amoah & Clarke, 2015). In 2014, the industry also contributed GH¢1.24 billion in tax revenue to the government and employed 12,148 Ghanaians (Long et al., 2015). On the regional and local level, any large-scale mining operation has the potential to significantly and positively affect economic opportunities for the poor. In the region where the mining operation is located, it can provide Substantial additional employment opportunities with higher income generation potential than most, if not all, other employees in the area; and investments in basic public infrastructure, goods, and services with universal access, for example, transport, water, and power - this creates opportunities for the local people.

The Associated Mineworkers of Zimbabwe (AMZ) as cited in Saunders (2008) noted that formal mining employment was at least 85,000 in 1985, before falling to around 83,000 in 1995 and less than 50,000 in 1999 as the country experienced a massive economic and industrial decline (Magidi & Hlungwani, 2021). Aside from a mining

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operation's direct employment impact, there is substantial potential for developing downstream and lateral economic activity with suppliers and refiners, particularly for small- and medium-sized enterprises, in turn generating employment opportunities for the non-miners surrounding area. Ghana, formerly known as Gold Coast, is the second largest gold producer in Africa and the ninth in the world, contributing about 40% of the country's gross foreign exchange earnings, an equivalent of about 5.7% of the country's GDP (Mensah *et al.,* 2015). According to him, employment generated indirectly by a mining operation amounts to a range of between 2 to 25 times the number of direct employees, in certain cases even more than that. Research has shown that every dollar spent by a mine on operations could generate an average of 2.8 dollars in the local economy, in terms of induced economic activities. A successful mining operation can catalyze further inflow of private-sector investment in a country or region if it takes place within a supportive policy context characterized by reliable regulatory frameworks. Coal mining has helped countries with significant coal resources such as China, India, and South Africa to access cheap energy, thereby fuelling these countries 'economic growth and creating further opportunities for those not involved in the mining sector. Besides the generation of revenue at the national level, notable benefits of mining also included the creation of employment for local people (Magidi, 2014).

The mining industry impacts directly the macro-economy by improving infrastructure, increasing employment, developing rural communities, and enabling new spin-offs and downstream businesses (Singh and Singh, 2016). The most publicized benefits of the increased mining sector investments resulting from Ghana's economic reforms include the following: - Mining is the leading earner of foreign exchange- Providing substantial government revenue- Providing capital and social infrastructure to the public-

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Generating direct and indirect employment- Developing communities in mining areas. While in gross terms, mining is the leading foreign exchange earner; its net foreign exchange contribution to the national economy has been minimal. Generous incentives and tax breaks are given to investors and the fact that mining companies retain on average about 75% of their export earnings in off-shore accounts for various purposes helps explain the sector‘s minimal contribution to net foreign exchange receipts. It is estimated that Ghana accounted for 36% of world gold output between 1493 and 1600 (Minerals Commission 2014). Mining companies were allowed 20–45% during the Economic Recovery Programme (ERP) in 1983 of foreign exchange retention accounts, improved access to mining inputs through export rehabilitation credits, and small-scale mining of gold and diamond was legalized (Ayee et al. 2011). Antwi-Boasiako (2003) observed that most of the companies in Ghana do not pay corporate income taxes due to the virtual tax holiday enjoyed by these companies as a result of the generous capital allowances. Another issue with surface mining is that it has a relatively limited capacity to generate employment (Akabzaa & Darimani, 2001). According to them, it is so because surface mining operations are capital-intensive with relatively low labor requirements. Mining on the other hand is perceived by other locals as a non-contributor to employment, and it has instead increased unemployment rates in mining communities (Mancini and Sala, 2018). Antwi-Boasiako (2003) also adds that the revenue-generating potential of mining may not always be used as efficiently as possible, particularly in the context of governance and corruption issues and where state ownership of the mining operation is involved. The poor are at some risk of not participating in the economic opportunities of mining while at the same time bearing many of the costs as well as risks that result from the introduction of a mine in an undeveloped area. He notes that a large-scale mining operation requires major capital

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investment in infrastructure, technology, services, and employment. However, the ability of the poor to participate in this investment is limited by their education and work skills. Antwi-Boasiako (2003) adds that what is even worse; their income-sustaining opportunities and livelihood might be reduced due to the presence of a mine.

The environmental impacts of mining are widespread especially in rural communities in developing countries (Antoci *et al.,* 2019). Antwi-Boasiako (2003) notes that environmental damage resulting from a mining operation, or left behind after mine closure, ranging from water pollution or restrained water quantity to tailings and subsidence, can seriously limit people‘s current and future income opportunities, in particular when dependent on agriculture, fishery, forestry or hunting. According to World Bank (2001), corruption and macro-economic mismanagement can severely limit the positive impact of mining creating opportunities on the national level. The World Bank (2001) gives an example of countries such as Congo and Zambia which have shown little overall development benefit from the copper production of the past decades, with state ownership and mismanagement characterizing the sector.

2.2.1 Socio-economic impacts of mining

The contributions of mining to economic development are immense in the country. Mining has an essential foundation for human development through the creation of wealth (Acheampong, 2004). The mining industry has been key to the development of civilization, underpinning the iron and bronze ages, the industrial revolution, and the infrastructure of today’s information age. In 2001, the mining industry produced over 6 billion tons of raw products valued at several trillion dollars (Mbendi, 2004). Traditional mining countries such as the USA, Canada, Australia, South Africa, and

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Chile dominate the global mining scene. These countries have become the traditional leaders in mining and exploration methods and technology (Mbendi, 2004). Ghana is home to several precious minerals. Over the past decades, the mineral sector has contributed to 37% of the exports of the country and accounted for 8.4% of the GDP of the country in 2011 from 6.1% the previous year (Ghana Statistical Service, 2010; Bach, 2014; Ofosu et al., 2020; Atta and Tholana, 2021). In recent years, gold production, for instance, has been observed to increase substantially from <20,000 ounces in 1990 to 1.6 million ounces in 2016 (Ofosu et al., 2020). The increase in gold mining in Ghana has also seen some significant improvement in the livelihoods of communities where gold mining is in operation (Ofosu et al., 2020).

The contributions of the mining sector for some selected countries can be evaluated. The mining industry in Peru accounts for 50% of the country's annual export earnings. In 1993 the mining industry's contribution to the Peruvian economy was represented by $2400 million paid in taxes, $400 million spent on local purchases, and $280 million on imported goods. This accounted for over 11% of GDP. North America is the major producer of gold and silver. Raw mineral production in 1998 was valued at approximately US$70 billion. The industry employs approximately 1 million people. Gold, the largest mineral foreign income earner in South Africa alone contributes 27.4% of mineral revenues. The gold industry is also responsible for 56% of South Africa's mine labor force (Mbendi, 2002). However, the United Nations Industrial Development Organisation (UNIDO) considers joblessness and landlessness (resulting from large-scale mining) to have forced people into small-scale gold mining, and UNIDO estimates that there are over a million people directly involved in small-scale gold mining operations in Latin America. If Africa and Asia are incorporated there

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could be as many as six million artisanal miners worldwide (UNIDO, 2001). For instance, there are no exact figures on the number of small-scale miners in Ghana, though it is estimated that approximately 100,000 Ghanaians are legally engaged in mining (Aryee, 2003).

'G*alamseys'* involved in illegal mining activities also create challenges for monitoring and regulating small-scale mining activities in the country. The legislative framework for the mineral sector in Ghana is the minerals and mining act 703 of 2006. Under the provision of the law, no person has the authority to conduct reconnaissance, prospecting, exploration, or mining in Ghana unless the person has a mining license (Benmudez-Lugo, 2016). However, illegal mining (both foreign and Ghanaian nationals) continues unabated in the country despite government efforts to curb these activities (Darimani et al., 2013; Benmudez-Lugo, 2016). Illegal mining is defined locally (Ghanaian context) as mining operations in which miners without a license have no concessions of their own and operate uncontrollably within concessions of large-scale mining companies or in areas prohibited for mining (Hilson et al., 2013). In Ghana, the mining sector now accounts for 41% of the country's foreign exchange and it's the leading foreign exchange earner. Gold, the most important mineral, which now earns over U$600 million and constitutes almost 90% of the mineral output, has replaced cocoa as the principal foreign exchange earner (Awudi, 2002). "The most publicized benefits of the increased mining sector investments resulting from Ghana's economic reforms include the following:

- Mining is the chief earner of foreign exchange in the country
- Provides substantial government revenue
- Provides capital and social infrastructure to the general public

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- Generates direct and indirect employment
- Contributes to community development in mining areas" (Akabzaa and Darimani, 2001).

"The industry generates revenue for the internal economy through the following sources:

- Salaries, wages, and other payments made to workers and contractors
- Corporate income taxes, royalties, concession rents, services, customs and
- harbor duties
- Taxes on salaries of employees, and social security contributions from workers and their employers
- Dividends to shareholders
- Equipment and consumables purchased locally
- Import duty and purchase tax on vehicles
- Electricity and water charges
- Divestiture of state mining companies and sale of government shares" (Akabzaa and Darimani, 2001).

Furthermore, it can be noted that since mining projects are usually located in remote sites, mining companies have had to invest in considerable physical and social infrastructure such as roads, schools, hospitals, electricity, and water supplies. Communities within mine locations have generally been beneficiaries of some of these facilities. Thus, while mining projects usually have weak links with the rest of a host national economy, they can have a significant impact on the communities in which or near which the mines are located.

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The positive economic development that often follows the establishment of a mining operation can also have negative effects on the consumption levels of the poor. Higher incomes of mine workers, especially in relatively isolated areas, can lead to rising local prices for key products (food, fuel, transport) with the poor left behind. Also, mining can use significant amounts of land and water, which can impact the poor who depend on these resources for their livelihood and food security. Akabzaa and Darimani (2001) note that in the context of mine closure, the sudden end of economic opportunities, when not planned for, tends to increase local poverty levels dramatically. He notes that in Namibia for instance, in the late 1990s, foreign mining investors closed their operations and withdrew without notice leaving the Government and the local communities to deal with the mine closure without any preparedness. Sudden mine closure can also deprive the local population of the most basic social services and access to public goods, such as clean water, energy, or transport if the mining company previously had provided these.

In Ghana, the sudden closure of Dunkwa Goldfields mines in the late 1980s deprived all the communities in the area of electricity supply since this had been previously provided by the mining company. According to Anderson (1997), the often-remote location of mining operations increases the challenges for local economic development in the aftermath of mine closure, with government resources typically hard to free up for these areas. The problematic social and environmental legacies left behind by mining operations, then, 19 can compromise the economic benefits they once yielded. In a study on the impact of mining in Tarkwa, Ghana, (Akabzaa and Darimani, 2001) identify two main factors responsible for the high cost of living in Tarkwa. Firstly, the disparity in incomes in favor of mining company staff where their salaries are indexed

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to the US dollar, which raises their income far above their counterparts in the public sector. In addition, the expatriate staff of the mines is paid internationally competitive salaries, which further widens the income disparities in Tarkwa.

This group of high-income earners has thus influenced the pricing of goods and services such as housing, food, and other amenities (Akabzaa and Darimani, 2001). A study by Downing (2002) also proved that disparities in incomes emerge and the lure of new opportunities creates in-migration. Different groups compete for access to public goods and social services and new tensions in the community abound. According to Downing (2002), new types of poverty are created, with a mixture of original residents who have been unable to share in employment opportunities and newcomers who have migrated in with the hope of finding employment but have been unsuccessful in doing so. Social ills such as alcohol abuse, prostitution, and child labor often increase. The second reason, Sumanth (2005) gave us that the mining industry has withdrawn a significant percentage of the labor force from agriculture another income-generating activity by taking farmland away and holding out the false promise of employment. The fall in food production in an area that is already densely populated, with high unemployment, accounts for high food prices. A major issue that is always investigated during decision-making procedures regarding the development of surface mines is public protest. For numerous groups of interest, including local authorities, chambers, ecological organizations, etc, a mine is a potential threat to the environment, public health, and socioeconomic activities that interfere with it. For this reason, any proposal for further development of mining sites is either rejected or it is accepted after setting a series of terms and conditions. According to Downing (2002), in general, the development of a surface mine affects the socioeconomic activities of local communities in the following

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ways: reduced access to public utilities (e.g. transportation), economic (employment, money inflow to the local economy), change of land uses (farmland, grazing, tourism, residential (relocation of villages) and culture (lifestyle, population density, archaeological sites &monuments).

In a study of the impact of mining at Tarkwa in Ghana, he found out that the concentration of mining operations has had a seriously adverse impact on the social organization and cultural values of the people. According to Akabzaa (2000), concerns have been expressed about inadequate housing, youth unemployment, family disorganization, school dropout rates, prostitution, and drug abuse. Although these problems are not new to the area, they have risen to a level that the population perceives to be threatening and the main cause has been the concentration of mining activities in the area. According to Akabzaa (2000), the concentration of mining activities has triggered a massive migration of all kinds of people to the area. The population growth rate is above the national average and might even be double it.

For example, at the Grasberg mine in Indonesia, the local population increased from less than 1000 in 1973 to between 100,000 and 110,000 in 1999. Similarly, the population of the squatter settlements around Porgera in PNG, which opened in 1990, has grown from 4000 to over 18,000.10 This influx of newcomers can have a profound impact on the original inhabitants, and disputes may arise over land and the way benefits have been shared. These were among the factors that led to violent uprisings at Grasberg in the 1970s and the 1990s. Sudden population increases can also lead to pressures on land, water, and other resources as well as bringing problems with sanitation and waste disposal.

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Migration effects may extend far beyond the immediate vicinity of the mine. Improved infrastructure can also bring an influx of settlers. For instance, it is estimated that the 80- meter-wide, 890-kilometer-long transportation corridor built from the Atlantic Ocean to the Carajas mine in Brazil created an area of influence of 300,000 square kilometers (IFC/World Bank, 2007). Surface mining results in the eviction of communities and their relocation to marginal sites, often with inadequate compensation also causes a lot of tensions and distrust between mining companies, the chiefs, and the people. According to Antwi-Boasiako (2003), a major principle of the environmental impact assessment (EIA) process is that the proponent is required to give notice and advertises the proposal in the national press to enable the public to express its interest or concerns or to comment on the project.

On receipt of a draft EIA report, EPA publishes it for people with specific interests or concerns to study the report and raise such concerns within 21 days from the first day of publication. The channel for notifying and soliciting information from interested and affected people does not provide a level playing field for the communities who are directly impacted by such mining projects. However, Antwi-Boasiako (2003) notes that the sources of information, which are primarily the national press or the premises of District Assemblies, are inaccessible to these communities. Worse still, EIA reports are presented in technical language and these communities cannot study and understand the issues raised in the reports. The input of the affected communities is thus lost in the process, resulting in distrust between mining companies, the chiefs, and the people. Sumanth (2005) observes that relocation and compensation measures implemented by various mining companies in Ghana have had serious consequences for the family as a

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close-knit social unit. New housing arrangements for resettled communities have also disrupted long-established family networks in the area. Akabzaa's (2000) study showed that in many instances, the housing units provided by the mining companies have not conformed to the size of households.

For instance, a family that had a house with five rooms and a large space was resettled in a house with three rooms in a crowded space. Many of the residents of the resettled communities complained of inadequate internal space (number of rooms, size of rooms) and open external space for other domestic activities (Akabzaa, 2000). Sumanth's (2005) study also showed that the compensation scheme has helped disorganize some families. In the Tarkwa area, irresponsible, male family heads opted for relocation instead of resettlement. This enabled them to collect cash compensation and they subsequently abandoned their families. This deepened the plight of affected rural women and children. In direct and indirect ways, mining accounts for the high rate of unemployment in the mining community. He notes that large-scale surface mining has taken up large tracts of land from farmers while at the same time mining activities do not provide enough jobs to match the total number of people laid off from agriculture. Miming greatly affects the livelihood of catchment communities.

When mining activities are not adequately managed, the result is degraded soils, water, biodiversity, and forest resources, which are critical to the subsistence of local people. When contamination is not controlled, the cost of the contamination is transferred to other economic activities, such as agriculture and fishing. The situation is made worse when mining activities take place in areas inhabited by populations historically marginalized, discriminated against, or excluded. Proponents of mining projects must

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ensure that the basic rights of affected individuals and communities are upheld and not infringed upon. These include rights to control and use land, the right to clean water, and the right to livelihood. Such rights may be enshrined in national law, based on and expressed through a range of international human rights instruments and agreements. All groups are equal under the law, and the interests of the most vulnerable groups (low-income and marginalized) need to be identified and protected (Bebbington & Williams, 2008).

