

Analysis of Accidents Data of Contractual Workers in Open Cast Metal Mines

Mahanta Manohar* and Kunar Mihir Bijay

Department of Mining Engineering, National Institute of Technology Karnataka, Surathkal, INDIA

*mahantamanohar@gmail.com

Abstract

This research delves into the intricate dynamics of risk factors contributing to injuries in open cast metal mines where a multitude of personal and impersonal elements converge to shape the safety landscape. Drawing insights from a comprehensive literature review, risk factors considered in the study are skill level of workers, the role of mine officials, attitudes toward safety and the involvement of contractors. The one-year contractual workers' accident data which includes offsite and onsite injuries was considered for the analysis.

The analysis of the provided data on on-site and off-site injuries reveals distinct patterns and trends throughout the month. The comparison of one year data set indicates that overall off-site injuries are more prevalent. Ultimately, this analysis contributes valuable insights for enhancing overall safety measures and mitigating the incidence of injuries.

Keywords: Safety Data Analysis, Open Cast Metal Mines, Risk Factors, Injuries, Contractual Workers, Workplace Safety.

Introduction

Surface mining, a vital sector of the global extractive industry, plays a pivotal role in resource extraction and contributes significantly to the world's economy^{3,5}. However, it is not without its inherent challenges and foremost among them is the safety and well-being of surface mine workers. Mining operations, by their dynamic nature, expose workers to a multitude of occupational hazards that can result in injuries and tragically, fatalities⁸. The well-being and safety of workers in surface mining are significant concerns for both industry participants and the broader society. Various elements such as individual traits, pre-existing health conditions and employment arrangements like contractual work, collectively impact the safety and welfare of surface mine workers⁹.

It is crucial to comprehend the intricate relationships among these factors to improve worker safety, to minimize injuries and to formulate successful preventive measures. The safety of surface mine workers is significantly impacted by individual characteristics, encompassing factors like age, experience, training and behavior¹¹. How workers see risks, make decisions and handle dangers, can seriously affect how many injuries happen on the job². The injuries are also

influenced by existing health problems and other factors. Injuries more likely affect how fast someone bounces back and sometimes mean special adjustments are needed⁶. Mining workers often opt for temporary or subcontracted jobs, posing safety challenges due to varying training, supervision and responsibility.

Understanding the impact of this work arrangement on injury rates is crucial¹. This research digs into the on-site and off-site injuries that happen both on-site and off-site in mining. It gives us a closer look at how things change each month and what trends stand out. The data really stresses how important it is to deal with safety issues, especially when it comes to off-site activities. Interestingly, there is a spike in off-site injuries in September, showing that we need specific safety steps to keep people safe. This study finds how skilled level of workers, attitudes about safety and role of contractors are playing important role in safe mining workplaces.

Material and Methods

Study Design for factors considered for the study: To comprehensively assess the risk factors contributing to injuries, our study employs a multifaceted approach⁷. We meticulously evaluated the skill levels of workers, considering educational backgrounds and various training modules such as refresher training, on-the-job training and specialized training. The role of mine officials was scrutinized through an in-depth analysis of safety and health policies, awareness programs and on-the-job inspections. Attitudes toward safety are gauged by exploring the positive outlook of workers and identifying opportunities for enhancing workplace safety⁴. The role of contractors is examined through the lens of management supervision, provision of safety-equipped equipment, remuneration structures, medical facilities, working conditions and adherence to DGMS norms.

Integral to our investigation is the exploration of control plan as strategic frameworks designed to counteract hazards. By addressing the entire spectrum of the organizational hierarchy, from frontline workers to managerial staff, a well-structured risk identification and control plan emerges as a proactive mechanism for addressing economic, health and safety concerns. This research underscores the significance of injuries and risk study in open cast metal mines.

Fig. 2 shows the methodology to develop case study of contractual workers in open cast metal mines. The mines studied located in Chhattisgarh State of India.

