

A Meticulous Study on Improving UCM's Safety: Analysing Causes of Accidents and Suggesting Recommendations

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Abstract- A single major injury suffered by a miner (or miner's death) changes the lives of many people connected with the miner such as his/her relatives, friends, neighbours, colleagues etc. Moreover, it creates panic among the co – miners and demotivates them and hence, can result in reducing the dedication, strength, skills etc., among the co - miners. Concerning the above scenario, safety is considered as among the top priorities in many of the industries but when it comes to coal mining, the safety of the workers should be assigned highest priority as even a little negligence can lead to major disasters (such as in the cases of fire, methane explosions, fall of roof, spontaneous heating of coal etc.) in the Coal Mines (CMs). The work presented here addresses the safety issues related with the coal mines by carrying out enhanced due diligence on the past accidents and their causes in the context of coal mining in India and forms a set of recommendations to be followed by the miners and the mining safety authorities in order to ensure the safe return of a father to his son/daughter, a husband to his wife, a wife to her husband, a friend to a friend, a son/daughter to his/her father/mother etc.

Keywords: CM safety; disasters; causes of accidents; recommendations; safety at work.

I. INTRODUCTION

Highlighting the importance of safety by addressing the past accidents and causes of accidents and recommending different measures to reduce the accidents (both fatal and non – fatal) occurring in the CMs is the main theme of the study work presented in this paper. The causes of various minor and major accidents (covering both fatal and non – fatal types) are analysed in this study work and recommendations are suggested in order to reduce the number of accidents and losses in the CMs by analysing data from the Statistics of Mines in India published in the years 2015, 2014 and 2013 ^{[1][2][3]}, acquiring data about the existing CMSs safety systems and carrying out review literature on the related articles. When it comes to providing coal to fulfil the requirements of coal in satisfying various needs such as meeting around 41% of the global electricity, dependence of coal on about 70% of steel production, in fulfilling aluminium production as about 50% of the energy requirement in producing aluminium comes from the coal ^[4] and many other applications. When talk about the energy needs in India, coal accounts to about meeting more than half of the nation's energy needs (55% of India's energy needs) ^[5]. As per the future statistics given by the IEA, the demand of coal will experience a peak of double the current coal through to 2040 ^[6]. To meet the above-mentioned needs and many other uses, it is of utmost importance to ensure

the safety of the work procedures to make sure that safety is maintained always and thus keeping the workers safe and the mine infrastructure. The safety in the CMs is of prime concern due to the following reasons:

- To safeguard the precious lives of the miners working in the harsh underground environment;
- To increase the productivity and hence profitability of the CM;
- To reduce the rate of absenteeism of the miners;
- To motivate the miners by building a safe and secure work environment and in turn increasing the dedication of the miners in completing their assigned tasks without having to worry about the accidents;
- Enhanced safety can reduce the accidents rate, thus saving the compensation and insurance claims by miners and the miners working hours as well;
- A CM with enhanced safety measures and reduced number of accidents (required to be down to nil) can attract people with great talent and sophisticated skills to work and increase the productivity of the mining industry.

To ensure safety of the coal mine and the miners, the paper has proposed some very useful and efficient recommendations which when followed can bring out the

word “dangerous occupation” from the coal mines and result in a working environment safe from the hazards. The paper discusses the accidents in India’s two major CMs (SCCL and CIL) in the next section followed by causes of accidents in section III, methodology being adopted to carry out the proposed work in section IV, recommendations suggested in section V and results in VI section and section VII concludes the study work described in this paper.

II. ACCIDENTS ANALYSIS OF INDIA’S TWO MAJOR COAL MINES

Before moving to set the recommendations for improving safety in the UCMs, the accidents occurring in the India’s two major coal mines [7] is analysed to understand the seriousness of the safety requirements; SCCL and CIL are considered here. The below tables (1) and (2) shows the number of accidents and the number of persons killed in India’s two major coal mines viz., CIL and SCCL respectively, whereas, the figures (1) and (2) graphically indicates the number of persons killed and the number of fatal accidents occurring in CIL and SCCL respectively.

Table. 1 CIL Accidents

Year	No. of Accidents		No. of Persons Killed		
	Fatal	Serious	Below ground	Above ground	Total
2013	55	135	19	13	32
2014	45	148	14	7	21
2015	39	108	16	6	22

As can be seen from the above table. 1, the number of persons killed in the underground mine is more than that which have occurred in the above ground CMs. There has been a decline in the number of fatal accidents as observed in the years from 2013 to 2015 graphically from figure (2); whereas, the number of killings in the mines noted in the years 2014 and 2015 are almost same showing no improvement in the reduction of the fatalities.