2.2.2 Environmental impacts of mining activities

The adverse environmental impact of mining activities on the environment is well documented. Particular attention has been directed toward the impacts of large-scale and small-scale gold mining activities on environmental contamination. While the land degradation caused by gold mining is pronounced, chemical contamination from the gold extraction process imposes a double burden on the environment, with harmful health implications for mining communities and people residing near such activities (Yelpaala, 2004). For instance, due to the informal nature of gold mining in the South (Africa and Latin America), most studies concentrate on mercury exposure and intoxication incurred in the extraction and processing stage of mining (Tirado *et al.,* 2000).

Another study in Tanzania with a similar design found lower levels of intoxication and a more complex mix of mining-related and environmental exposures to mercury through household items such as soap. One study in Ecuador reports higher levels of intoxication in children involved in "gold washing". One study in Venezuela found no mercury intoxication, despite occupational and community exposures (Rojas *et al.,*

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2001) In Ghana several studies in mining towns have revealed that environmental problems such as land degradation, pollution, and others are associated with mining activities. Some of these are enumerated below.

2.2.2.1 Degradation of Land and Vegetation

According to Akabzaa and Darimani (2001), extensive areas of land and vegetation in Tarkwa have been cleared to make way for surface mining activities. Currently, open pit mining concessions have taken over 70% of the total land area of Tarkwa. It is estimated that at the close of mining a company would have utilized 40-60% of its total concession space for activities such as siting of mines, heap leach facilities, tailings dump, open pits, mine camps, roads, and resettlement for displaced communities (Akabzaa and Darimani, 2001).

This has a momentous adverse impact on the land and vegetation, the main sources of livelihood for the people. There is already a scramble for farmlands in Atuabo and Dumais. In most parts of Tarkwa, the environment is undergoing rapid dreadful conditions and its immense economic value is dwindling from year to year, due mainly to the heavy concentration of mining activities in the area. Agricultural lands are not only generally degraded, but the loss of land for agricultural production has also led to a shortening of the fallow period from 10-15 years to 2-3 years. The traditional bush fallow system, which sufficiently recycled substantial amounts of nutrients and made the next cycle productive, can no longer be practiced due to the insufficiency of land. Large-scale mining activities generally continue to diminish the vegetation of the area to levels that are vicious to biological diversity (Akabzaa and Darimani, 2001).

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The deforestation that has emanated from surface mining has long-term effects even when the soil is replaced and trees are planted after mine decommissioning. The new species that might be introduced have the potential to influence the composition of the topsoil and then determine soil fertility and fallow period for certain crops. In addition to erosion when surface vegetation is depleted, there is deterioration in the viability of the land for agricultural activities and loss of habitat for birds and other animals. This has degenerated into the destruction of the luxuriant plant life, biodiversity, cultural sites, and water bodies (Akabzaa and Darimani, 2001).

2.2.2.2 Water Pollution

Many mines have an active program to reduce the water table or divert major watercourses away from the mines. This exercise has disruptive outcomes for the quality and availability of surface and groundwater. The concentration of mining operations in Tarkwa has been a chief cause of both surface and groundwater pollution. Four main problems of water pollution have been identified in Tarkwa mining areas. These are chemical pollution of groundwater and streams, siltation through increased sediment load, increased fecal matter, and dewatering effects (Akabzaa and Darimani, 2001).

2.2.2.3 Air and Noise Pollution

Mining activities and mining support companies discharge particulate matter into the ambient air. The grievances of the affected communities regarding air quality have been airborne particulate matter, emissions of black smoke, noise, and vibration. Airborne particulates of major concern within the Tarkwa area include respirable dust, sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), and black smoke. The

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activities that produce this particulate matter include site clearance and road building, open-pit drilling and blasting, loading and haulage, vehicular movement, ore, and waste rock handling as well as heap leach crushing by companies during heap leach processing. Others include fumes from the roasting of sulfide ores by assay laboratories and in refining processes. The discharge of airborne particulate matter into the environment -- principally minute dust particles of less than 10 microns -- poses health threats to the people of the Tarkwa area.

All fine dust at a high level of exposure has the potential to cause respiratory diseases and disorders and can exacerbate the condition of people with asthma and arthritis. Dust from gold mining operations has a high silica content which has been responsible for silicosis and silico-tuberculosis in the area (Akabzaa and Darimani, 2001). Unfortunately, the mining companies have not laid down adequate measures to prevent harmful emissions of dust into the ambient air. Measures to reduce dust emission are restricted to occasional spraying of roads within the premises of the mining concessions. This seems to be a misplaced effort because road dust does not appear to be the main source of dust pollution.

2.2.2.4 Noise and Vibration

The sources of noise and vibration in the area comprise mobile equipment, air blasts, vibration from blasting, and other machinery. The impact of high-pitched and other noises is known to include damage to the auditory system, cracks in buildings, stress, and discomfort (Akabzaa and Darimani, 2001). These noises can also terrify animals, hinder their mating processes and also cause abortions, therefore adversely affecting the animal population. Communities within the concessions of GAG and TGL have

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lodged several complaints with the Wassa West District Assembly Environmental Management Committee on noise aggravation (Akabzaa and Darimani, 2001).

However, the measures being put in place by the mining companies have not sufficiently addressed the problem of noise pollution in the area. A critical assessment of the literature under review showed that many of the negative environmental and health effects of mining activities have been documented. However, little do we know as to suggestions and policy directives needed to be implemented to redress the hazardous health effects of mining. In addition, most of the literature reviewed was focused mainly on mining and economic development. Hence, these presented fewer findings on environmental and health impacts of mining on surrounding communities This research work, therefore, intends to undertake a thorough and broader outlook into the environmental and health implications of mining on surrounding communities, both negative and positive, and recommend policy directives to improve the already instituted health policies by the Ashanti Goldfields Company, as well as reducing the rate of hazardous health effects of the mining activities that may be identified in Obuasi and other surrounding towns.

2.2.3 Health impacts of mining activities

Health can be defined as a state of complete physical, mental and social well-being of an individual, and not merely the absence of disease and infirmity (World Health Organization, 2005). An alteration in the living cells of the body which jeopardizes survival in the environment results in diseases. Health problems arise from a variety of man's activities including industrialization, farming, mining, migration, and others. Available literature examines the impact of mining on the health of both mine workers

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and the people within the surrounding communities of the mines. According to Stephens and Ahern (2001), mining remains one of the most perilous occupations in the world, both in terms of short-term injuries and fatalities, but also due to long-term impacts such as cancers and respiratory conditions such as silicosis, asbestosis, and pneumoconiosis. Studies of mining and health by type of mine process are divided into deep and open cast mines. Deep mines produce severe harm for employees in terms of their risks of high blood pressure; heat exhaustion; myocardial infarction and nervous system disorders. Studies of surface mining focus on coal, granite, and rock mining and health risks related to dust breathing. At all levels of mining health risks occur with dust exposure (Stephens and Ahern, 2001).

Respiratory impacts are the most studied and problematic health impacts for mine workers. Injuries have declined in importance but continue to be an important safety issue in mines. Long-term effects include cancers, mental health impacts, and some proof of impacts on the genetic integrity of workers. The heated discussion on the impact of the mining and minerals sector on both worker and community health is polarized. On the one hand, the industry tends to underscore the supposed benefits of the sector, whilst on the other, community groups and NGOs suggest that the sector is injurious to health and sustainable development (Stephens and Ahern, 2001). Further, the mining sector has been affected by the worldwide epidemic of HIV/AIDS, and this is apparent in the studies of South African mines. Several studies (Campbell, 2000) have focused on the condition of the gold mines in South Africa. Migrant labor plays a vital role in the mining sector of South Africa, and these migrants are believed to play an important role in the transmission of HIV/AIDS. In terms of how the mining industry has dealt with this problem, one study reports that “many mines made substantial efforts

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to establish HIV-prevention programs relatively early on in the epidemic, (but) these appear to have had little impact". Meanwhile, Corbett, Churchyard, *et al.* (2000) investigated the combined effects of HIV infection and silicosis on mycobacterial disease in a South African gold mine and concluded that the danger of silicosis and HIV infection combine in a multiplicative manner. This indicates that tuberculosis (TB) remains as much a silica-related occupational disease in HIV-positive as in HIV-negative miners, and HIV- positive silicotics have far higher TB prevalence rates than those reported from other HIV-positive Africans. The increasing impact of HIV over time may indicate epidemic TB transmission with swift disease development in HIV-infected miners. There were relatively few studies of policy initiatives by Stephens and Ahern (2001). According to them, health and safety improvements in mines have been developed over a long period of negotiation and struggle. Laws have come after union and management activities. Governments have supported organized labor in the improvements.

Moreover, Stephens and Ahern (2001) stress that scientific evaluation of long-term impacts has grown. Employees have been able to use scientific evidence for improved "hazard visibility" and for shifts in health and safety legislation. However, much of the small-scale mining sector falls outside the formal legislative shield or scientific analysis. Companies have provided a range of community initiatives including vaccination programs and health services. These have mixed results. Companies have seldom addressed the community claims for damage made against them internationally. Communities have worked with scientists to understand some of the impacts associated with living near mines. Unions have scarcely played an overt role in support of community claims (Stephens and Ahern, 2001). In Ghana, available literature on the

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effects of mining on health is reviewed as follows. Biostatistics obtained from Obuasi hospital in a survey by Friends of the Earth-Ghana (FOE-Ghana) showed a high prevalence of upper respiratory tract infection (URTI) in the area which medical experts linked to the mining activities and associated pollution (Awudi, 2002).

Clinical symptoms similar to arsenic poisoning have been observed in patients in AGC hospital at Obuasi and have been associated with aerial pollution from mineral procession by the AGC (Awudi, 2002). In the Tarkwa area, with the initiation of mining investment, mining impact-related diseases such as malaria, diarrhea, upper respiratory tract infections, skin disease, acute conjunctivitis, and accidents constitute the top ten diseases in the area according to biostatistics, obtained by FOE – Ghana in Korle-Bu Hospital in a survey in 2001. The area has the highest incidence of malaria in the Western Region and the country as a whole. Skin rashes are widespread, particularly among communities living along rivers and streams which regularly receive leaked cyanide waste waters and other mining wastes within concessions (Akabzaa and Darimani, 2001).

2.3 Hazards Associated with Surface Mining

According to Weber-Fahr (2002), surface mining though less dangerous than underground mining has a greater impact on surface landscapes. Surface mining requires the removal of massive amounts of topsoil to gain access to the minerals, which can cause erosion, loss of habitat, and dust pollution. It can cause heavy metals to dissolve and seep into both ground and surface water thereby erupting marine habitats and deteriorating drinking water sources. Vast agricultural lands are destroyed through surface mining, affecting food production in the country, and the sources of income for

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the people affected (Weber-Fahr, 2002). Pavloudakis and Roumpos (2004) noted that the most dramatic change which occurs during surface mining is the disturbance and associated change in land configuration and vegetation. According to Weber-Fahr (2002), a cross-study analysis of environmental damages as a result of mining operations in 51 mining countries across the globe put about 60% of the residents in these communities at risk. The mechanisms that are considered to have a greater potential for causing environmental damage are the following (Pavloudakis and Roumpos, 2004).

Modification of morphology leads to changes in hydrological patterns and loss of wild animal habitat and degradation of landscape value, which in turn leads to a reduction of property value; topsoil removal leading to loss of agricultural land, and increased surface run-off leading to loss of incomes and water pollution. According to a study commissioned by the European Union, because of the large area of land disturbed by mining operations and the large quantities of earthen materials exposed at sites, erosion can be a major concern at hard rock mining sites. Consequently, erosion control must be considered from the beginning of operations through the completion of reclamation. Erosion may cause significant loading of sediments (and any entrained chemical pollutants) to nearby water bodies, especially during severe storm events and high snowmelt periods. Sediment-laden surface runoff typically originates as sheet flow and collects in rills, natural channels or gullies, or artificial conveyances. The ultimate deposition of the sediment may occur in surface waters or it may be deposited within the floodplains of a stream valley. Historically, erosion and sedimentation processes have caused the build-up of thick layers of mineral fines and sediment within regional

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flood plains and the alteration of aquatic habitats and the loss of storage capacity within surface waters.

The main factors influencing erosion include the volume and velocity of runoff from precipitation events, the rate of precipitation infiltration downward through the soil, the amount of vegetative cover, the slope length or the distance from the point of origin of overland flow to the point where deposition begins, and operational erosion control structures. Major sources of erosion/sediment loading at mining sites can include open pit areas, heap and dump leaches, waste rock and overburden piles, tailings piles, and dams, haul roads and access roads, ore stockpiles, vehicle, and equipment maintenance areas, exploration areas, and reclamation areas.

Air emissions (CxHy, COx, SOx, NOx) cause air pollution and life quality degradation and contribute to the greenhouse effect. Airborne emissions occur during each stage of the mining cycle, but especially during exploration, construction, and operational activities. Mining operations mobilize large amounts of material, and waste piles containing small size particles are easily dispersed by the wind. The largest sources of air pollution in mining operations are; Particulate matter transported by the wind as a result of excavations, blasting, transportation of materials, wind erosion (more frequent in open-pit mining), and fugitive dust from tailings facilities, stockpiles, waste dumps, and haul roads. Exhaust emissions from mobile sources (cars, trucks, heavy equipment) raise these particulate levels; and gas emissions from the combustion of fuels in stationary and mobile sources, explosions, and mineral processing. These pollutants can cause serious effects on people‘s health and the environment. These airborne emissions from the mine‘s operation can affect the air quality of a surrounding community. Finer

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particles (often referred to as PM2.5 or smaller), which have a higher health concern, account for around 5% of mine dust emissions and are mostly generated by vehicle exhausts and combustion processes, similar to urban areas (U.S. Environmental Protection Agency, 2009).

Disturbances (noise, vibrations, etc.) also cause life quality degradation and reduction of property value. Noise pollution associated with mining may include noise from vehicle engines, loading and unloading of rock into steel dumpers, chutes, power generation, and other sources. Cumulative impacts of shoveling, ripping, drilling, blasting, transport, crushing, grinding, and stock-piling can significantly affect wildlife and nearby residents. Vibrations are associated with many types of equipment used in mining operations, but blasting is considered the major source.

Vibration has affected the stability of infrastructures, buildings, and homes of people living near large-scale open-pit mining operations. According to a study commissioned by the European Union in 2000:―Shocks and vibrations as a result of blasting in connection with mining can lead to noise, dust, and collapse of structures in surrounding inhabited areas. The animal life, on which the local population may depend, might also be disturbed‖ (MINEO Consortium, 2000).

When an open pit intersects the water table, groundwater flows into the open pit. For mining to proceed, mining companies must pump and discharge this water to another location. Pumping and discharging mine water cause a unique set of environmental impacts that are well described in a study commissioned by the European Union: ―my water is produced when the water table is higher than the underground mine workings

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or the depth of an open pit surface mine. When this occurs, the water must be pumped out of the mine. Alternatively, water may be pumped from wells surrounding the mine to create a cone of depression in the groundwater table, thereby reducing infiltration. When the mine is operational, mine water must be continually removed from the mine to facilitate the removal of the ore. However, once mining operations end, the removal and management of mine water often end, resulting in possible accumulation in rock fractures, shafts, tunnels, and open pits and uncontrolled releases to the environment.

Groundwater drawdown and associated impacts to surface waters and nearby wetlands can be a serious concern in some areas. ―Impacts from groundwater drawdown may include reduction or elimination of surface water flows; degradation of surface water quality and beneficial uses; degradation of habitat (not only riparian zones, springs, and other wetland habitats, but also upland habitats such as greasewood as groundwater levels decline below the deep root zone); reduced or eliminated production in domestic supply wells; water quality/quantity problems associated with the discharge of the pumped groundwater back into surface waters downstream from the dewatered area. While dewatering is occurring, discharge of the pumped water, after appropriate treatment, can often be used to mitigate adverse effects on surface waters.