Results and Discussion

Results of On-site Injuries Data: The accident statistics of onsite and offsite has been illustrated in table 1. The table presents a comprehensive overview of the relationship between the total number of personnel involved and the corresponding incidence of injuries in a mining setting over the course of the year 2023-24. In April, the data reveals a

notable 7.85% injury rate, as 75 injuries occurred among a total of 956 personnel. The subsequent months demonstrate variations in both total personnel and injury counts with may exhibiting an 8.07% injury rate and 81 injuries among 796 individuals. Interestingly, there seems to be a fluctuating pattern in the injury rates despite changes in the total number of personnel.

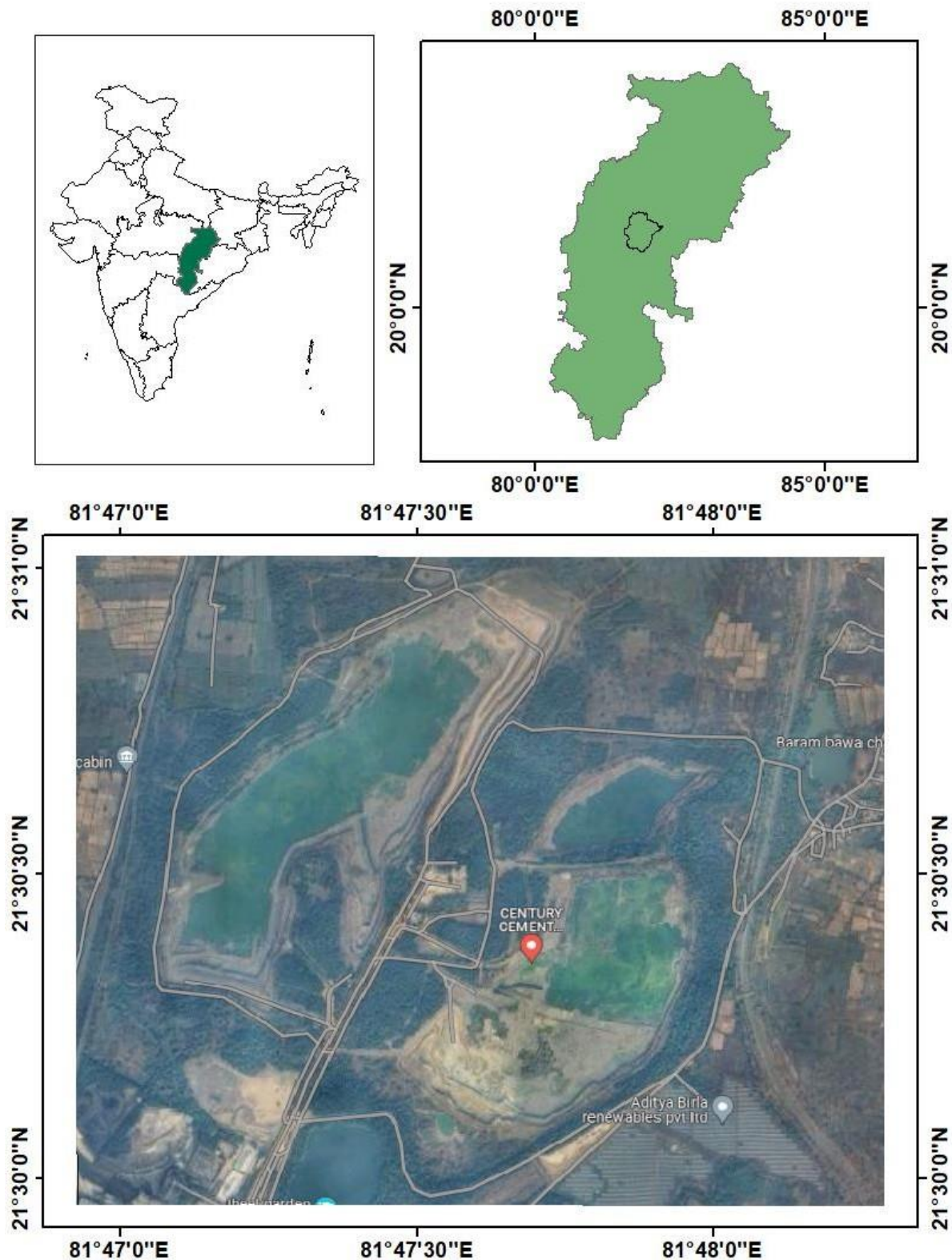


Fig. 1: Location map of mines

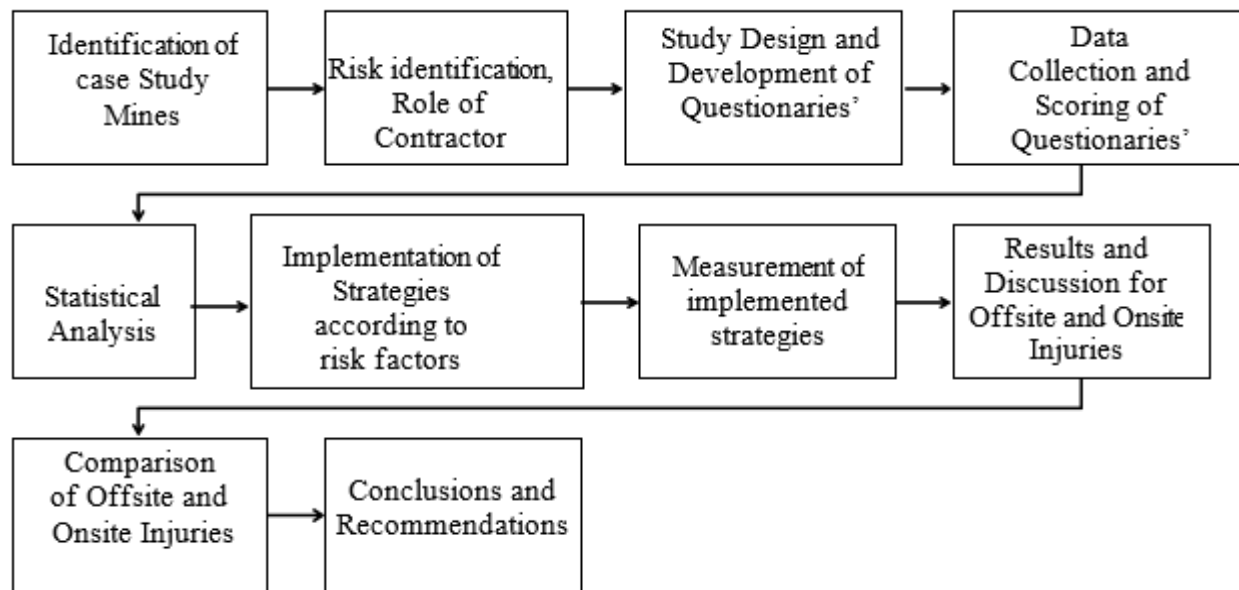


Fig. 2: Methodology for the case study of contractual workers.

Table 1
Accident Statistics of On-site and Off-site for the case study surface metal mines

Month 2023-24	On Site		Off Site	
	Total person	Injury person	Total person	Injury person
April	956	75	127	20
May	796	81	101	12
June	706	67	94	14
July	724	69	99	13
August	633	68	111	18
September	641	76	86	12
October	480	60	54	7
November	523	56	49	5
December	614	58	38	8
January	584	54	38	5
February	568	55	48	8
March	594	52	68	10

This pattern may suggest the influence of factors such as operational variations, safety training effectiveness, or seasonal conditions on workplace safety. Notably, the lowest injury rate of 8.75% is observed in March, with 52 injuries among 594 individuals. This dataset underscores the importance of continuous scrutiny of personnel safety in mining operations, emphasizing the need for a thorough analysis to identify underlying factors and to enhance targeted safety measures. Further investigation into the specific circumstances surrounding these variations is essential for the development of strategies aimed at reducing injury rates and ensuring the well-being of individuals working in the mining industry.

