Critical Analysis of Safety Aspects of an Underground Graphite Mine with Reference to Bogala Mines

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Abstract: Trend analysis of occurrence of mine accidents was proposed to assess the risks associated with occurrence of underground accidents and human health in order to manage and control measures and support decision making. It provides the right balance between different concerns, such as safety and costs. For this purpose, information collected from Bogala graphite Lanka PLC located at Aruggammana in Kegalle district, Sri Lanka, was used to manage the risks affecting the health and safety of the miners. In order to categorize the data, various hazardous activities were identified and classified under eleven categories: Scaling, Hammering, Supporting, Lifting of weights, Drilling, Graphite transportation, Loading, Mucking, Machine/tool operating, Machine/tool repairing. The ranking process is accomplished by analyzing the past accident records. Further, four critical groups of body parts with different illnesses were obtained. These groups were; eye, limbs, back, head. From these groups, the most common injuries with the highest level of occurrence are sprains, cuts, bruises and contusions. According to the results, the proposed methodology can be a reliable technique for management of mine hazards and coping with uncertainties affecting the health and safety of miners when performance ratings are imprecise. The proposed recommendations can be primarily designed to identify potential hazards and help in taking appropriate measures to minimize or remove the risks before accidents occur in future mining activities in Bogala mines.

Keywords: trend analysis, risk, safety, cost

1. Introduction

Mining is considered to be one of the most hazardous professions. It entails a constant struggle of human beings, armed with reason and resources, against the changing forces of nature. The single most valuable asset in any mining organization is human resources and, protection of healthand ensuring safety of employees from excessive or undesirable stresses in the occupational environment is

important. The term hazard is used to describe an unsafe situation in a mine. This may be unsafe physical condition or unsafe acts of miners. Perception of a hazard is essential. A hazard source is the background condition which is not posing a danger in itself. Mining environment, especially underground operational environment is constrained by the absence of natural light, fresh air and open space and the undesirable presence of high temperature, humidity, dust, fumes, noise and rock stresses. Due to these constraints, the hazards and hazard potential inherent in a mine may trigger accidents unless sound and strong measures are taken to prevent them. The hazardous nature of underground mine operations can easily be deduced from analyzing past statistics of mine accidents and injuries.

It has become widely accepted that technical approaches alone are inadequate to reduce accident rates to desired levels. Even when the purely technical problems associated with work settings are addressed, unacceptably high accident rates often persist. This has attracted researchers from many fields, such as those involving behavioural, social or organizational behaviour to explore alternative perspectives that take into account the context of personal and socio-technical factors when assessing the risk of occupational injury and illness of employees.

Bogala Graphite mine is situated at Aruggammana in Kegalle district. graphite mineralization occur in steep dipping veins. Cut-and-Fill mining method ensures high levels of recovery low dilution. Down –stream processes include sorting according to particle size, crushing, grinding and upgrading.

Currently, Bogala Graphite Lanka Plc has reached a strong position in marketing. With the introduction of flotation technology upgrading of low carbon graphite has been improved with low levels of loss.

In this paper, an attempt has been made to evaluate the risk of potential occupational injuries at Bogala Underground operations. The study has been conducted with the analysis of accident statistics frequency-wise, severity-wise, incidence rate and identifying curative approaches.

2.Safety Evaluation of Mines.

Risk assessment and safety evaluation are important in almost all industries. Mining as a high risk operation is no exception and in this respect several studies with different approaches had been done. Notwithstanding, accidents and hazards, underground mines are very complex in nature of activities and many factors can contribute to occurrence of undesirable events (Sari et al., 2004). Due to the importance of the problem, research work has been directed to find out the impact of environmental parameters on human health and occurrences of injuries or fatalities in underground mines.

Modern safety management practices recognize that there is a close association between safety and reliability (Cox and Tait, 2002). It is suggested that there is a need for an integrated approach to safety, reliability and risk management.

However, studies on behavioural indicators of mine accident are rather limited. This is particularly due to several reasons. First, mining is a hazardous occupation. It was initially believed that elimination of hazardous conditions alone would result in better safety performance. Second, mining industry is highly regulated. Stringent rules and regulation are in practice and the regulating bodies are perhaps complacent with their functioning for overall safety improvement in mines.

3. Methodology

Methodology given below is based on the following subtopics which address how safety issues in Bogala Mines were addressed and analysed to derive the results.

1. Identification of activities which can lead to injuries.
2. How injuries could occur in each of these activities.
3. Prioritizing the most vital types of activities based on accident observations.
4. Analysis of preventive measures taken by the Bogala management. (Risk management system)
5. Effects of preventive measures on safety enhancement

3.1 Identification of the types of activities which can lead to injuries.

The first step in identifying health hazards is desktop analysis. This is particularly useful where records of previous HRAs (Health Reimbursement Account) and other employment records are available. Several documents were obtained from reports such as, incident reports, audit reports, previous health risk appraisals, occupational illness and injury reports, equipment maintenance and fault reports, sickness absence and leave reports, site inspection reports and minutes of safety meetings etc.