According to the World Bank (2001 corruption and macro-economic mismanagement can severely limit the positive impact of mining creating opportunities on the national level. The World Bank (2001) gives an example of countries such as Congo and Zambia which have shown little overall development benefit from the copper production of the past decades, with state ownership and mismanagement characterizing the sector. Disturbances (noise, vibrations, etc.) also cause life quality degradation and reduction

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of property value- Radiations which are dangerous to human health- Discharges from pit protection wells causing a drop of the water table and increased flow in streams which also cause irrigation problems, floods, and degradation of potential water use. Surface run-off and discharges from surface water collected in the pit cause suspended solids in streams and aquatic life disturbance, floods, and degradation of potential water use.

Discharges from wastewater treatment plants and water/oil separators cause pollution and contamination of aquatic receivers which also lead to aquatic life disturbance and degradation of potential water uses. Improper management of municipal and special/hazardous waste causes increased concentration of toxic substances in soils/waters and aesthetic problems.

EIAs of mining projects often underestimate the potential health risks of mining projects. Hazardous substances and wastes in the water, air, and soil can have serious, negative impacts on public health. The World Health Organization (WHO) defines health as a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity. The term hazardous substances are broad and include all substances that can be harmful to people and/or the environment. Because of the quantity, concentration, or physical, chemical, or infectious characteristics, hazardous substances may (1) cause or contribute to an increase in mortality or an increase in serious irreversible or incapacitating illness; or (2) pose a substantial or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed (World Health Organization 2010). According to Kitual (2005), individual health risks associated with large-scale mining evolve around

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work-related injuries and health risks, as well as around an increased exposure to infectious diseases and environmental issues. He notes that the number of injuries and fatalities in mining varies a lot between countries, mostly depending on mining methods and technologies used and whether minerals are mined in open pits or underground.

According to Sumanth (2005), mining regions may have a higher prevalence of certain diseases because mining alters the environment and allows disease-causing pathogens and vectors to survive more freely than in other environments. Malaria is endemic in many tropical regions of the world. The warm and wet climate is ideal for mosquitoes, the vector for the disease. However, due to the physical and environmental changes that mining produces, malaria may have an increased prevalence in mining areas in tropical regions. Water pits created by mining activities serve as a reservoir for mosquito breeding. Sumanth (2005) also notes that in addition to malaria, some skin diseases may also have a higher prevalence in mining areas. In tropical regions with active mining, cyanide and mercury runoff from gold processing into local water bodies often increases the prevalence of skin diseases, as people use such water for daily necessities without treatment. Pollution caused by quarrying and blasting in open-pit mines increases not only the dust particles in the air and the surrounding environment, but also promotes the spread of toxic chemicals. Some of the toxic chemicals that result from blasting include cyanide and sulfur dioxide, which are all very harmful to the body (Akabzaa, 2000). Pavloudakis also adds that in addition, arsenic, which is used in processing the crushed rock, flows into streams and rivers, the major source of drinking water for residents.

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2.4 Types and Sources of Occupational Hazards Encountered in Small Scale Mining

All mining is inherently dangerous whether large, small-scale, or artisanal. Hazards and risks include blasting, rockfalls, landslides, flooding, machinery, toxic chemicals, and poor air quality. In the context of SDG8, the need to improve health and safety at ASM sites is paramount to achieving decent work for all through safe and secure working environments. The impacts of poor safety measures at ASM sites not only directly affect workers but also have negative spillover effects on local communities (World Bank, 2020). One of the most popular issues in mining is non-compliance with occupational health safety standards. Many small-scale mining operations are said to be lacking in the following- safety regulations, reinforcement of mine safety requirements, awareness of the risks inherent in mining, and access to better equipment. These risk factors lead to higher health risks and poorer working conditions in small-scale mining compared to formal and large-scale mining. The incidence of accidents in small-scale coal mining in Africa was found significantly higher than in large-scale mines (Hentschel *et al.,* 2002).

Small-scale mining makes to local employment, wealth creation, and community resilience, it is the landslide that "buries at least 54 jade miners" in Myanmar (BBC, 2019), gold mine explosion that "kills eight and injures two miners in Zimbabwe" (Casey, 2019), and the "three artisanal miners [that] died from inhalation of gases" in Nicaragua (Bnamericas, 2017) that attract the most attention. These preventable incidents capture public awareness for a short while and, rightfully so, acknowledge the tragic loss of life. But, as is often the case, when these articles are accompanied by negative language that criminalizes "illegal miners" in an "industry with few

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regulations" that "kills dozens" every year, the apathetic reporting places blame squarely onto miners themselves and does little to garner sympathy or generate long term committed actions from governments and companies alike. Instead, the reports of fatalities in ASM are normalized. Certainly, miners and communities face multiple health and safety risks. Many of these originate from the common informality of ASM operations. Poverty and the general lack of technical and financial support and training for miners are also frequently suggested as further causes of injuries, fatalities, and recurring illnesses in mining areas (Hilson and McQuilken 2014). Of all the possible safety issues, only mercury use in gold extraction and processing has received considerable academic and programmatic attention over the years (Bose-O'Reilly *et al.,* 2008; Hilson *et al.,* 2018; Veiga and Fadina, 2020).

2.4.1 Physical hazards

According to World Bank (2020), physical hazards in mining include musculoskeletal injuries & disorders trauma, loud noise & vibration, overexertion (heat & humidity), radiation, poor air quality and burns, and skin lesions. Under this, traumatic injury remains a significant problem and ranges from trivial to fatal (DeJoy, 2000). He asserted that common causes of fatal injury include rock falls, fires, explosions, mobile equipment accidents, falls from height entrapment, and electrocution. And other less common but recognized causes of fatal injury include flooding of underground workings, wet-fill release from collapsed bulkheads, and air blast from block carving failure. According to Nachimas and Nachimas (2009), the systematic application of risk management techniques has contributed to a substantial decline in injury frequency rates in developed nations as against poor countries where accidents are frequent. They were of the view that further improvement, however, is required to reach rates

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acceptable to the wider community. A review of work done by Osuala (2003), on measures to control physical hazards covers system safety and risk management in mining. Noise is almost pervasive in mining. It is produced through drilling, blasting, cutting, materials handling, ventilation, crushing, conveying, and ore processing. Measures to control noise have proven extremely difficult in mining and noise-induced hearing loss remains common (Nachimas and Nachimas, 2009). Iwundu (2000) emphasized that heat and humidity are encountered in tropical areas and in deep underground mines, where the virgin rock temperature and air temperatures increase with depth, due principally to the geothermal gradient and auto-compression of the air column. Fatal heat and its associated factors have been a significant problem in the Anglo-Gold Obuasi mines deep underground gold mines and heat exhaustion remains a contemporary problem in deep underground mining (Nachimas and Nachimas, 2009).

According to Harvey et al, (2001) whole body vibration is commonly experienced whilst operating mobile equipment, such as load-haul-dump units, trucks, scrapers, and diggers. This can cause or exacerbate pre-existing spinal disorders. Poorly maintained roads and vehicles contribute to the problem. Aryeetey's (2004) hand-arm vibration syndrome is also encountered with the use of vibrating tools such as air leg rock drills. Radon dust exposure in underground mining has increased the risk of lung cancer but is now generally being managed by mine ventilation. Occupations involving substantial outdoor work appeared not to be associated with an increased risk of melanoma.

2.4.2 Chemical hazards

Heavy metal poisoning (Hg, CN, As, Pb) and unborn & breastfeeding babies at risk are well-known chemical hazards (World Bank, 2020). Chemicals like crystalline silica

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have long been a serious hazard in mining, with the risk of silicosis at its worst during dry drilling late in the nineteenth century (Guzzo and Dickson, 2000). Silicosis has been subject to considerable investigation in mining areas (Haddel and Ojikutu, 2005). In the developed nations, axial water–fed rock drills, wet techniques; ventilation, enclosed cabins, and respiratory protection have largely controlled silicosis. However, silicosis remains a problem in developing nations and silico-tuberculosis is important in Africa, where the high prevalence of HIV infection among miners increases the risk. Prolonged exposure to crystalline silica can also cause chronic obstructive pulmonary disease (Gilmer and Haller, 2004).

Coal dust has also been a serious hazard in mining, causing coal workers' pneumoconiosis or 'black lung' and chronic obstructive pulmonary diseases (Ingalls, 2001). The risks have now been largely controlled in developed nations by dust suppression, ventilation, and respiratory protection (Gilmer and Haller, 2004). Vigilance is, however, required to maintain effective control. Although largely historic in the developed world, the mining and milling of asbestos have caused a legacy of asbestos-related diseases, which continue to occur today. Again, Gilmer and Haller (2004) pointed out that diesel particulate exposures occur in underground mines because of diesel-powered mobile equipment, used primarily for drilling and haulage. They emphasized that diesel particulate is a probable human carcinogen and several epidemiological studies from other industries suggest there is an excess risk of lung cancer. Measures to control this include the use of low sulfur diesel fuel, engine maintenance, and mine ventilation.

Arsenic is sometimes a contaminant of metal ores and has been commercially extracted during gold refining with an accompanying risk of lung cancer. Gilmer and Haller

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(2004) also said exposures to nickel compounds in some nickel refineries have been reported to increase the risk of lung cancer and nasal sinus cancer. However, these risks have declined substantially with improving hygiene in developed nations. Several other metal ores, including lead, cadmium, manganese, platinum, and cobalt, posed health hazards. Haddel and Ojikutu (2005) noted that the risks are usually greatest during metallurgical processing when air concentrations exceed those experienced during mining of the ore. Appropriate control measures are required. Exposures to coal tar pitch volatiles in Soderberg aluminum smelters have been reported to increase the risk of lung cancer and bladder cancer. Occupational asthma has also been a problem in the pot rooms of aluminum smelters and gold refineries (Huselid, 2006). Coal dust and methane gas explosions in underground gold and coal mines remain a serious risk requiring comprehensive monitoring and management. Some underground gold mines also have problems with carbon dioxide and hydrogen sulfide gas.

Furthermore, cyanide is used as a solvent for metals such as copper and gold in hydrometallurgical processes (Hale and Hale, 2005). Exposure to hydrogen cyanide gas can occur during cyanide solution preparation. Skin splashes with cyanide solutions are hazardous, although the risk is minimized by the use of low concentration solutions. Cyanide solutions are usually alkalinized to reduce the risk of hydrogen cyanide gas being evolved in contact with water. Mercury is still used in some gold mining operations, especially in developing nations, to extract gold through the formation of mercury vapor during the preparation of amalgam, retorting, or smelting. This is a poisonous metal and its exposure to humans is extremely dangerous.

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2.4.3 Biological hazards

Hale and Hale (2005) asserted that certain biological diseases are very common in mining areas in developing countries. For example, the risk of tropical diseases such as malaria and *dengue* fever is very substantial in some remote mining locations. A study conducted by Haddel and Ojikutu (2005) revealed that Leptospirosis and ancylostomiasis were common in mines, but the eradication of rats and improved sanitation has controlled these hazards effectively in the developed world. To control this, Haddel and Ojikutu suggested that regular microbiological analysis of the water is necessary to detect *Legionella* contamination or high concentrations of other heterotrophic microorganisms.

2.4.4 Ergonomic hazards

Huselid (2006) suggested that although mining has become increasingly mechanized, there is still a substantial amount of manual handling. Cumulative trauma disorders continue to constitute the largest category of occupational disease in mining and often result in prolonged disability. He continued that overhead work is common underground, during ground support, and the suspension of pipes and electrical cables. Huselid (2006) asserted that this is the cause of shoulder disorders among mining workers. The broken ground can also cause ankle and knee injuries among mining workers.

Mining operations are usually done 24 hours per day, 7 days per week, so, therefore, shift work is not uncommon to see in mining companies. There has generally been a trend towards 12 hours shifts in recent years. Eninger (2006), noted that fatigue from shiftwork has been subject to considerable investigation in the mining industry. He

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mentioned that sleep deficiency, which might be expected in hot locations, has been shown to cause impairments of cognitive and motor performance among drivers from other industries. Measures like remote control of mobile equipment in underground mining have been introduced to reduce fatal injuries from rock falls. This has required attention to cognitive ergonomic issues, many of which are similar to those found in metallurgical plant control rooms. Proximity safety devices have also been developed (Eninger, 2006).

2.4.5 Psychosocial hazards

A study conducted by Flippo in 2003 on 'mining and alcoholism' revealed that drug and alcohol abuse has been a difficult issue to deal with in mining companies, but policies and procedures are now in place in most large mining operations. Debate continues about how to measure psychosocial impairment. Eninger (2006) noted nevertheless, mining operations commonly require the measurement of urinary drug metabolites and breath or blood alcohol on pre-employment and following accidents. Most mining companies are located in remote locations. Massive ore bodies, such as those at Obuasi mines, which have been mined for over 100 years, justify the establishment of a city. However, companies tend to locate in areas that do not have the establishment of permanent townships. As a result, there has been a trend toward 'drive-in-drive-out' operations, with my employees separated from their families and communities during work periods. Unfortunately, fatal and severe traumatic injuries continue to occur in mining and often have a profound impact on morale. Post-traumatic stress disorders sometimes develop in witnesses, colleagues, and managers.

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2.5 Health and Safety Practices of Small-Scale Miners

Safety and health can be assessed and studied from different angles. Guldenmund (2010) distinguished three broad strategies for assessing health and safety at workplaces which include academic (anthropological), analytical (psychological), and pragmatic. These distinct approaches each entail specific methods and instruments to assess an organization's health and safety culture.

2.5.1 Diagnostic assessment approach

The analytical strategy is the most popular and predominant approach in health and safety culture assessment and focuses specifically on organizational safety climate (Hopkins, 2006). To Guldenmund (2010) health and safety climate is assessed/measured by conducting questionnaire surveys among a group of workers in an organization. In such surveys, workers are asked to complete a specific, standardized questionnaire, i.e. giving their perception/opinion (or the perception that is shared among the co-workers) on certain health and safety-related dimensions. The resulting data of the survey are processed and analyzed, providing a snapshot of the present safety climate in an organization.

Lucas (2001), postulated that these survey questionnaires can be rather simple (one page) or more exhaustive (up to 100 and more items), using tick boxes or Likert scales for responses. The simpler it is, the rougher will be the results. On the other hand, too, many questions will reduce the response rate significantly. In its guideline, the IAFA recommends around 60-80 items to cover the most important topics. Safety climate (and underlying safety climate dimensions), is typically assessed using standardized questionnaires with numerical results. This allows comparisons to be made with past

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results (to quantify changes processes or to assess the effects of intervention), and/or with results from other working groups or units. According to Guldenmund (2010), however, this potential for comparison/benchmarking within or between organizations is rather limited.

As already mentioned above, the measured safety climate appears to be a (strong) predictor for safety performance, which makes it a very appealing construct for researchers, managers, and occupational health and safety professionals (Clake, 2006). Since then many safety climate scales have been developed, tested, and applied worldwide, in a wide range of sectors and occupations A review by Seo *et al.* (2004), in which 16 safety climate questionnaires were examined, identifies the following five core constructs/dimensions of the safety climate concept:

a) Management commitment to health and safety,

b) Supervisor health and safety support,

c) Co-worker health and safety support,

d) Employee participation in health and safety-related decision-making and activities and

e) Competence level of employees regarding health and safety.

2.5.2 Theoretical assessment strategy

The academic strategy focuses more on things from the past, accident statistics, policy statements, etc (Guldenmund, 2010). This contrasts with the analytical strategy that uses questionnaire surveys to focus more on the present situation, attempting to quantify the safety culture/ climate. This is a descriptive strategy, meaning that seeks to describe and understand safety culture rather than judging it, seeking to promote change and

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development (Antonsen, 2009). For this purpose, specific data collection methods are based on, or at least ''inspired by'', anthropological and sociological research. This implies that required data and information are collected through 'fieldwork in the whole organization, using techniques such as observations, document analysis, and interviews (Antonsen, 2009, Guldenmund, 2010). These techniques are briefly described below.

2.5.2.1 Observations

Observation functions to generate an overview of typical artifacts of an organization. Management and workers are typically observed during their normal work to get information on working practices, processes, communication channels, decision making, symbols, etc. Observation can be made discreetly or using participant observation methods.