Results of Off-Site Injuries Data: Table 1 also offers a detailed perspective on the relationship between the total number of personnel and reported injuries in a mining environment throughout the year 2023-24. In April, a total of 127 individuals were engaged in mining activities and the

data indicates a 15.75% injury rate, with 20 reported injuries. Subsequent months display fluctuations in both total personnel and injury counts. Notably, October records a relatively lower total personnel count (54), resulting in a 12.96% injury rate, despite a smaller absolute number of injuries (7). Conversely, August exhibits a higher total personnel count (111) and a higher absolute number of injuries (18), yielding a comparable injury rate of 16.22%. The variation in injury rates suggests the need for a nuanced analysis, considering factors such as changes in operational conditions, safety training efficacy, or seasonal influences on workplace safety etc.

Interestingly, November records the lowest injury rate (10.20%) despite an absolute number of injuries (5), indicating a potential focus area for understanding and implementing effective safety measures. This dataset underscores the importance of continual scrutiny and detailed examination of the interplay between total personnel

and injury occurrences to inform targeted safety initiatives in the mining industry. Notably, the peak in off-site injuries is observed in September, indicating a heightened risk during this period shown in fig. 3.

Comparison of On-site and Off-site Injuries data: The comparative analysis of on-site (Cyan Boxplot) and off-site (Olive-Green Boxplot) injuries is depicted in figure 4 where a box plot graph has been drawn. A box and whisker plot, commonly known as a box plot, visually represents the five-number summary of a dataset including the minimum, first quartile, median, third quartile and maximum values. To construct the plot, a box is drawn from the first quartile to

the third quartile, with a vertical line indicating the median within the box. Whiskers extend from each quartile to the minimum and maximum values, providing a concise visual summary of the distribution of the data.

The left side box shows the on-site injured percentage while the right side represent the off-site injured percentage. The data reveals that overall, the number of persons injured off-site is consistently higher throughout the months, with the exception of August. The average percentage of injured was 10 % in on-site and this has increased to 14 % in off-site. This suggests that individuals off-sites are more susceptible to injuries.