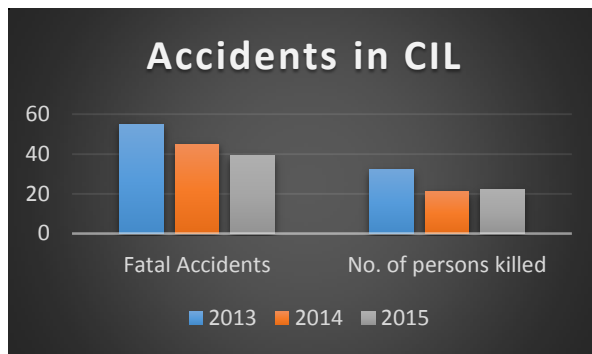


Figure 1. CIL – Fatal accidents and deaths

Table. 2 SCCL Accidents

Year	No. of Accidents		No. of Persons Killed		
	Fatal	Serious	Below ground	Above ground	Total
2013	10	313	2	4	6
2014	8	222	7	1	8
2015	7	187	4	1	5

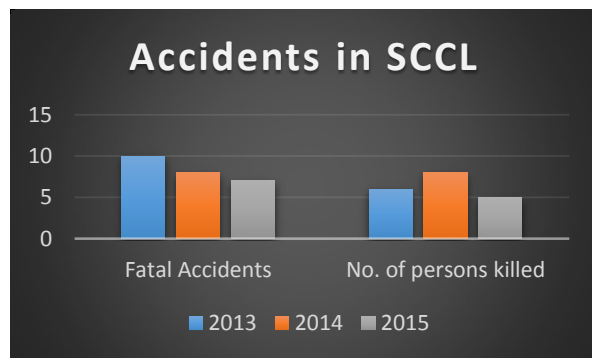


Figure 2. SCCL – Fatal accidents and death

Talking about the accidents occurred in the SCCL (addressing table. 2), SCCL has seen an improvement and has reduced the count of the fatal accidents and deaths in the years 2013 to 2015. Both the major coal industries viz., CIL and SCCL have implemented several measures to reduce the number of accidents and losses.