2.5.2.2 Documentation analysis

Documentation analysis can reveal artifacts or espoused values in the organization. Internal documentation can tell much about management processes, decision-making, and communication (e.g. quality management system documentation). Documentation that is directed to the public or which is channeled through media such as an intranet or further communication channels (e.g. newsletter, self-presentation, organization's policy statement, business ethics, etc.) often deals with espoused values.

2.5.2.3 Personal interviews

According to Antonsen (2009), personal interviews with company management, safety experts, or workers in sensitive areas are regularly done to learn more about management and safety practices in the company (which can be both artifacts or values) and can provide a deeper insight into complex contexts. Such interviews aim to get qualitative estimations of experts. Hence, open questions are the most suitable interviewing technique, but this makes the interpretation of the results rather difficult.

2.5.2.4 Open discussions in groups (focus group interviews, focus groups)

Open discussions in groups (focus group interviews, focus groups) can be used to discuss findings and observations and can help to get a more quality insight into an organization. They need to be conducted by a specialist as the answers will be highly influenced by group dynamics and the method is still more open than the qualitative interviews. What all these techniques/instruments have in common is that they should be preferably applied by a person from outside the organization, who has a rather neutral point of view and who should have the expertise needed in conducting the assessment. The use of ethnographic research methods in safety is apart from examples by Guldenmund (2010) also described by Brooks (2008), in a study of organizational safety culture in an SME (constructions firms). He underlines the fact that such field studies can be very time-consuming, which might encourage people to use quicker methods such as safety climate questionnaires. However, the deepest layers of an organization's culture can only be uncovered and understood by applying a more academic approach.

2.5.3 Practical assessment strategy

Apart from the analytical and academic assessment strategy, Guldenmund (2010) also distinguishes the pragmatic strategy. He stressed that in this strategy, the focus is on assessing a company's current state of maturity regarding safety culture, giving it a ranking on a predefined 'cultural maturity ladder' that shows different levels or stages of cultural maturity. The purpose goes beyond assessing the current situation to a level

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that defines and explores what should be done to develop the organization's health and safety culture to a higher level of maturity (or at least maintain the current level of maturity). The pragmatic strategy is thus future-oriented and prescriptive (normative) as to descriptive.

Guldenmund (2010) indicated that the most popular example of a pragmatic strategy is the 'Hearts and Minds Programme, which is used in large parts of the world. This Programme was developed by Shell (originally for the offshore industry) and distinguishes five different stages of cultural maturity (the 'health and safety culture step ladder') which include: pathological, reactive, calculative, proactive, and generative. One important tool of the 'Hearts and Minds' Toolkit is the 'Understanding health and safety Culture Checklist', which can be used to assess the safety culture development. It is a so-called 'Behaviourally Anchored Rating scales(BARS) (Guldenmund (2010). The Checklist needs to be completed by a group or team of workers during a workshop, led by an expert. The answers to the different items/dimensions ultimately indicate the safety culture maturity i.e. one of the five stages of the HSE Culture Step Ladder. The outcomes of such an assessment are then further linked to other tools and strategies that can be used to improve the organization's health and safety culture.

2.6 Factors and Challenges Associated with the Promotion of Health and Safety Practices in Small Scale Mining

The challenges which may be associated with Health and Safety practices have been classified into three main and overlapping aspects; people, process, and technology. The 'people' problems ranged from the risk of employees' emotional or psychological stress, reduction of loyalty to loss of internal expertise, and the fact that there is a lack of commitment among employees to provide and be brother's keeper to minimize industrial injury. Malhorta (2004) agreed with this by adding that the lack of cooperation; among workers themselves contributes among others to industrial accidents. The 'process' meanwhile comprises two classifications; incompatibilities between the authority (government safety department in charge of health and safety in organizations) and the organization itself, and the inability of the organization to sufficiently implement its decision to comply with health and safety standards. Among others, authorities' in industrial health and safety programs only implement general health and safety programs applicable to all industries and companies but do not take into recognizance specific company demands. At the same time, Mansfield (2001) has found that many companies have embarked on health and safety practices without any formal methodology or guidance. There is a lack of progressive and innovative human resource management (HRM) philosophies, policies, and processes, (including a proactive and collaborative approach) thereby practicing health and safety on an ad hoc basis.

A work done by Ingalls, (2002) on 'measures on safety performance' identify that there is also a high cost of providing health and safety materials at workplaces which deter management from fully executing health and safety standards in companies thereby leaving employees at the mercy of unsafe work environment. Further, DeJoy, *et al.* (2000) wrote that unqualified safety officers employed to manage the health and safety issues in many companies have been the bane of industrial accidents thereby causing needless industrial injuries and loss of life. There is a lack of routine, regular, and seasoned training courses on safety management for workers to appreciate the need for

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occupational health and safety precautions. Finally, there is a lack of governmental control and monitoring programs to visit business organizations, particularly mining companies to unravel whether these companies comply with certain minimum safety standards.

2.7 Legal, Institutional, and Policy Framework in Ghana's Mineral Industry

2.7.1 The minerals act, 1962 (Act 163)

In brief, this Act was enacted to consolidate with enactments and amendments relating to the administration of the mineral industry, mineral resources, stool, and other lands in Ghana. The Act vested ownership of minerals in the President who may grant licenses for prospecting for minerals, dredging rivers, winning minerals and obtaining water, or diverting streams for mining purposes, and declare land for mining purposes. Under the Act, prospecting licenses were limited to 60 square miles and 2 years. In addition, any grant of any mining rights was not to exceed 60 years and mining rights could not aggregate more than 60 square miles for anyone applicant (Minerals Act, 1962, Act 123).

2.7.2 The minerals and mining law of 1986 (PNDC Law 153)

The Minerals and Mining Law of 1986 (PNDC Law 153) is said to be one of the measures that have provided the framework for the resurgence of the mining sector. The law which has the underlying aim of creating a positive enabling climate for both local and foreign investment in the industry provided numerous incentives and benefits for mining companies. Among others, mining companies were to pay royalties on gold production from 3 to 12% depending on the rate of returns. A mining lease attracted an income tax of 45%, but where the rate of returns exceeded certain agreed levels, the

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company paid an additional profit tax. A holder of a mining lease qualified for a capital allowance of 75% of the capital expenditure incurred in the year of investment and 50% in subsequent years. Mining companies under the Act were also granted allowances on capitalization expenditure for reconnaissance and prospecting. Where the holder started the development of a commercial find, the company was allowed an investment allowance of 5%. Another additional benefit provided was exemption from payment of customs import duties in respect of plant and machinery imported for mining operations. The Gold Mining Companies' Law permitted free transfer of dividends or net profits and also allowed the detainment of 45 to 60% of foreign earnings. Unlike in Zimbabwe where producers needed to sell what they produced to the central bank, in Ghana, gold export according to the Act was done directly by the producers, giving investors more control over the marketing of their output (Minerals and Mining Law of 1986, PNDC Law 153). One of the most significant features of the Minerals and Mining Law is the scaling down of corporate income tax liability and the provision of more specific fiscal allowances that aim to reduce the general tax liability of mining sector operators. For example, corporate income tax, which stood at 50-55% in 1975, was reduced to 45% in 1986 and further scaled down to 35% in 1994 (Biney, 1998).

2.7.3 Small-scale gold mining law, 1989 (PNDC Law 218)

The Small-Scale Gold Mining Law, 1989 (PNDC Law 218) was enacted in pursuance of the Provisional National Defence Council (Establishment) Proclamation 1981. The importance of this law to this study is the fact that it gave birth to the legalization of small-scale gold mining operations in Ghana. The Law which was composed of twenty-one sections has three main parts. Part one deals with the registration and licensing of small-scale gold miners; part two focuses on the operations of small-scale gold miners;

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and finally, part three concentrates on the license to deal in gold and miscellaneous provisions. According to the Small-Scale Gold Mining Law, 1989 (PNDC Law 218), a license for a small-scale gold mining operation was granted to persons who are citizens of Ghana and have attained the age of eighteen years, and a license was granted to any person or group of persons other than a co-operative society should be for a period not more than three years from the date of issue in the first instance and may be renewed thereafter. The Secretary by the legislative instrument was supposed to prescribe the fees that must be paid for the grant and renewal of a license. About the operations of small-scale gold miners, the Law provided that a person licensed to mine gold may win, mine, and produce gold by any effective and efficient method and in his operations should observe good mining practices, health and safety rules and pay due regard to the protection of the environment.

The law, however, prohibited the miners from the use of any explosives in their operations. They were, however, permitted to purchase mercury from any authorized dealer in such quantities that may be reasonably necessary for mining. For three years from the date of the coming into force of the Law, all persons engaged in small-scale gold mining operations were to be exempted from the payment of income tax and royalties in respect of their mining operations. According to legal experts, the Law failed to consolidate small-scale mining operations into the mining act. Again, the law did not reflect new thinking and developments in the mining industry and hence, the need to revise the Law. This led to the enactment of the Minerals and Mining Act, 2006 (Act 703).

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2.7.4 The minerals and mining act, 2006 (Act 703)

The Minerals and Mining Act, 2006 (Act 703) is the current act that regulates the administration of the mineral industry and mineral resources in Ghana today. The purpose of the Act is to revise the existing Minerals and Mining Law, 1986 (PNDC Law 153) and consolidate the Small-scale Gold Mining Law, 1989 PNDCL 218 to reflect on new thinking and developments in the mining industry. The Act highlights the following: ownership of minerals and cadastral system; mineral rights; royalties, rentals, and fees; dispute resolution; types of mining licenses: reconnaissance license, prospecting license; a mining lease; radio-active minerals; surrender suspension, and cancellation of mineral rights; surface rights and compensation; industrial minerals; small-scale mining; and administration and miscellaneous provisions.

Sections 1 – 80 concentrate on large-scale mining while sections 81 – 99 give attention to small-scale mining and sections 100 – 112 focus on administration and miscellaneous provisions. On the ownership of minerals, like the Minerals and Mining Law of 1986 (PNDC Law 153), the Minerals and Mining Act, 2006 (Act 703) vests every mineral in its natural state in, under, or upon the land in Ghana, rivers, streams, water-courses throughout the country, the exclusive economic zone and an area covered by the territorial sea or continental shelf as the property of the Republic and is vested in the President in trust for the people of Ghana and the Minister responsible for mines on behalf of the President and the recommendation of the Minerals Commission may negotiate, grant, revoke, suspend or renew mineral lights by this Act. Under the Act, mining activities require a mineral right and a person must be granted a mineral right before he/she engages in the search, reconnaissance, prospecting, exploration, or mining activities Holders of mineral rights have obligations that include: appointing a

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manager with the requisite qualification and experience to be in charge of that holder's mineral operations; notifying the Head of the Inspectorate Division of the Minerals Commission of the appointment of a manager and on each change of the manager; and obtain the necessary approvals and permits required from the Forestry Commission and the Environmental Protection Agency for the protection of natural resources, public health, and the environment.

In respect of fees, royalties, and rentals, mining companies are obliged to pay the following: a prescribed application fee; annual ground rent to the owner of the land or successors; annual mineral right fees; and royalties between 3 – 6% of the total revenue of minerals obtained by the holder. A fee, royalty, or other payment which falls due under this Act is a debt owed to the Republic and recoverable in the Court. To oversee the efficient and effective operations of small-scale mining in the mining districts, the Act has made provision for the establishment of Small-Scale Mining Committees which are made up of the following members: the District Chief Executive or his/her representative as the chairperson of the Committee; District Officer of the Minerals Commission; one person nominated by the relevant District Assembly; one person nominated by the relevant Traditional Council; an officer from the Inspectorate Division of the Commission; and an officer from the Environmental Protection Agency. It could be observed that even though, the Act does not permit foreigners to own or directly engage in small-scale mining, it permits foreign mining servicing companies to provide consultancy services and, hire and sale of equipment to the miners. Some indigenous miners may collude with foreigners under the pretext of hiring equipment and seeking consultancy from them only to form partnerships with them and increasingly add up to the number of illegal miners to the detriment of the national

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economy. It is important to emphasize the expected benefits or economic gains from the improved (investor-friendly) legal regime in the economy of Ghana. The consequence of the new mining regime according to Vieta (1994) was the rapid expansion of existing mines, reactivation of abandoned mines, and escalation of new exploration sites.

Vieta (1994) further stated that at the beginning of 1992, as many as 82 local and 25 foreign companies held gold prospecting and reconnaissance licenses in Ghana. As of 2003, over 150 companies were operating, with 25 of them in active gold exploration and production. Notable among the companies with mining leases as per Vieta (1994) were Ashanti Goldfields Corporation (AGC) now AngloGold Ashanti (Gh) Ltd., Billiton Bogosu Goldfields Limited (BSSG), Golden Rae Mining Co Ltd, Ghanaian-Australian Goldfields Ltd (GAG), Goldfields (Gh) Ltd, Southern Cross Mining Company (SCMC) and State Gold Mining Corporation (SGMC).

2.7.5 Institutional and policy framework

Available literature shows that there are several institutions established in recent times to provide administrative and regulatory mechanisms for small-scale mining operations in Ghana (World Bank, 1993; IMF, 1994). They include the following:

Ministry of Lands, Forestry, and Mines

Minerals Commission of Ghana

Chamber of Mines

Precious Minerals Marketing Company (PMMC)

Geological Survey Department (GSD) of Ghana

Environmental Protection Agency (EPA)

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2.7.5.1 Ministry of lands, forestry, and mines

The Ministry of Lands, Forestry, and Mines (MLFM) ensures the sustainable management and judicious utilization of the country's lands, forestry, wildlife, and mineral resources for the socio-economic growth and development of Ghana. The Mines Section of the MLFM (the former Ministry of Mines) is the principal governmental authority responsible for the mining sector in Ghana and has the task of advising and coordinating government policy on mining issues and reviewing recommended licenses and important documents and agreements related to the mining sector (Minerals Commission, 2007).

2.7.5.2 Minerals Commission of Ghana

The Minerals Commission was established by the Minerals Commission Act, 1993, (Act 450). The Commission is responsible for the regulation and management of the utilization of the mineral resources of Ghana and the coordination of the policies concerning them. The Commission among other things formulates recommendations of national policy for the exploration and exploitation of mineral resources with special reference to establishing national priorities having due regard to the national economy; advises the government on matters relating to minerals; monitors the implementation of laid down government policies on minerals and the operations of all bodies or establishments with responsibility for minerals (Minerals Commission, 2007). The Minerals Commission has established seven Small-Scale Mining District Offices/Centres in the country to compile a register of all prospective small-scale gold miners and to supervise and monitor their operations and activities. These centers are located at Akim-Oda, Asankrangwa, Assin-Fosu, Bibiani, Bolgatanga, Dunkwa, and Tarkwa (Minerals Commission, 2007).

2.7.5.3 Precious minerals marketing company (PMMC)

The PMMC was established by the Precious Minerals Marketing Corporation Law, 1989 (PNDCL 219) to buy from small-scale miners precious minerals, such as diamonds and gold, and sell such precious minerals to enhance Ghana's foreign exchange earnings from the mining sector. The PMMC also exists to promote the development of the precious minerals and jewelry industry in Ghana by grading, assaying, valuing, and processing precious minerals. It was also established to appoint licensed buying agents for the purchase of precious minerals produced by small-scale miners; and to perform any functions conferred upon it by the Precious Minerals Marketing Corporation Law, 1989.

2.7.5.4 Geological survey department (GSD) of Ghana

The GSD of Ghana was established in 1913 as the "Gold Coast Geological Survey". The main task of GSD is to undertake geological mapping, research, and investigations to generate, collect and store geoscientific data and knowledge. The GSD has the responsibility to advise the state and the general public on matters relating to geological implications in national development such as issues concerning mineral resources, environment, groundwater management, land use planning, and geohazards (Minerals Commission, 2007).