Bogala Underground was visited several times and a few "walk through survey's" was carried out. A walk-through survey of the area, process or task enables the assessor to identify the types of potential health hazard, the levels of exposure, general level of health, physical and mental functioning of the worker through the careful use of the senses – vision and hearing.

Based on this information, underground activities at Bogala which concern safety are listed down below and several critical activities were chosen from those to further discuss on the implications of safety;

1. Drilling
2. Scaling
3. Mucking
4. Hammering and supporting
5. Lifting weights/loading
6. Transportation
7. Machine and tool operations.

3.2 Prioritizing the most vital types of activities based on the accident observations.

By considering percentages of occurrence, five critical activities were selected, namely;

- Scaling
- Hammering
- Supporting
- Weight lifting
- Drilling

3.3 Analyse the Preventive measures taken by Bogala Graphite

The Management has given great emphasis on instituting and maintaining effective corporate governance practices and principles in respect of management and operations of the Company. Accordingly, systems and structures have been introduced and improved from time to time to enhance risk management measures and to improve safety and transparency. In the year 2009, Bogala graphite has improved the safety program on par with the global standards.

3.4 Current risk Assessment Procedure of Bogala mines (according to OSHA procedures)

Step 1: Identify the Hazard

Step 2: Assess the Risks

Step 3: Evaluation existing risk controls

Step 4 : Implement additional risk controls

3.5 Effects of preventive measures on safety enhancement

To evaluate the effects of new preventive method, accident data gathered were analysed by categorizing them into various groups. These groups are; accident type (minor, loss time, fatal), type of injury(eye injury, sprain, cuts and bruises, contusion), type of affected body part (eye, limbs, back, head, face, chest) , time of the day, age of the miner, experience of the miner etc.

4. Results and Discussion

Using the findings, various relevant relationships between thevariables were built up in order to identify trends and interrelated relationships among various types of accidents and associated variables. Relationships as shown below were graphed and charted for trend and accident analysis;

- Number of accidents against the month
- Activity vs. lost hours
- Activity vs. body parts
- Type of illness vs. year
- Accidents vs. experience
- Age vs. accident rate

4.1 Data Analysis

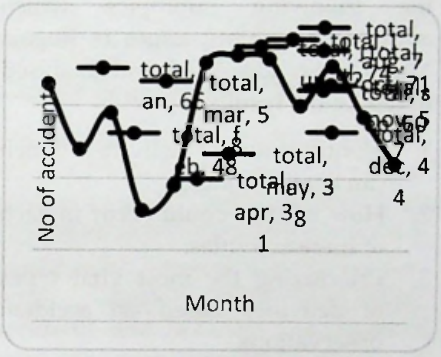

Figure 1. Accidents vs. Month

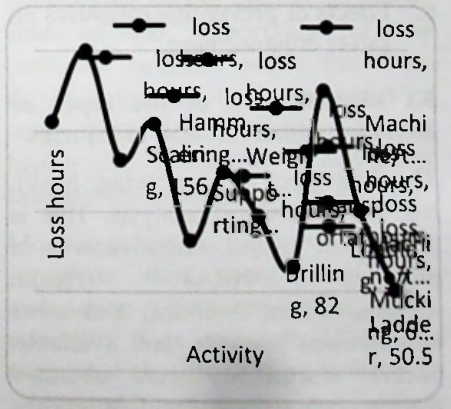

Figure 2. Activity vs. Body Parts

Analysis was carried out based on the findings indicated in the figures 1 to 9;