III. CAUSES OF ACCIDENTS IN CMs

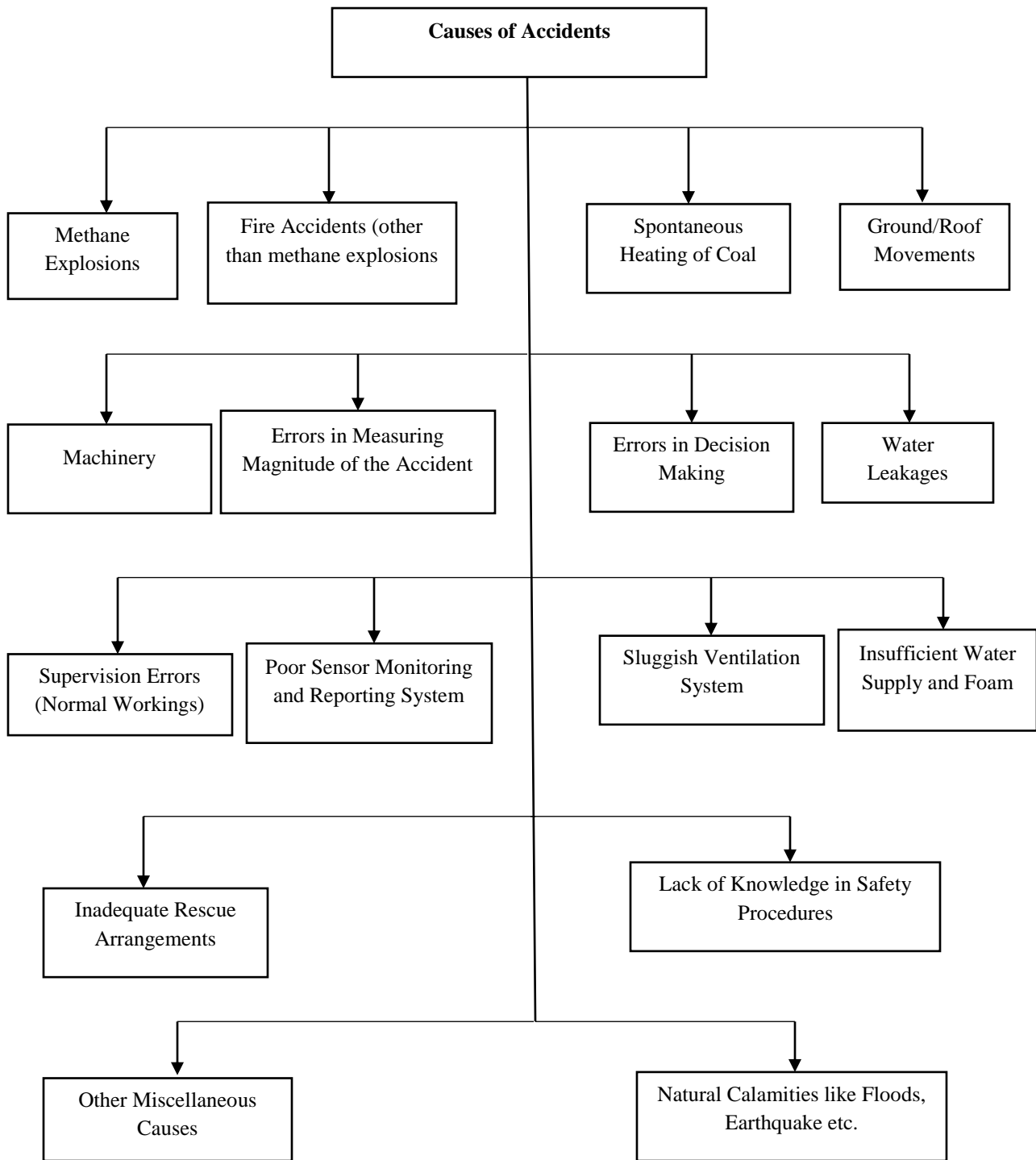


Figure 3. Causes of Accidents in Coal Mines

IV. METHODOLOGY

The methodology adopted in this paper is based on analysing the accidents, causes of the accidents occurring in the CMs and suggesting recommendations to be followed to ensure the reduction in the count of the fatal, serious and minor accidents and the number of deaths occurring in the CMs. The causes of the accidents are deeply analysed based on the history of accidents in the CMs and ways are framed to address and reduce the accidents and losses by suggesting recommendations to early tackle the triggers of accidents occurring in the CMs.

V. RECOMMENDATIONS

The recommendations proposed in this paper are based on providing multiple ways to improve safety and work procedures in the CMs. The suggested recommendations are:

1. An easy to upgrade and troubleshoot safety system should be implemented to monitor the various safety parameters;
2. The sub – modules in the safety system such as the sensors, communication modules and actuators etc., should be periodically checked to ensure the continuous and efficient working of the safety system;
3. Any deviation in the critical parameters measurements due to failure or weak working of the sensors etc., should be immediately addressed and worked upon;
4. The number of junction points (electrical) should be minimized and ways to communicate data wirelessly should be made a choice of communication system;
5. The escape routes provided in the mines to be used in case of an emergency should be marked in such a way that it shows the route even in the dark situations which can arise due to thick smoke resulting because of fire etc.;
6. In the cases when the escape route is blocked due to some reason such as fall of roof etc., there should be provided an alternate or multiple route and the miners should be well educated of it;
7. Enhanced due diligence should be carried out to nullify the cracks and fractures in the walls and the roofs to ensure there is no methane out flow which can trigger an explosion when the level reaches the explosion limit;
8. The hot components associated with the machinery or vehicles etc., in the CMs should be well encapsulated or shielded;
9. Enhanced care should be ensured to make sure there are no dust, lose, unnecessary objects etc., in the CMs;

10. Quick and efficient rescue operating system should be established as even a small unnecessary delay in initiating a rescue operation can convert a minor accident into a major disaster;
11. Proper arrangements should be made for collection of CH₄ and CO₂ and the continuous and efficient ventilation system should be made sure of;
12. Spot audit checks should be carried out throughout the year to check the work procedures and safety related questionnaires should be asked to the miners and suitable training should be given accordingly.

VI. RESULTS

The outcome of the study work presented here suggests several recommendations based on the problem statement, accidents and causes of accidents analysed through review literature and exploring the data provided in the ‘Statistics of Mines in India’ and other publications for the years 2015 through 2013. The study work will not only enhance the safety measures and rescue services being adopted and implemented in the CMs but will also have very good impact on increasing the coal production by reducing the accidents and improving the safety implementations.

VII. CONCLUSION

The study work addressing the analysis of the fatal and non – fatal (severe and non – severe) accidents taking place in the CMs is carried out considering the various causes of accidents and related activities and as an outcome of the study work, suggesting of recommendations is presented here with an objective of improving the safety in the CMs and thereby, ensuring that the miners return to their loved ones safely. The recommendations suggested in the proposed work will not only improve the existing safety systems and saves lives of the miners but also will save the CMs from financial loses and miner work hours, thus increasing the productivity and profitability of the CM.

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