2.7.5.5 Environmental protection agency (EPA)

The Environmental Protection Agency (EPA) was also established by the Environmental Protection Agency Act, 1994, (Act 490). The EPA was set up, among other things, to protect the environment through policy formulation and economic,

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scientific, and technological interventions needed to mitigate any harmful impacts caused by development activities including mineral exploration and processing. It exists to coordinate, supervise, monitor, and evaluate the activities in the environment that support goals and targets of the national sustainable development. The EPA also provides the standard setting and regulating activities regarding the application of science and technology in managing the environment for sustainable development. Finally, the EPA promotes the activities needed to underpin the standards and policies required for planning and implementation of development activities (Environmental Protection Agency Act, 1994, Act 490). Despite the establishment of the above-mentioned institutional, administrative, legal, and regulatory structures to regulate and provide a congenial environment for effective small-scale mining operations in the country, weak institutional structures, inadequate capacity to implement existing regulations, inadequate financial support services, and sometimes lack of political will, further contribute to making small-scale mining far from achieving its full potential.

2.7.6 Policy framework in the mining sector

The policy framework in the mining sector which commenced in 1986, formed an integral part of the macro-economic policy reforms of the Economic Recovery Programme (ERP) initiated in 1983 (Hilson, 2001). The mining sector which is a potential and major contributor to the gross foreign exchange received priority attention following the World Bank's policy recommendations for restructuring the key export sectors, especially mining, under the Structural Adjustment Programme (SAP). According to the World Bank (1986), the policy recommendations included: the need for a coordinated program of rehabilitation of state-owned mines, a satisfactory degree

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of management autonomy, gradual divestiture of mines to private investors, together with financial assistance to reverse the downward trend of production.

According to Songsore, *et al.* (1994), two types of policy actions positively impacted the mining sector. First, macroeconomic policy reforms; and second, sector-specific policy reforms. In more specific terms, the mining sector policy reforms included: changes in mining sector legislation to make the sector attractive to foreign investment; increasing fiscal liberation of the mining sector; strengthening and reorientation of government support institutions for the mining sector; privatization of state mining assets; enactment of environmental laws and other mining sector legislative changes. At the macro level, the policy framework also focused on the following: trade liberalization policies; public expenditure policies; state-owned enterprises reform; and public sector management.

According to IMF (1994), the Ashanti Goldfields had substantial funds during the period for expansion and rehabilitation while former state entities such as Tarkwa Goldfields, Prestea Mine, and the Ghana Consolidated Diamond Company were given out to various groups of investors under management contract agreements. The second stage entailed the privatization exercise, which was carried out in a variety of ways including the following:

Firstly, the government systematically disengaged itself by selling its shares in these mines to the private sector. In the case of Ashanti Goldfields Corporation, the government progressively reduced its stake to 19% in 1998, from its original 55% through the sale of its shares initiated in 1993, while in the case of Ghana Bauxite

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Company, the government reduced its shareholding from 55% to 20% in 1998 (Hilson, 2001; and Songsore, *et al.*, 1994).

Secondly, complete divesture of hitherto state-owned mines to the private sector with the government maintaining a statutory 10% free equity in those mines (Hilson, 2001; Songsore, *et al.*, 1994). Akabzaa *et al.* (2004) reported that initially, foreign companies were invited to participate in management contract agreements and eventually bought them where they found them viable. For instance, Goldfields South Africa ran the Tarkwa mine on a management contract from 1993 and 1994 and eventually purchased it in 1995. Johannesburg Consolidated Investments (JCI), another South African company, ran the Prestea mine on contract from 1995 to 1996 and purchased it in 1997. Dunkwa Goldfields and Ghana National Manganese Corporation were sold outright while Ghana Consolidated Diamonds, which was run by De Beers on contract, has failed to attract buyers and De Beers refused to exercise its option (Hilson, 2001).

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CHAPTER THREE

METHODOLOGY

3.1 Study Area

3.1.1 Location of the study area

The study was conducted in Wassa Amenfi (West, East, and Central) Districts in the Western Region of Ghana.

3.1.1.1 Amenfi West

Amenfi West Municipal is located in the middle part of the Western Region of Ghana. It is bounded to the west by Sefwi Wiaso and Aowin Suaman districts, to the south by Jomoro and Ellembele, to the southeast by Prestea- Huni Valley, and to the north by Bibiani-Anwiasi-Bekwai and to north-east by Wassa Amenfi East. It lies between latitude 5^{o} 30' and 6^{o} 15'N and longitude 1^{o} 45 W and 2^{o} 11'W. It has a total land area of 3,464.61 Square kilometers and is made up of over 250 communities (Ghana Statistical Service, 2014).

3.1.1.2 Amenfi East

The Wassa Amenfi East District is one of the districts in the Western region of Ghana. The district can be found in the middle part of the region. It lies between Latitudes 5^{o}, 30^{1} N and 6^{o}, 15^{1} N, Longitudes 1^{o}, 45^{1} W and 2^{o}, 11^{1} W. It is bounded to the west by Wassa Amenfi West District, to the east by Mpohor Wassa East District, to the south by Prestea Huni Valley District, and to the north by Upper Denkyira West and East District (GSS, 2014).

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3.1.1.3 Amenfi Central

The district is located in the middle part of the Western Region of the country. It has an estimated land size of 1,845.9 square kilometers with 131 communities. It is bounded to the North by Bibiani-Anhwiaso-Bekwai and Upper Denkyira West Districts and Sefwi-Wiawso Municipal; to the North-West by Aowin District; to the South by Prestea Huni-Valley; to the East by Amenfi East District and to the West by Amenfi West District. It lies between latitudes 5º 20'N and 6º 7'N and longitudes 2º 9'W and 2º 27'W (GSS, 2014).

3.1.2 Climate

The districts fall within the wet parts of the country. Average annual rainfall ranges from 173mm in the south to 140mm in the north. There are two main rainfall regimes: March to July and September to early December. Temperatures are generally high, ranging from 24°C-29°C (75 F -83 F). Maximum temperatures occur in March and the coolest month is August (Ghana Statistical Service (GSS), 2014).

3.1.3 Agricultural activities

The main economic activity in the municipalities is agriculture. Cocoa, oil palm, and rubber are the cash crops that are mostly grown. Other major food crops grown are cassava, maize, rice, garden eggs, and tomatoes. Most of the farmers use family hands, hired labor, and farmers 'mutual help (Nnoboa). Land acquisition is mostly on a leasehold or share-cropping systems (Abunu or Abuse). The farmers are mostly engaged in indigenous farming. The practice of slash and burn, bush following, and shifting cultivation are the main methods used. (GSS, 2014).

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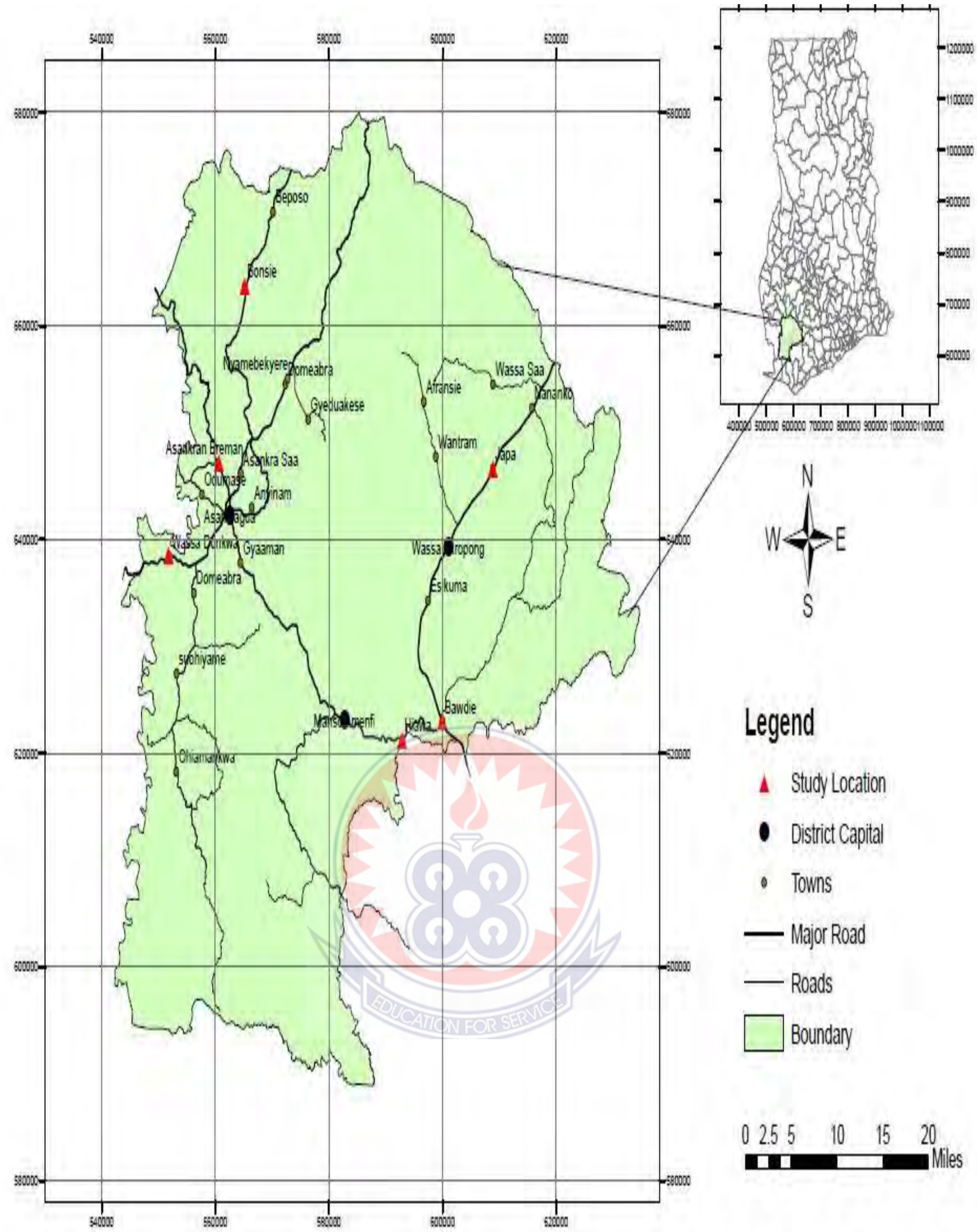

Figure 3.1: Map of the study area; Wasa Amenfi (West East and Central).

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3.2 Data Collection

3.2.1 Study design

A descriptive cross-sectional survey design was adopted for this study to assess occupational health safety practices among small-scale miners in Wassa Amenfi West Municipalities of Ghana.

3.2.2 Sample population and sample size

The population for the study included personnel from small-scale mining firms in the Amenfi West, East, and Central, Environmental Protection Agency, and the Minerals Commission.

3.2.2.1 Sample size

A total of 295 participants were sampled for the study using Sl's technique to calculate the sample size. Slovin's formula is written as $n = N \div (1+Ne^2)$ Where n = Number of samples, N = Total population and e = Error tolerance

Table 3.1: Sampling size

S/N	MINING COMPANY	TOTAL POP.	SAMPLED POP.
1	OBENG	65	56
2	AKROPONG COMMUNITY MINE	55	48
3	AWINO MINE	75	63
4	PRINCE EXPRESS	50	44
5	MINTA MINES	40	36
6	BREMAN COM. MINE	55	48
	TOTAL	340	295

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3.2.3 Sampling technique

Data was collected using both primary and secondary data collection methods. A multi-stage sampling procedure was employed, involving purposive and simple random sampling techniques to select the participants. Purposive sampling was used to select the small-scale mining sites namely; Obeng Mines, Akropong Community Mines, Awino Mines, Prince Express, Minta Gold Mines, and Breman Community Mines while simple random sampling was used to select mine workers. Consent of the respondents was sort before administering questionaaire.

3.2.1 Primary data collection tool

Primary data was collected by using a questionnaire, personal observation and checklist, in-depth interview guide, and laboratory analysis for the concentration levels of mercury and arsenic in water and soil. A structured questionnaire comprising of closed and open-ended questions was employed to solicit information from the respondents on the health and safety practices in the mining operations. Also, data on the types and sources of hazards in small-scale mining was collected with the use of a questionnaire.

3.3 Test for Mercury (Hg) and Arsenic (As)

Water and sediment samples were taken to the laboratory to determine the levels of mercury and arsenic.

3.3.1 Sampling sites

Samples were taken from wastewater of the selected mining sites within the study area (Wassa Amenfi West, East, and Central).

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3.3.2 Sampling procedure

Samples were collected from the surface of the stagnated water surface using 1.5L high-density polyethylene bottles. Water sampling bottles were rinsed twice with the water before sampling was done at each site. Samples were sealed and transported in an ice chest to the laboratory. Water samples were acidified with concentrated nitric acid, well labeled, and kept over ice in an ice chest according to the standard method (APHA, 1995) to maintain them at a temperature below 4°C during the transfer from the field to the laboratory.

3.3.3 Laboratory analysis for Hg and As.

Metal digestion was done using the Milestone Acid digestion method. A 5 ml volume of each water sample was pipetted into a 20 ml Teflon tube. Concentrated acids of 6 ml nitric acid (HNO_3, 65%), 3 ml of hydrochloric acid (HCl, 37%), and 0.25 ml hydrogen peroxide (H_2O_2) were added to each sample. The samples were placed in an ETHOS 900 microwave digester for 3 min. After digestion, the samples were allowed to cool to room temperature and the solutions were then diluted to 20 ml with distilled water. The liquid extracts were used for the determination of arsenic and mercury using a VARIAN AA240FS fast sequential atomic absorption spectrophotometer under the recommended instrument parameters. Two standard reference materials - IAEA 356 from the National Institute of Standards and Technology, USA, and NIVA SLP 0838 PROVE I from Norway were used for the validation of the analytical results. The concentration of each metal was calculated using the formula:

Final concentration (mg/l) = concentration of metal x dilution factor x nominal volume/Sample volume (ml).

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3.4 Pre-testing

Filled forms for the study were pretested using the population target to test for question variation, interpretation, essentiality, and respondent views and understanding. The pre-test questions included questions abstracted from similar studies. The question's reliability was assessed by comparing answers given by respondents with responses given during data collection. The comparison of answers was checked for convergent validity.

3.5 Data Handling

Filled forms for the research were checked for competencies and accuracy by supervisors. They were administered to workers of the small-scale mining companies in the study area for study as a means of exploring primary data for the study. The coded data was further stored and utilized in research analysis in the form of sequences and numbers.

3.6 Data Analysis

Data were entered into Microsoft Excel (Microsoft, 2010) and then transferred to SPSS 22 for analysis. Descriptive statistics were calculated by demographic and occupational factors. One-way ANOVA and independent sample t-tests were used to evaluate potential differences in continuous variables. Demographic factors, mining activities, and mining experience, hours worked per week, and frequency of PPE use was tested individually and in combination for potential association with injury risk. Mining experience was estimated using the greatest number of years an individual had spent on any single mining activity. Levels of water and sediment samples were analyzed and One-way ANOVA was used.

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CHAPTER FOUR

RESULTS

4.1 Demographic Characteristics of Respondents

The demographic characteristics considered in the study included age, sex, educational status, and marital status, (Table 4.1). The majority of the respondents 108 (36.7%), in the study, had an age range of 30-39 years. This was followed by 106(35.9%) with an age range of 20-29 whiles 40-49 years recorded 59 (19.4%). Ages from 50 years and above recorded 12 (4.6%) and those below 20 years recorded 10 (3.4%), (Table 4.1). Most of the respondents 266 (90.2%) were males and a few 29 (9.8%) were females. The majority of the respondents 150 (50.2%), had a JHS/Middle level of education. Primary education was 68 (22.8%), SHS/O'level was 56 (18.9), tertiary education 12 (4.0%) and no education/school 9 (2.1%). The marital statuses of respondents were married, single, divorced, and widowed. Married respondents dominated the study with 158 (53.7%) whiles 131 (43.3%) were single, divorced, and widowed 3 (1.0%) each. (Table 4.1).