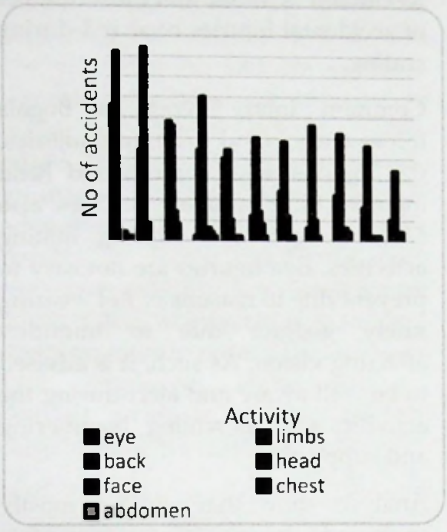

Figure 3. Type of illness vs. Year

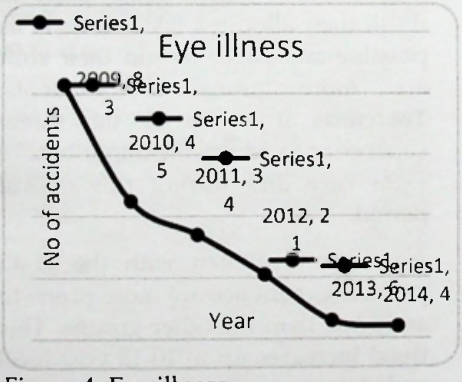

Figure 4. Eye illness

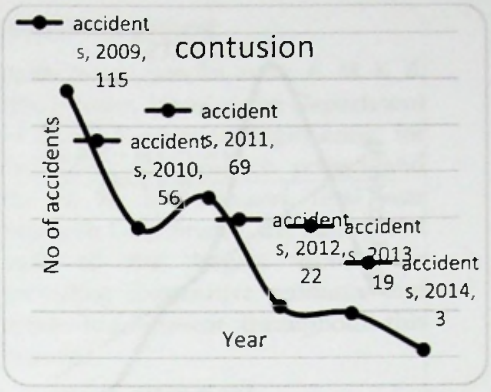

Figure 5. Contusion

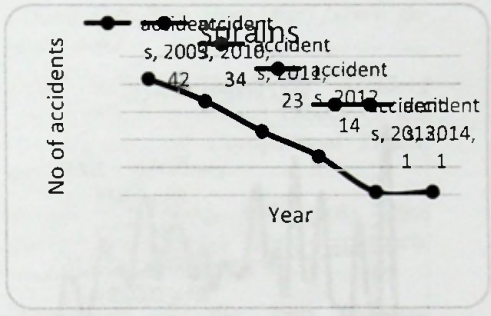

Figure 6. Sprains

Figure 7. Cuts and Bruises

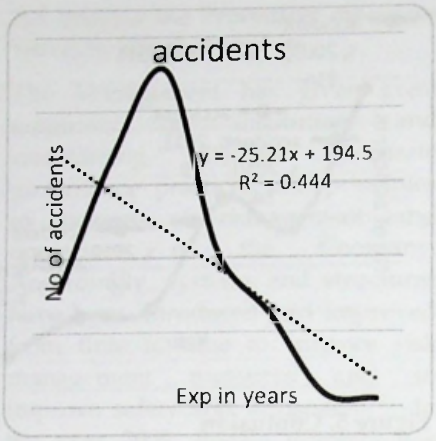

Figure 8. Accidents vs. Experience

Figure 9. Accidents vs. Age

5. Conclusion and Recommendations

When considering, the five critical activities, scaling is identified as the most critical activity in Bogala mines. Scaling is the activity of removal of loose rock from the roof, the sidewalls and hanging wall of the mine openings. It is particularly important when the rock and ore are removed by blasting, as in most underground metal and non-metal mines. Scaling may be conducted either with a hand-held pry bar or with mechanical equipment. Through the present research it is found that most number of accidental injuries occurred during scaling.

Common injury types at Bogala mines were found to be limb injuries, eye injuries, back injuries and head injuries. Limb and eye injuries also assume significance during mining activities. Eye injuries are not easy to prevent due to reasons of not wearing safety goggles due to humidity affecting vision. As such, it is advised to be well aware and alert during the activities such as scaling, hammering and supporting.

Analysis show that workers mostly sustained injuries in accidents between 10:00a.m and 1:00p.m. This shows that workers being keen to finish their allocated tasks as early as possible and eager to end their shift are more prone to accidents. Therefore, it is up to the safety supervisor to advise the minor to take extra care and during this critical period.

Age-wise, workmen with the 11-15 years of experience are more prone to accidents than the other groups. This trend increases up to 10-15 year level and decreases afterwards. Reasoning on this, it can be said the overconfidence of the worker at this age lead to this high incidence of accidents.

It is difficult to identify fake injuries specially related to back pains. Therefore, it is advised to keep personal data separately. Through this, the management will be in a position to form an idea whether the employee got a fake accident or not.

As such, this category of workmen should be considered be special care. According to the literature review workers' age does not affect the occurrence of injuries. But in this research when the data are analysed, it is observed that young workers had higher number of accidents than others. The course of this may be due to inadequate experience. So it is advisable to provide adequate training to young employees, with repetition annually. It is advisable for Mines Safety Management to conduct safety surveys in order to obtain ideas from employees about how to prevent accidents as they are the people facing hazardous situations.

Accident recording process must be computerised and it is important to maintain personal data files. It is also important to keep the employees medical reports updated to enable the management to identify whether the person is suitable to do a particular job or not. It is important encourage the safety officer to undergo continuous training and keep himself updated about the latest safety procedures in the world mining industry.

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