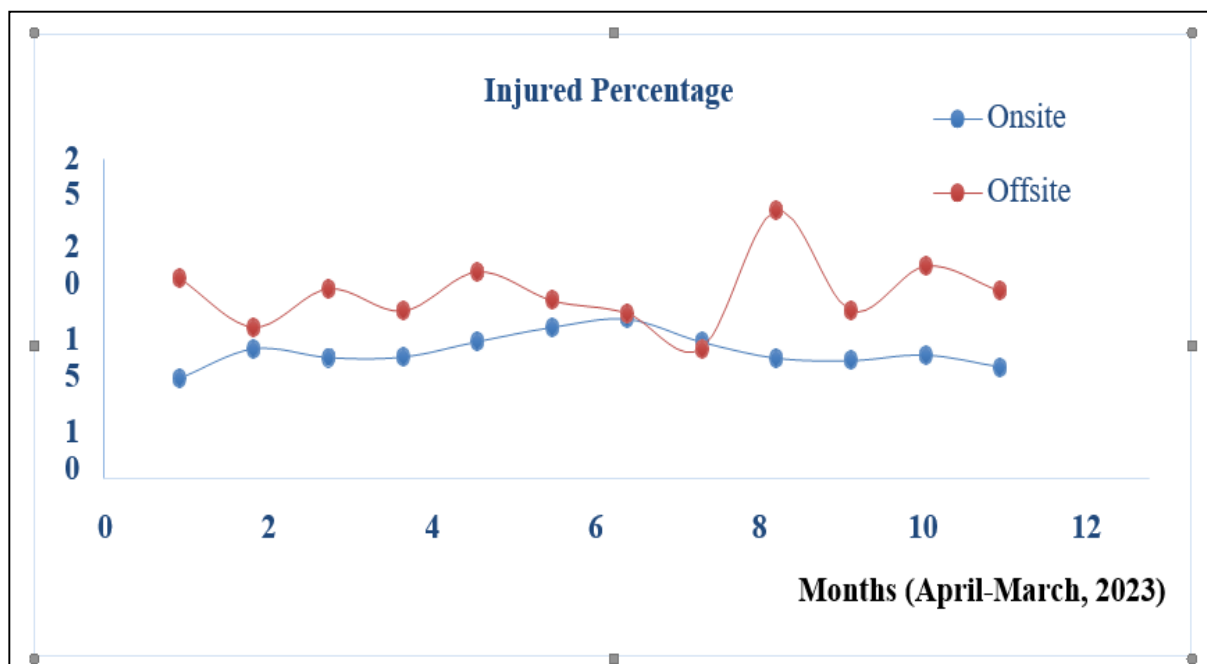


Fig. 3: Percentage of injured in on-site and off-site of mines

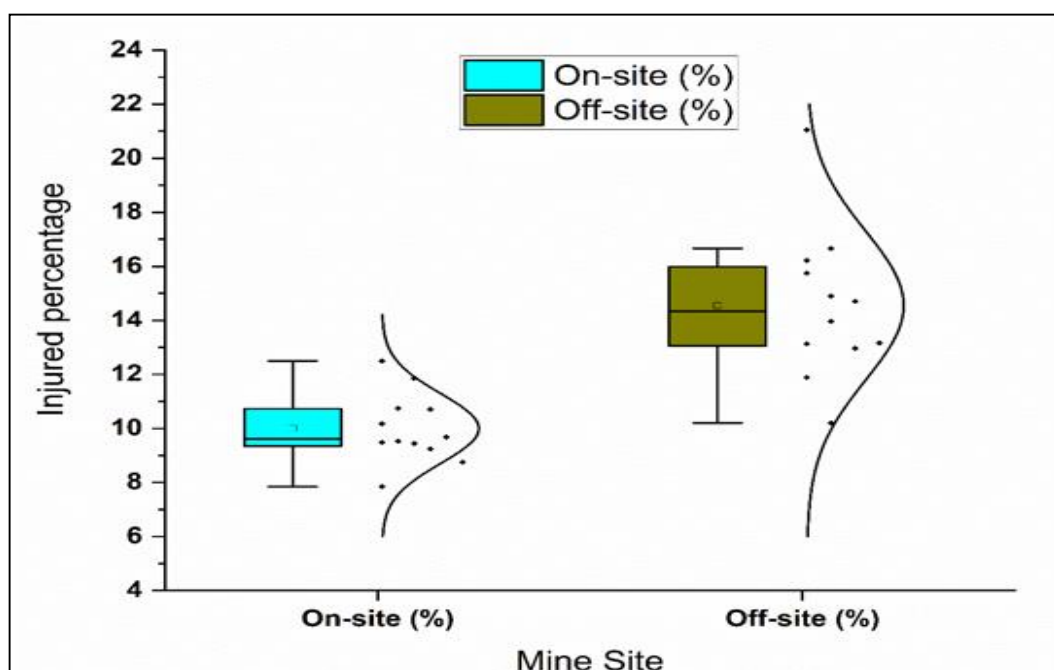


Fig. 4: Box plot diagram for the injured percentage of On-site and Offsite

Conclusion

- The on-site average injury rate was initially 10%, but it has risen to 14% in the off-site setting.
- The data highlights a notable increase in off-site injuries, particularly in September, suggesting the necessity for focused safety measures during that specific month.
- Generally, off-site injuries outnumber on-site injuries, with the exception of an anomaly in August. This anomaly in August may indicate unique conditions or events influencing higher on-site injury rates during that month.
- The study compares injury percentages for on-site and off-site mines locations. On-site injuries are lower with a small interquartile range while off-site injuries are higher, with a larger interquartile range. Off-site operations show a broader spread and more extreme values, suggesting systemic differences in safety conditions. Off-site safety concerns require immediate attention and safety protocols may need revision. On-site stability suggests better-controlled environments or more effective safety measures. Resource allocation should focus on reducing off-site injury rates and maintaining stability in on-site operations. Investigating outliers and high injury percentages in off-site operations could help to develop targeted interventions.
- The data underscores the crucial need for robust safety measures, emphasizing the significance of implementing specific precautions, especially for off-site activities, with the overarching goal of reducing the overall incidence of injuries.
- Additional contextual information and historical data are recommended, as it will contribute to a more comprehensive understanding of the factors influencing the observed trends. Such insights would facilitate the development of more targeted and proactive approaches to workplace safety within the mining industry.

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