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Table 4.1: Demographic characteristics of respondents

Parameter	Responses	Frequency	Percentage (%)
Age	Below 20 years	10	3.4
	20-29 years	106	35.9
	30-39 years	108	36.7
	40-49 years	59	19.4
	50 years and above	12	4.6
Sex	Female	29	9.8
	Male	266	90.2
Educational status	No education	9	2.1
	Primary	68	22.8
	JHS/Middle form	150	50.2
	SHS/O Level	56	18.9
	Tertiary	12	4.0
Marital status	Married	158	53.7
	Single	131	43.3
	Divorced	3	1.0
	Widowed	3	1.0

4.2 Knowledge of Health and Safety in Mining

Knowledge of health and safety in mining was assessed and the results revealed that most of the respondents had high knowledge in the health and safety of mining 289(98.00%). Respondents indicated that safety in mining means protection from hazards, recording 193(65.00%). This was followed by wearing PPE 50(17.00%) and regular hospital check-ups 46(16.00%). Very few of the respondents had no idea about safety in mining 6(2.00%). Respondents from Awino small-scale mining companies had the highest knowledge level of safety in mining 63(21.36%). Respondents from Obeng Mines had 56(18.98%), AKCM company and Breman Community Mines recorded 48(16.27%) each, Prince Express had 44(14.92%) while Minta company had 36 (12.20%). (Table 4.2). There was no significant difference (P=0.997301) between

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knowledge of health and safety in mining and within the various companies as all companies were mostly at the same level of understanding regarding safety.

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Table 4.2: Respondents' knowledge of health and safety in mining

Safety in mining	Companies						Total(%)
	AKCM(%)	AWINO(%)	BREMAN(%)	MINTA(%)	OBENG(%)	PE(%)	
Protection from hazard	26(8.81)	34(11.53)	33(11.19)	30(10.17)	35(11.86)	35(11.86)	193 (65)
Regular hospital check-up	9(3.05)	13 (4.41)	5 (1.69)	(0.00)	11 (3.73)	8 (2.71)	46 (16)
Wearing of PPE	13 (4.41)	16 (5.42)	7 (2.37)	3(91.02)	10 (3.39)	1 (0.34)	50 (17)
No idea	0.00	(0.00)	3 (1.02)	3(1.02)	(0.00)	(0.00)	6 (2)
Total	48(16.27)	63(21.36)	48(16.27)	36(12.20)	56(18.98)	44(14.92)	295(100)

P-value=0.997301 Field data: 2020

4.3 Awareness of Available Regulations Regarding Worker's Safety

The study showed that the majority of the respondents were aware of available regulations regarding workers' safety 233(78.98%). Sources of awareness of the respondents were from mining companies 217(73.56%), online 10(3.39%), and television 6(2.03%). Again Respondents from Awino had a greater level of awareness of available regulations regarding workers' safety 47(15.94%). This was followed by Obeng 46(15.59%), PE 43(14.58%), AKCM and Breman 35 (11.86%) each, and Minta 27 (9.15%). (Table 4.3).

Table 4.3: Source of awareness of available regulations regarding workers' safety

Companies	Sources				
	No (%)	Yes (%)	Mining Firm (%)	Online (%)	Television
AKCM	13(4.41)	35(11.86)	35(11.86)	0.00	0.00
AWINO	16(5.42)		45(15.25)	2(0.68)	0.00
BREMAN	13(4.41)		31(10.51)	3(1.02)	1(0.34)
MINTA	9(3.05)		21(7.12)	5(1.69)	1(0.34)
OBENG	10(3.39)		46(15.59)	0.00	0.00
PE	1(0.34)		39(13.22)	0.00	4(1.36)
Total	62(21.02)		217(73.56)	10(3.39)	6(2.03)

Field data: 2020

4.4 Safety Measures Deployed in Small Scale Mining

Safety measures put up by the companies were investigated and the study revealed that safety measures by the companies were safety training, regular monitoring, and prompt reporting of incidence. Safety training was the highest safety measure adopted and executed across the various mining companies 259(35.00%). PPE was the next

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recording 244(33.00%), regular monitoring was 209(28.00%), and prompt reporting of the incidents was recorded at 27(4%) (Table 4.4). There was no significant difference (P=0.264596) regarding safety measures put in place by the companies.

Table 4.4: Safety measures by companies

Companies	Safety measures			
	Safety training(%)	Regular monitoring(%)	PPE(%)	Prompt reporting of incident(%)
PE	44(5.95)	43(5.76)	43(5.82)	4(0.59)
OBENG	56(7.56)	46(6.16)	46(6.22)	0
AWINO	63(8.51)	47(6.30)	47(6.36)	0
AKCM	48(6.49)	35(4.69)	35(4.73)	0
BREMAN	33(4.46)	26(3.48)	45(6.08)	8(1.19)
MINTAH	15(2.03)	12(1.61)	28(3.79)	15(2.22)
Total	259(35)	209(28)	244(33)	27(4)

P=0.264596 Field data: 2020

4.5 Adherence to Safety Measures in Small Scale Mining Industry

Adherence to safety measures in the small-scale minimall-scaley is very important in the prevention of occupational hazards. Compliance with occupational safety & health (OSH) rules and regulations at work (M=4.31 SD=0.479) was the highest safety measure respondents indicated that it was necessary for the small-scale mining industry. This was followed by the wearing of personal protective equipment (PPEs) in the organization (M=4.25 SD=0.477), employees having representatives in the health and safety committee (M=4.19 SD=0.834), presence of health and safety cultures followed by employees (M=4.06 SD=0.680). The rest of the factors are presented in Table 4.6.

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Table 4.6: Adherence of safety measures in small scale mining industry

S/N	Safety adherence	SD	D	N	A	SA	Mean
1	Wearing of Personal Protective Equipment (PPE)	0	0	3(18.8)	7(43.8)	6(37.5)	4.25
2	Compliance with safety cultures	0	0	3(18.8)	4(25.0)	9(56.3)	4.06
3	Employees' representation in the health and safety committee	0	0	0	5(31.3)	11(68.8)	4.19
4	Employees' compliance with rules and regulations at work	0	0	0	5(31.2)	11(68.8)	4.31
5	Workers refuse to report minor injuries or near misses	3(18.8)	0	0	6(37.5)	6(37.5)	3.80
6	Workers refuse to wear (PPEs)	0	0	0	4(25.0)	12(75.0)	4.25
7	Report hazardous conditions to the management	2(12.5)	5(31.5)	0	2(12.5)	7(43.8)	3.13
8	Employees responsible for their health and safety	2(12.50)	4(25.0)	0	3(18.8)	7(43.8)	3.31

SD: strongly disagree, D: disagree, N: neutral, SA: strongly agree, A: Agree

Field data: 2020

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4.6 Tools and Equipment Used in Small Scale Mining Activities

Tools and equipment used in small-scale mining activities in the study area include pick ax, shovel, excavator, and pumping. Pickax and shovel usage was the highest, recording 287(27.0%) each while pumping machine and excavator 274(25.0%) and 221(21.0%) respectively. There was no significant difference (P=0.508823) regarding tools and materials used in small-scale mining activities (Table 4.7).

Table 4.7: Tools and equipment used in small-scale mining activities

Company	Pick ax (%)	Shovel(%)	Excavator(%)	Pumping machine(%)
PE	44(4.1)	44(4.1)	44(4.2)	44(4)
OBENG	51(4.8)	51(4.8)	30(2.9)	51(4.7)
AWINO	62(5.8)	62(5.8)	62(5.9)	62(5.7)
AKCM	48(4.5)	48(4.5)	48(4.6)	48(4.4)
BREMAN	46(4.3)	46(4.3)	15(1.4)	40(3.6)
MINTAH	36(3.5)	36(3.5)	22(2.0)	29(2.6)
Total	287(27)	287(27)	221(21)	274(25)

P=0.508823 Field data: 2020

4.7 Health and Safety Emergency Management in Small Scale Mining Industry

Emergency management of health and safety included taking action on dangerous situations before and after work, presence of warning alarms/sirens, and escape routes at the work stations. Most of the respondents 225(76.27%), indicated that actions must be taken in dangerous situations before and after work while a few were not aware 70 (23.73%). There was a significant difference (P=0.00006) in actions taken in emergencies before and after concerning the various companies. With the presence of warning alarms/sirens at the workplace majority of the respondents, 158 (53.56%)

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indicated it as a necessity whiles the remaining 137 (46.44%) disregarded the need for warning alarms/sirens as shown in Table 4.8. There was no significant difference (P=0.22966) in the presence of alarms/sirens concerning the various companies. The majority of the respondents 179 (60.68%), indicated that the escape route was important at work stations while 116 (39.32%) had different thoughts. There was no significant difference (P=0.1885) in the escape routes at the work stations for the respondents from various companies.

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Table 4.8: Awareness of health and safety emergency management in small scale mining industry

Parameter	AKCM(%)	AWINO(%)	BREMAN(%)	MINTA(%)	OBENG(%)	PE(%)	Total(%)	P-Value
Actions are taken in dangerous situations before and after work								
No	17(5.76)	21(7.12)	5(1.69)	0.00	17(5.76)	10 (3.39)	70(23.73)	0.00006
Yes	31(10.51)	42(14.24)	43(14.58)	36(12.20)	39(13.22)	34(11.53)	225(76.27)	
Company Total	48(16.27)	63(21.36)	48(16.27)	36(12.20)	56(18.98)	44(14.92)	295(100.00)	
Presence of warning alarm/siren at workplace								
No	34 (11.53)	46(15.59)	13 (4.41)	(0.00)	39(13.22)	26 (8.81)	158 (53.56)	0.22966
Yes	14(4.75)	17(5.76)	35(11.86)	36(12.20)	17(5.76)	18 (6.10)	137 (46.44)	
Company Total	48(16.27)	63(21.36)	48 (16.27)	36 (12.20)	56(18.98)	44(14.92)	295(100.00)	
Escape route at work station								
No	26(8.81)	34(11.53)	10(3.39)	(0.00)	28(9.49)	18(6.10)	116(39.32)	0.1885
Yes	22(7.46)	29(9.83)	38(12.88)	36(12.20)	28(9.49)	26(8.81)	179(60.68)	
Company Total	48(16.27)	63(21.36)	48(16.27)	36(12.20)	56(18.98)	44(14.92)	295(100.00)	

Field data: 2020

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4.8 Types and Sources of Hazards in Small-Scale Mining

Types of occupational hazards included physical, chemical, biological psychosocial, and ergonomic hazards. Sources of physical hazards included non-wearing of PPEs, working from height and around a dangerous environment, high level of noise during drilling, blasting, milling, exposure to dusty conditions at the working place, and accumulation of smoke emitting from diesel-operated equipment at working areas. The majority of the respondents indicated that exposure to dusty conditions in the working place (3.50) was the highest source of physical hazard. For psychosocial hazards, there is frequent violence among workers (4.50) was the major psychosocial hazard respondents indicated that they faced at the work. Employees work for long hours and employees have adequate time to rest after working hours (2.33). Lifting of heavy materials (3.00) was the major ergonomic hazard recorded. This was followed by materials being lifted unaided (2.33), working in awkward body posture and performing the same task repeatedly and workers working for long hours (2.17) each and there is frequent bending during work (1.50). Workspace unclean and unclear of mold and fungi (3.50) exposed most small-scale miners to biological hazards. This was followed by sharp materials disposed of unsafely and workers standing in dirty water whiles working (3.33) each and the presence of stingy insects (2.00). Chemical hazards include the usage of chemicals that are poisonous and corrosive, usage of chemicals throughout mining operations, not wearing PPEs when dealing with chemicals, and workers being exposed to substances that can be inhaled, ingested, or absorbed into the body.

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Table 4.9: Types and sources of occupational hazards encountered in small-scale mining

HAZARDS	SA(%)	A(%)	N(%)	D(%)	SD(%)	Mean
Physical Hazard						
The Non-wearing of PPEs	33.3	33.3	00	33.3	00	2.33
Working from height	50	50	00	0	00	1.50
High level of noise from operational activities.	50	50			00	1.50
Exposure to dusty conditions at the working place.	16.7	00	00	83.3	00	3.50
Accumulation of smoke emitting from diesel-operated equipment in working areas	00	66.7	00	33.3	00	2.67
Psychosocial Hazards						
Long hours of work for employees	33.3	33.3	00	33.3	00	2.33
Frequent violence among workers	00		00	50	50	4.50
Adequate resting time	00	83.3	00	16.7	00	2.33
Ergonomic Hazards						
Manual lifting	33.3	33.3	00	33.3	00	2.33
Awkward body posture and repeated performance of a task	50	16.7	00	33.3	00	2.17
Working for long hours	50	16.7	00	33.3	00	2.17
Frequent bending during work	50	50			00	1.50
Lifting of heavy materials	00	50	00	50	00	3.00

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Biological hazards						
Presence of reptiles	00	50	00	50	00	3.00
Workers stand in dirty water whiles working	00	50	00	16.7	33.3	3.33
Presence of stingy insects	00	100				2.00
Dirty working environment	00	33.3	00	50	16.7	3.50
Sharp materials disposed of unsafely	00	33.3	00	66.7	00	3.33
Chemical hazards						
Exposure to poisonous chemicals	00	100	00		00	2.00
Not wearing PPEs when dealing with chemicals	00	50	00	50	00	3.00
Use of chemicals for mining operations			00	100	00	4.00
Usage of chemicals that are poisonous and corrosive	0	66.7	00	33.3	00	2.67

SD: strongly disagree, D: disagree, N: neutral, SA: strongly agree, A: Agree

Field data: 2020

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4.9 Injuries and Accidents in Small Scale Mining

Injuries encountered in the small-scale mining in the study area included cuts, fractures, sprain, broken arms, and burns. The majority of the respondents 166(55%), indicated that the cut was the most accident or injury sustained in the industry. This was followed by broken arm recording 93(31%), fractures 36(12%), and burns 7(2%). There was a significant difference (P=0.0000) in injuries and accidents among workers of small-scale mining in the study areas. (Table 4.10).

Table 4.10: Injuries and accidents in small-scale mining

Companies	**Injuries and accidents**			
	Cuts	**Fracture**	**Broken arm/leg**	**Burns**
PE	29(9.6)	0	22(7.4)	0
OBENG	29(9.6)	0	17(5.6)	0
AWINO	29(9.6)	0	17(5.6)	0
AKCM	21(7.0)	0	14(4.7)	0
BREMAN	31(10.2)	16(5.3)	12(4)	3(0.9)
MINTAH	27(9.0)	20(6.7)	11(3.7)	4(1.1)
Total	166(55)	36(12)	93(31)	7(2)

P=0.0000 Field data: 2020

4.10 Personal Protective Equipment Used by Small Scale Miners

Personal protective equipment included helmets, safety boots, hand gloves, eyeglasses, and overall. Safety boots were the most common PPE used 284(37%). Helmets were the next PPEs used, hand gloves131 (17%), followed by eyeglasses and overall 99(13%) and 60(8%) respectively. There is a significant difference (P=0.0000123) in personal protective equipment used by small-scale miners (Table 4.11).

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Table 4.11: Personal protective equipment used by small-scale miners

	Helmets	Safety boots	Hand gloves	Eyeglasses	Overall
PE	23(2.9)	44(5.8)	14(1.8)	10(1.3)	0
OBENG	45(5.6)	56(7.4)	17(2.2)	17(2.2)	3(0.4)
AWINO	49(6.2)	62(8)	21(2.7)	21(2.7)	6(0.8)
AKCM	39(4.9)	48(6.2)	17(2.2)	17(2.2)	4(0.5)
BREMAN	27(3.4)	48(6.2)	36(4.5)	21(2.2)	27(3.6)
MINTAH	15(1.9)	26(3.4)	26(3.4)	13(1.7)	20(2.6)
Total	198(25)	284(37)	131(17)	99(13)	60(8)

P=0.0000123 Field data: 2020

4.11 Implementation of Health and Safety Policies by Mining Management of the Small Scale Mining Industry

On the implementation of health and safety policies, most of the respondents indicated that management communicated regularly with employees on health and safety measures (M=4.38, SD=0.500) was one of the highest ways of implementing health and safety policies. This was followed by formulated policy to implement occupational health and safety practices, the management is highly committed to health and safety practices, the management recognizes and rewards safe behavior and the management has regular audits and inspections of the health & safety systems with the same mean of 4.25 each.

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Table 4.12: Implementation of health and safety policies by mining management of the small-scale mining industry

S/N	Health and Safety policies implementation	SD	D	N	A	SA	Mean
1	Presence of formulated policy to implement occupational health and safety practices	0	0	0	4(25.0)	12(75.0)	4.25
2	High committed to health and safety practices	0	0	0	4(25.0)	1275.0	4.25
3	Recognition and reward for safe behavior	0	0	2(12.5)	6(37.5)	8(50.0)	4.25
4	Provision of the necessary protective and safety equipment	0	0	318.8	3(18.8)	10(62.5)	4.00
5	Regular audits of health & safety systems.	0	0		4(25.0)	12(75.0)	4.25
6	Committee for overseeing health and safety issues	0	0		3(18.8)	13(81.3)	4.19
7	Regular communication with employees on health and safety measures	0	0		6(37.5)	10(62.5)	4.38

SD: strongly disagree, D: disagree, N: neutral, SA: strongly agree, A: Agree

Field data: 2020

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4.12 Implementation of Health and Safety Practices in Small Scale Mining by Government Institution

EPA and Minerals commission were interviewed about their involvement in the implementation of health and safety practices. EPA's main duties in the mining operations were permitted regulations and advice on the environment whereas the minerals commission is involved in promoting and monitoring small-scale mining activities. The two government organizations stated that there are policies put in place to regulate mining operations. EPA policies were LI 490 and LI 1652 whereas the Mineral Commission uses the Minerals and Mining Act 703.

EPA and Minerals commission do visit mining sites for inspection. Compliance monitoring and field monitoring were the inspections done by EPA and Minerals Commission. EPA visited the mining site for inspection quarterly and the mineral commission visited monthly for inspection. Implementations of health and safety practices were paramount to both EPA and the Minerals Commission in the mining industry. Each of the institutions used different acts in the implementation of health and safety practices. EPA uses the Act 1990 and the minerals commission uses the mining regulation act. Factors that influenced the implementation of health and safety practices were technology, politics, culture, and finance. EPA was affected by all the factors (technology, politics, culture, and finance) whereas the minerals commission was affected by technology and finance.

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Table 4.13: Implementation of health and safety practices in small-scale mining by a government institution

Institution	Policy on mining regulation	Type of inspection	Factors that influence the implementation of health and safety practices			
			Technology	**Politics**	**Cultural**	**Finance**
EPA	EPA Act1990 (Act 490) LI 1652	Compliance monitoring	√	√	√	√
Minerals Commission	Minerals and Mining Act 703	Field monitoring	√	X	X	√

√: Agree on X: Disagree

Field data: 2020

4.13 Heavy Metals (Hg and As) Present in Water and Soil Sediments within Mining Area

Heavy metals analyzed in soil and water sediments were mercury and arsenic. For the soil sediments, Hg ranged from 0.057-0.145ppm. PE had the highest Hg value of 0.145ppm and Obeng had the lowest of 0.057ppm. The Hg in soil sediments was above the WHO maximum permissible limit of 0.05ppm. Arsenic levels in the soil sediments ranged from 0.084-0.087ppm. Awino had the highest As the level of 0.087ppm and Minta and Breman had the lowest As the level of 0.084 ppm. Samples of arsenic were below the WHO MPL of 10ppm. Hg in water samples ranged from 0.010-0.086ppm. Minta had the highest Hg value of 0.086ppm and Obeng had the lowest of 0.010 ppm. The Hg in the water samples was above the WHO MPL of 0.001ppm. Arsenic levels in the water samples ranged from 0.004-0.008ppm. PE had the highest Arsenic level of 0.008 ppm and Minta and AKCM had the lowest Arsenic level of 0.004 ppm. The As in the water samples were below the WHO MPL of 0.01. (Table 4.14).

Table 4.14: Mean ±STD values (ppm) of heavy metals in water and soil sediments

LABELS	WATER SEDIMENT SAMPLES		WATER SAMPLES	
	Hg ppm	As ppm	Hg ppm	As ppm
MINTA	0.116±0.001	0.084±0.002	0.086±0.001	0.004±0.001
PE	0.145±0.003	0.085±0.001	0.022±0.003	0.008±0.001
BREMAN	0.093±0.006	0.084±0.002	0.062±0.002	0.006±0.001
AKCM	0.064±0.003	0.085±0.001	0.060±0.004	0.004±0.001
OBENG	0.057±0.003	0.079±0.003	0.010±0.002	0.005±0.001
AWINO	0.113±0.001	0.087±0.001	0.052±0.002	0.005±0.001
WHO MPL	0.05	10	0.001	0.01

Field data: 2020

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CHAPTER FIVE

DISCUSSION

Small-scale gold mining in Ghana has attracted much attention due to the increased rates of morbidity and mortality and environmental destruction associated with it. Small-scale mining has more occupational health hazards than regulated mining (Calys-Tagoe *et al.,* 2017).

5.1 Demographic Characteristics

The bio-data of the respondents revealed the characteristics of the miners. Results on the sex of the respondents differed from that of Lu (2012) who stated that women are largely seen in the mining sector, particularly small-scale mining. Though Nyambe and Amunkete, (2009) stated that Africa has the highest percentage of female miners at 40-50%. However, this study revealed that only 10% were females.

5.2 Knowledge and Awareness of Safety Regulations

One of the most popular issues in mining is non-compliance with occupational health safety standards. The awareness and implementation of occupational health and safety practices are generally poor in most developing countries (Acquah & Nouban, 2020). The study's results which indicated that almost all respondent (289, 98%) had a fair knowledge of safety in mining was not in agreement with that of Attakora (2012) whose results, 95 (63.3%) stated that most mining workers in Obuasi had low knowledge of occupational health and safety regulations. Hentschel *et al.* (2002) stated that many small-scale mining operations are said to be lacking in the following- safety regulations, reinforcement of mine safety requirements, awareness of the risks inherent in mining,

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and access to better equipment. However, this study revealed a high number of respondents having knowledge of safety in mining. The study was also in line with Attakora (2012) who stated that the majority of the respondents were aware of health and safety regulations in the mining industry. The high awareness could be attributed to a higher percentage of respondents having received formal education and a greater number of the respondents having knowledge of health and safety in the mining industry. The study revealed that a greater number of the respondents were aware of available regulations regarding the safety of workers from the mining company. This indicated that the mining industry made effort to educate their workers on regulations regarding workers' safety. The high levels of knowledge on health and safety might be probably attributed to recent attention that had been paid to OHSR in Ghana, due to the increased mining-related injuries and diseases (International Labour Organization, 2015).

5.3 Adherence to Safety Measures in Small Scale Mining Industry

One of the most common occupational health and safety deficiencies in small-scale mining is a lack of awareness of the risks in mining coupled with a lack of education and training (Henstschel *et al.*, 2002). It was of no surprise that safety training was part of orientation on first employment in all the mining sites visited in this study. This study also revealed that adequate training on the usage of PPEs was important in the prevention of exposure of miners to occupational health hazards and problems in the workplace. According to Attakora (2012), if workers are issued adequate PPE and OHSR are implemented, if workers are not educated on the use of PPE and observing OHSR, they will still be potentially exposed to occupational health hazards and

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problems in the workplace. Therefore safety training on the use of PPEs is very important than the mere provision of PPEs.

5.4 Types and Sources of Occupational Hazards Encountered in Small Scale Mining

Livelihoods and risk are closely linked in rural areas of the developing world (Smith *et al.,* 2016). Workers in the mines are exposed to several types of hazards and including physical, chemical, biological, psychosocial, and ergonomic hazards. Exposure to dust was a common physical hazard identified among workers in the mining companies in the study. This is supported by the study of Kuffour (2020) which reported that the source of health problems among workers in mining sites is dust. The dust, when inhaled, can cause lung diseases and other respiratory ailments. Exposure to dust can also cause skin irritation and eye damage. These results of these hazards can result in several accidents and other diseases.

5.5 Personal Protective Equipment Used by Small Scale Miners

Personal protective materials used by miners in this study were helmets, safety boots, hand gloves, eyeglasses, and overall. In Papua New Guinea, personal protective equipment (PPE) was never used in small-scale mining activities (Lu, 2012). This indicates the usage of PPE by miners in this study is an improvement in the health and safety practices and high awareness, training, application of safety regulation, and literacy. Proper protective equipment is important in the mining industry. This study could not establish the fact as to which category of gender is put on PPE. Lu (2012) stated that women miners are also found lacking in proper protective equipment. Workers in the small-scale mining industry indicated that they purchase their PPE. In the study of Hentschel *et al.* (2002), small-scale miners purchase safety equipment such as helmets, boots, gloves, and face masks.

5.6 Factors Influencing Implementation of Health and Safety Policies among Small Scale Miners

Efforts are been made by the government to implement occupational health and safety practices in its developmental agenda but several lapses and bottlenecks have made its implementation difficult (Acquah & Nouban, 2020). Such challenges were outlined to include inadequate occupational health and safety infrastructures and occupational health safety measures (Ghana Health Service, 2007; Ministry of Health Report, 2007), the absence of comprehensive national occupational health and safety policy (Clark, 2005; Muchiri, 2003), lack of knowledge and illiteracy (Ghana Ministry of Health Report, 2007). These challenges, therefore, make the adherence and implementation of occupational health and safety practices challenging. In this study, EPA personnel stated that factors such as politics, cultural technology, and finance influence the implementation of health and safety policies whereas. It was revealed through an interview that, politics play major roles in the administration process because top management at the EPA, for example, the Chief Executive Officer is appointed by the incumbent government which in a way affects its functions.

Cultural practices within the study area such as taboo days, sometimes impede the monitoring of the agency. Technology has its way of affecting the duties of EPA. Advancement in technology positively affects the agency whiles a decline also affects the agency negatively, the study revealed. The above factors were also recorded on the side of the Minerals Commission when contacted through a face-to-face interview

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during the study. Available literature shows that there are several institutions established in recent times to provide administratively and regulatory mechanisms for small-scale mining operations in Ghana The EPA was set up, among other things, to protect the environment through policy formulation and economic, scientific, and technological interventions needed to mitigate any harmful impacts caused by development activities including mineral exploration and processing.

The Minerals Commission among other things formulates recommendations of national policy for the exploration and exploitation of mineral resources with special reference to establishing national priorities having due regard to the national economy; advises the government on matters relating to minerals; monitors the implementation of laid down government policies on minerals and the operations of all bodies or establishments with responsibility for minerals (Minerals Commission, 2014).

5.7 Heavy Metals (Hg and As) Present in Water and Water Sediments within Mining Area

The impacts of mercury and arsenic on human health and the environment are well documented (Cordy *et al.*, 2011; Eisler, 2003; Gibb and O'Leary, 2014; Schwarzenbach *et al.,* 2010; Spiegel and Viega, 2010), and small-scale mining is the largest human source of mercury emissions, contributing around 35% of total anthropogenic emissions globally (UNEP, 2013).

From the study, mercury levels in both soil and water were above the WHO limit, and as such workers were at risk of being exposed to the adverse effect of a mercury compound. Mercury was identified as the main chemical used by the miners which are

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known to be the main chemical used in laterite gold mining (Soelistijo and Mili, 2014). The mercury vapor and its converted methyl mercury are noted to bioaccumulate in vital organs of humans when entered into rivers/streams (Idowu, *et al.,* 2013). Since miners were not conscious of the harmful effects of mercury, they predispose themselves to the dire effect of mercury through inhalation, absorption through the skin, and ingestion.

The adverse health effects that are associated with Hg and mercuric compounds in humans include possible carcinogens; damage to the brain, lungs, and kidneys; damage to developing fetuses; high blood pressure or heart rate; vomiting and diarrhea; skin rashes and eye irritation.

A study conducted in the Obuasi region reported the region to be one of the regions in the world with elevated levels of As which has been attributed to the richness of arsenopyrite (FeAsS) mineralization in the gold-bearing ore (Ahmed *et al.,* 2000; Bernard & Duker, 2007). In this study, the As level was relatively below the WHO permissible limit. Despite the arsenic levels below the WHO limit, continuous exposure has detrimental health effects The highest toxicity level of As is seen in the inorganic forms As(III) and arsenate As(V) which are the predominant forms in mine tailings.

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CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The study aimed at investigating occupational health safety practices among small-scale miners in the Wassa Amenfi Districts of Ghana.

- Respondents have been exposed to all kinds of hazards mainly physical, psychosocial, biological, and chemical hazards.
- The study revealed that occupational health and safety was a priority in the small-scale mining companies within the study which in effect had a positive impact on accidents recorded.
- Health and safety practices implementation in small-scale mining companies is affected by advancements in technology, political interference, and financial constraints.
- Levels of Hg in water and water sediments recorded in the study area were above the WHO recommended limiting whiles that of As recorded were below.

6.2 Recommendations

- There is a need for government to ensure proper monitoring, surveillance, evaluation, and regulation at both the local and national levels.
- There should be enforcement of more stringent water and land monitoring and pollution scheme through Environmental Protection Agency (EPA) and the Minerals Commission.
- Human rights and human dignity are a prerequisite for socio-economic development and should therefore be promoted. Since the right to good health

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and safety is the right of all, occupational health and safety should be given the needed social, legal, and moral attention in the country by the government.

6.2.1 *Area for further studies*

- One area of research is the vulnerability of women in the mining sector. Challenges must be addressed in the areas of occupational safety and health as well as in the implementation of feasible work opportunities for women in small-scale mining. These studies could employ data collection tools such as focus group discussions to yield more in-depth information on the subject.

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APPENDIX

Survey questionnaire on assessment of Occupational Health and safety practices among small-scale mining workers in Ghana

I Sabsatian Samuel Kwesi a student of the University of Education, Winneba, undertaking a study on a Survey questionnaire on **Occupational Health and Safety practices among Small scale mining workers in Ghana** therefore seeking your support to participate in the survey as a respondent. Any information you provide will be treated with anonymity and your response will remain confidential.

Informed **CONSENT**: Agreed [ ]

Biodata/profile		
No	**QUESTIONS AND FILTERS**	**CODING CATEGORIES**
1.	Date of interview :	
2.	Age of respondent	1. Below 20 years [ ] 2. 20 – 29 years [ ] 3. 30 – 39 years [ ] 4.40-49 years [ ] 5. 50 and above
3.	Sex of respondent:	1. Male [ ] 2. Female [ ]
4.	Highest educational level:	1. Primary [ ] 2. JHS/Middle form [ ] 3. SHS/O'level [ ] 4.Tertiary [ ]

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		5. Other (specify)…………………
5.	Marital status	1. Married [ ] 2. Single [ ] 3. Divorced [ ] 4. Separated [ ]
6.	What is your nationality?	………………………………………
7.	How long have you been working in small-scale mining?	1. Under 5 years [ ] 2. 6-10years [ ] 3. 11-15years [ ] 4. 16-20years [ ] 5. Other (specify)………………
8.	Did you receive any form of Formal training before joining small-scale mining?	1. Yes [ ] 2. No [ ]
9.	If yes, what type of training did you receive?	1. Apprentice [ ] 2. Vocational School [ ] 3. Other (specify)……
Health and Safety issues		
	What do you understand by safety in mining?	1. Employees' welfare [ ] 2.Employers' welfare [ ]

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		3. Both employer's and employees' welfare [ ] 4. Employers, employees, and third-party welfare [] 5. Other (specify)………………
	Are you aware of the available regulations regarding workers' safety in small-scale mining?	1. Yes [ ] 2. No [ ]
	If yes, how did you get to know?	1. From the company [ ] 2. School [ ] 3. Television [ ] 4. Online 5. Other (specify)………………
	Are you aware of any government or non-governmental establishments which deal with small-scale workers' safety?	1. Yes [ ] 2. No [ ]
	If yes, can you provide the name?	…………………………………………………
	What are some of the safety measures put in place in your company? (tick as applicable)	1. Safety training as part of orientation on first employment [ ] 2. Regular monitoring of safety and health standards to ensure that workers are complied with

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		[ ] 3. Using of Personal Protective Equipment [ ] 4. Prompt reporting of accidents/injuries [ ] 5. Re-training on safety and health practices [ ] 6. None [ ] 7 Other (specify)………………
	Indicate how satisfied you are with the current health and safety measures put in place	1. Very satisfied [ ] 2.Satisfied [ ] 3.Dissatisfied [ ] 4. Very Dissatisfied [ ]
	The person ultimately responsible for your safety and health in the performance of your duties is?	1. The manager [ ] 2. Yoursel [ ] 3. Your field supervisor [ ] 4. Other (specify)………………
	Currently, do government/non-governmental agencies visit your site for a Safety inspection?	1. Yes [ ] 2. No [ ]
	If yes, what kind of safety inspection? (tick as many as applied)	1. Company safety [ ] 2. Worker/employee safety [ ] 3. Building safety [ ] 4. Other (specify)………………

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	Does your company provide health and safety training for workers before starting work?	1. Yes [ ] 2. No [ ]
	If yes, what do they train you on	1. Proper Usage of safety materials [ ] 2. Safety measures to be observed [ ] 3. Building safety procedures [ ] 4. Other (specify)………………
	Are there strict measures put in place against managers of small-scale miners who violate safety regulations regarding the health and safety of employees?	1. Yes [ ] 2. No [ ] 3. No idea [ ]
	If yes, what is the consequence?	1. Fines 2. Contract is revoked 3. Suspension of manager from a professional body 4. Work is stopped 5. Other (specify)………………
Operational Activities/Safety Practice in Small Scale Mining		
	Which of the following tools does use for your work?	1. Pick ax [ ] 2. Shovel [ ] 3. Excavator [ ]

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		4. Pumping machine [ ] 5. Other (specify)......................
	Which of the following tools has a high risk of incident or `accident?	1. Pick ax [ ] 2. Shovel [ ] 3. Excavator [ ] 4. Pumping machine [ ] 5. Other (specify)......................
	Have there been changes in the tools used in small-scale mining over the past years?	1. Yes [ ] 2. No [ ]
	If yes, what are the changes?	....
	Which of the following personal protective equipment do you use currently in your mining activities?	1. Helmets [ ] 2. Safety Boots [ ] 3. Hand gloves [ ] 4. Eye Glasses [ ] 5. Other (specify)......................
	17. How often are you likely to wear your protective gear?	A. All the time B. Sometime C. Not often D. Not at all
	18. Are you aware of emergency actions before and after work?	Yes_____ No_____

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	19. Are you aware of any safety/emergency alarms at your workplace?	Yes_____ No_____
	20. Were you informed about what to do when the alarm rings?	Yes_____ No_____
	21. Were you given an escape route in case there is danger at your workstation?	Yes_____ No_____
	Do you get on-the-job training?	Yes_____ No_____
	Which type of training?	
	How regular is training organized for staff on occupational health and safety after being employed?	1. Quarterly [ ] 2. Biannually [ ] 3. Annually [ ] 4. No definite time fixed for training [ ]
	How often are monitoring, inspection, and evaluation conducted on occupational health and safety implementation?	1. Monthly [ ] 2. Quarterly [ ] 3. Biannually [ ] 4. No definite time fixed [ ]
	Do you think effective occupational health and safety policies have any	1. Yes [ ] 2. No [ ] 3. Not sure [ ]

	impact on job performance in the small-scale mining industry?	
Health challenges		
	How often do you experience occupational accidents during working hours	1. Anytime we are on the field [ ] 2. Once on a field [ ] 3. Other (Specify) ------------
	What are the accidents you often suffer from?	1. Cut [ ] 2. Fracture [ ] 3. Sprain [ ] 4. Broken arm [ ] 5. Other (Specify) ------------
	How often do you suffer from the above accidents?	---------------------------------
	Do you normally experience any health problems?	1. Yes [ ] 2. No [ ]
	If yes, which health problem do you experience	1. Hypertension [ ] 2. Anaemia [ ] 3. Diarrhea [ ] 4. Headache [ ] 5. Respiratory problem 6. Other (Specify) ------------
	Do you attend hospital when you suffer from occupational accidents?	1. Yes [ ] 2. No [ ]

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	How often do you visit the hospital?	1. Weekly [ ] 2. Monthly [ ] 3. Yearly [ ] 4. Other (Specify) ------------
	If not how do you treat it?	1. Self-medication [ ] 2. No treatment [ ] 3. Other (Specify) ------------
	Have you been advised about your work about your health	1. Yes [ ] 2.No [ ]

OBSERVATIONAL CHECKLIST

S/N	HAZARDS	1	2	3	4	5
	Physical Hazard					
1	PPEs are worn by all workers					
3	Employees work from height and around the dangerous environment					
4	There is a high level of noise during drilling, blasting, milling, and other operational activities.					
5	Employees are exposed to dusty conditions at the working place.					
6	There is an accumulation of smoke emitting from diesel-operated equipment in working areas					
	Psychosocial Hazards					
8	Employees work for long hours					

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9	There is frequent violence among workers					
10	Employees have adequate time to rest after working hours					
	Ergonomic Hazards					
11	Materials are lifted unaided					
12	Working in awkward body posture and performing the same task repeatedly					
13	Workers work for long hours					
14	There is frequent bending during work					
15	Lifting of heavy materials					
	Biological hazards					
16	Presence of reptiles/insects					
17	Workers stand in dirty water whiles working					
18	Presence of stingy insects					
19	Workspace clean and clear of mold and fungi?					
20	Are there any "sharp" materials that need to be cleaned regularly and properly and/or disposed of safely and securely?					
	Chemical hazards					
21	Are workers exposed to substances that can be inhaled, ingested, or absorbed into the body?					
22	Workers dealing with chemicals wear PPEs					
23	The usage of chemicals throughout mining operations?					

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24	Chemicals used are poisonous and corrosive					

Please Tick Appropriately **Key: Strong Agree=1; Agree=2; Neither agree nor Disagree=3; Disagree=4; Strongly Disagree=5**

Survey Questionnaire/Interview for Small Scale Mining Managers on assessment of Occupational Health and safety practices among Small scale mining workers in Ghana

I Sabsatian Samuel Kwesi a student of the University of Education, Winneba, undertaking a study on Survey on **Occupational Health and Safety practices among Small scale mining workers in Ghana** therefore seek your support to participate in the survey as a respondent. Any information you provide will be treated with anonymity and your response will remain confidential.

Informed **CONSENT**: Agreed [ ]

1. Age …………………………………………………………………………….
2. Sex………………………………………………………………………………
3. Educational level ………………………………………………………………
4. Position …………………………………………………………………………
5. What are your main duties in the mining operation? ....
6. How long have you been in the mining industry? ....

Health and Safety issues

7. Dan inspections the mining site?
8. What type of inspections are carried out at the mining site

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10. Are there any Policies that are put in place to regulate mining operations?

A) Yes[ ] b) No[ ]

11. If yes what are some Policies

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………

12. How is an effective occupational health and safety policies beneficial to mining workers?

a) Reduces accidents [ ]

b) Reduces cost of compensation to injured employees [ ]

c) 3. Lost or death of staff [ ]

d) 4. labor turnover is reduced [ ]

e) 5. The corporate image of the construction industry is enhanced [ ]

f) 6. All the above [ ]

g) Other (specify)……………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

9. How does your leadership influence the implementation of health and safety practices?..

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Operational Activities/Safety Practice in Small Scale Mining		
1	Which of the following describe your mining?	1. Surface [ ] 2. Underground [ ] 3. Others(s) specify……………………………………
2	What are the main methods used in Small-scale mining?	……………………………………………………………………… ……………………………………………………………………… ....
3.	Do you have a valid mining license?	(1) Yes [ ] (2) No [ ]
4.	How do you acquire land for your mining activities?	1. Family [ ] 2. From chief [ ] 3. From the mining company 4. Other(s) specify………………………………
5.	Do you have supervisors?	1. Yes [ ] 2. No [ ]
6.	Do you have a safety officer?	1. Yes [ ] 2. No [ ]
7.	Do you use explosives?	1. Yes [ ] 2. No [ ]
8.	Have you attended occupational health and safety training concerning mining	1. Yes [ ] 2. No [ ]

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	If yes, what specific health and safety issues are discussed during training?	1. Reports from ad-hoc committees for previous periods are discussed [ ] 2. Suggestions are received from staff on occupational health and safety [ ] 3. Staff who are identified as having safety consciousness are awarded [ ] 4. Proper Usage of safety materials [ ] 5. Safety measures to be observed [ ] 6. Building safety procedures [ ] 7. Other (specify)………………

Workers' and Managers' involvement

The following items examine your worker's involvement (participation) in the implementation of health and safety practices

1. Please, indicate your agreement or disagreement with the following statements by **ticking** (□) your response using this scale:

S/N	Safety adherence	1	2	3	4	5
1	Whenever necessary employees usually wear personal protective equ (PPE) given to them.					
2	The agency has health and safety cultures followed by employees					
3	The employees have representatives inipmeon the health and safety committee					

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4	Usually, employees comply with occupational safety & health (OSH) rules and regulations at work					
5	Workers refuse to report minor injuries or near misses as a result of fear of being sacked is a challenge					
6	Workers' refusal to wear personal protective equipment (PPEs) in the organization is a challenge					
7	Employees usually report hazardous conditions to the management					
8	Employees feel that they are responsible for their health and safety and not the employer					

Statements; 1 Strongly disagree, 2 Disagree, 3 Neutral, 4 Strongly Agree, 5 Agree

This part will investigate how management commitment influences the implementation of health and safety practices.

1. Please, indicate your degree of agreement or disagreement with the following statements by ticking **(□)** your response using this scale:

S/N	Safety adherence	1	2	3	4	5
1	There is a formulated policy to implement occupational health and safety practices					
2	The management is highly committed to health and safety practices					
3	The management recognizes and rewards safe behavior					

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4	The management provides the necessary protective and safety equipment					
5	The management has regular audits and inspections of the health & safety system.					
6	There is a committee for overseeing or checking health and safety issues.					
7	Management communicates regularly with employees on health and safety measures					

Statements; 1 Strongly disagree, 2 Disagree, 3 Neutral, 4 Strongly Agree, 5 Agree

Survey Questionnaire/Interview for EPA/Minerals Commission on assessment of Occupational Health and safety practices among Small scale mining workers in Ghana

I Sabsatian Samuel Kwesi a student of the University of Education, Winneba, undertaking a study on Survey on **Occupational Health and Safety practices among Small scale mining workers in Ghana** therefore seek your support to participate in the survey as a respondent. Any information you provide will be treated with anonymity and your response will remain confidential.

Informed **CONSENT**: Agreed [ ]

Institution…………………………..

13. Age …………………………………………………………………………

14. Sex………………………………………………………………………..

15. Position...

16. Educational level...

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17. What are your main duties in the mining operation? ....

18. Are there any Policies that are put in place to regulate mining operations?

    A) Yes [ ]   b) No [ ]

19. If yes what are some Policies

    ………………………………………………………………………………………

    ………………………………………………………………………………………

    ………………………………………………………………………………………

    ………………………………………………………………………………………

20. Dinspectionsect of the mining site?

    a. Yes

    b. No

21. What type of inspections are carried out at the mining site

    ………………………………………………………………………………………

    ………………………………………………………………………………………

    ………………………………………………………………………………………

    ………………………………………………………………………………………

22. How often do you visit the mining site for inspection?

    a. Daily

    b. Weekly

    c. Monthly

    d. Yearly

23. Do you organize safety training for mine workers? a) Yes [ ] b) No [ ]

24. If yes, how often do you organize safety training for mine workers?

    a. Daily

    b. Weekly

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c. Monthly

d. Yearly

25. How does the EPA/Minerals Commission influence implementation of health and safety practices in mining?

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

26. Indicate how each of the following influences the implementation of safety practices in the small-scale mining sector.

a. Technology………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

b. Political interference …………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

c. Cultural…………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

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………………………………………………………………………………………

………………………………………………………………………………………

d. Finance……………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

27. Indicate the degree to which the following factors influence occupational health and safety practices in the mining industry?

S/N	Occupational health and safety practice	Rating
1	Absence or inadequate occupational health and safety officers for monitoring	Strongly Agree [ ] Agree [ ] Disagree [ ] Strongly Disagree [ ] Neutral [ ]
2	Poor commitment/motivation of all parties (EPA officials, minerals commission, and mine workers)	Strongly Agree [ ] Agree [ ] Disagree [ ] Strongly Disagree [ ] Neutral [ ]
3	Extensive use of foreign workers in the small-scale mining sector	Strongly Agree [ ] Agree [ ] Disagree [ ] Strongly Disagree [ ] Neutral [ ]

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4	Lack of reports from mine workers to EPA/Minerals Commission	Strongly Agree [ ] Agree [ ] Disagree [ ] Strongly Disagree [ ] Neutral [ ]
5	Third-party influence of subcontractors in the handling of mining activities	Strongly Agree [ ] Agree [ ] Disagree [ ] Strongly Disagree [ ] Neutral [ ]
6	Ineffective implementation of laws on culprits	Strongly Agree [ ] Agree [ ] Disagree [ ] Strongly Disagree [ ] Neutral [ ]
7	Absence of safety officers on site	Strongly Agree [ ] Agree [ ] Disagree [ ] Strongly Disagree [ ] Neutral [ ]
8	Monitoring logistics	Strongly Agree [ ] Agree [ ] Disagree [ ] Strongly Disagree [ ] Neutral [ ]

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M/DEHSE/ADM/G/04/15

21st July, 2020

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

LETTER OF INTRODUCTION
MR. SABASTIAN SAMUEL KWESI
7181930001

This is to introduce Mr. Sabastian Samuel Kwesi as a student in the Faculty of Science and Environment Education of the University of Education, Winneba (Mampong-Campus), with Student Registration Number, 7181930001.

Mr. Sabastian Samuel Kwesi entered the University in August, 2018, to pursue a 2-year MPhil programme in Environmental and Occupational Health Education.

Mr. Sabastian Samuel Kwesi is conducting research on the topic: **"Occupational Health and Safety Practices among Small Scale Miners in Ghana: A Case Study in the Wassa Amenfi East Municipal"** as partial fulfilment of the award of the MPhil (**Environmental and Occupational Health Education**) and has requested us to introduce him as a student of the University to enable him obtain data for his work.

We would be grateful if he could be given the necessary assistance.

Thank you.

Yours faithfully,

EMMANUEL DARTEY (PROF.)
HEAD OF DEPARTMENT
emmldartey@yahoo.co.uk / edartey@uew.edu.gh
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21st July, 2020

M/DEHSE/ADM/G/04/16

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

LETTER OF INTRODUCTION
MR. SABASTIAN SAMUEL KWESI
7181930001

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We would be grateful if he could be given the necessary assistance.

Thank you.

Yours faithfully,

EMMANUEL DARTEY (PROF.)
HEAD OF DEPARTMENT
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WASSA AMENFI WEST MUNICIPAL ASSEMBLY

P O BOX, 50 ASANKRAGWA- WESTERN REGION, GHANA

Tel: 0502460242
Fax: 03920-22022
Email:amenfiwestmunicipalassembly@gmail.com

In case of reply, the reference number and date of this letter should be quoted

Our Ref. No WAMA/GEN.34/[illegible]/50

Your Ref. No............................

Date:24th June,2020

LETTER OF INTRODUCTION

MR SABESTIAN SAMUEL KWESI

We wish to inform you that Mr Samuel Kwesi is an MPHIL student from the University of Education Winneba pursuing Environmental and Occupational Health Education. He has requested to undertake a research work in this Municipality.

We would therefore be grateful if you could grant him the opportunity to carry out the research work at your outfit/organization/institution.

We wish to count on your maximum cooperation, please.

HON. GEORGE AGYIRI

MUNICIPAL CHIEF EXECUTIVE

TO WHOM IT MAY CONCERN

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AMENFI CENTRAL DISTRICT ASSEMBLY

Our Ref. No. ACDA/IN/059/VOL.1/01

In case of reply, the number and date of this letter should be quoted

DATE: 17TH AUGUST, 2020

RE: INTRODUCTORY LETTER
(MR. SABASTIAN SAMUEL KWASI- 7181930001)

With reference to letter number M/DEHSE/ADM/G/04/16 dated 21st July, 2020 from the University of Education, Winneba (Mampong Campus) introducing the above student to the District to collect data on **"Occupational Health and Safety Practices among Small Scale Miners in Ghana: A Case Study in the Amenfi Central District".**

The Amenfi Central District Assembly has no objection to this request as it is purely for academic purposes. We therefore wish that you accord him with the necessary assistance.

Thank you.

EMMANUEL BOATENG
(DISTRICT COORD. DIRECTOR)
for: DISTRICT CHIEF EXECUTIVE

TO WHOM IT MAY CONCERN