



Human Factors Analyzing By Using Swiss Cheese Model

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ABSTRACT

Mining is the most dangerous profession in the world. There are different ways of causing accidents in mines. Mine accidents are unplanned and unexpected. The accident analysis and literature studies indicate that most of the accidents happening in mining industry are due to human errors. So, there is a need to minimize human errors. In this paper, human factors are analyzed to understand the causes of accident by using Swiss Cheese Model. The study is performed with the help of questionnaire survey. According to the survey the prime factors are considered as management, supervisor, and workers. And the drawbacks of these factors are analyzed by the Swiss cheese model. And favorable options are added to decrease the cause of the accident.

KEYWORDS: Swiss cheese, management, supervisor, workers, accidents

1. INTRODUCTION

Mining is the most dangerous professions in the world. Unsafe conditions in mines result in a range of accidents resulting in death and injury, property damage, production stoppages. It is a dangerous profession associated with a high rate of accidents and injuries. Understanding the causality of accidents is an important step in reducing accidents. Accident modeling techniques provide the necessary platform for interpreting and understanding workplace accidents.

The Swiss cheese model of accident causation is used worldwide in industries. The Swiss cheese model of accident causation is a model used in risk analysis and risk management including aviation safety, engineering, healthcare, emergency medical services organizations and as the principle behind layered security as used in

computer security and defense in depth[2]. It compares human systems to multiple slices of Swiss cheese stacked side-by-side, where the risk of a threat becoming a reality is mitigated by the different layers and types of defenses "layered" one behind the other. Therefore, errors and weaknesses in a defense theoretically do not allow for any risk since there are also other defense measures to prevent a single point of failure. It uses slices of cheese on a diagram to show how accidents can occur unexpectedly when certain events, conditions, or hazards "collision" simultaneously in an unprotected system[4].

Mine accidents are unplanned and unexpected events that disrupt work activities and may or may not result in injury or property damage. Thousands of miners die each year from mining accidents, particularly in underground coal mines, although accidents also occur

in hard rock mines. Coal mining is considered much more dangerous than hard rock mining due to the flat-lying rock strata, generally incompetent rock, presence of methane gas (CH₄), and coal dust. Most deaths today occur in developing countries and rural parts of industrialized countries where safety measures are not as widespread. Accidents happen but are caused - 85% of accidents are caused by human error[7].

The Swiss cheese model is used to find out the cause of accidents in various industries. The Swiss cheese model is like cheeses it can refer multiple layers of a cheese. Like the cheeses the safety measures can define as various layers. If any hazards or any accidents happens, it can be find out through Swiss cheese model. The Swiss cheese model was developed by James Reason in 1990 to find out the factors of hazards that need to considered during in investigation of accidents during in a complex system.

2. LITERATURE STUDY

While studying the literature of larouzee &Guarnieri[2015] the study suggests in this article intends to revert to the history and theoretical .

The literature of Justin and Jeen [2020] , this article shows that the Swiss cheese model is a product of specific historical cron stones.

Peter and patrick waterson has published an article in the year 2014, the aim of this paper was consider weather SCM can provide a system thinking approach and remain a viable option for accident analysis.

The literature review by Dash and Ram [2015] highlights that the authors emphasized the importance of using the suitable investigating methodology for investigating Indian mining occasion by case study. Accident has been presented to highlight the necessity of using the suitable accident methodology like Swiss cheese model identifying root causes of such accident.

The Swiss cheese model is used as a method in various industries to find out the loopholes in safety precautions that Leads to accidents. In these several literature reviews, each one shows the investigation of accident causes, various layers like cheese so it can identify the root causes of accidents which happens in various industries

CASE STUDY

To find the cause of accidents from the literature review and study about Swiss cheese method. To find out the loopholes in safety precautions visited Thomson mine , present in Kerala.

3. METHEDODOLOGY

The Swiss Cheese model is on defense measures are taken by the organization against threats modeled as a series of barriers, represented as slices of cheese. That

depict holes in the cheese slices weaknesses in individual parts of the system and constantly vary in size and position in all disks. The system as whole produce errors when holes in all the slices are currently aligning themselves in such a way that the danger goes through holes in everyone defense, resulting in an accident. Identified the hazards through questionnaire. To determine the hazards in mines can be conducts a survey. According to survey it divide into three categories.

1. managers
2. supervisors
3. workers

Those three categories can represent the three different levels of a mine. So in this way, it can find out the causes of accidents in three various levels of a mine. In a mine, the management, supervisor, and workers have their duties. To explain more clearly if the management does not care about the safety precautions, the chances of an accident will be high. The management has to decide on hiring staff and field workers for the mine. The overall safety precautions, decisions about the excavation, workers' training and orientations sections, work schedules, etc are decided by the management. The supervisors are the overall management of the worksite. The supervisor coordinates the workers' duties and reports the daily work activities. The workers are doing the excavation, loading, drilling, and blasting operations on the worksite. The involvement of management, supervisors, and workers in safety management will be different. So in this project, take a survey to identify the major reasons for mine accidents. When the major hazards are identified, with the help of the Swiss cheese model mine accidents can be under control.

QUESTIONNAIRE

Table 1: Questionnaire used for the study

QUESTIONNAIRE	
MANAGEMENT	
Does the management are providing awareness class regarding operation ?	
	Daily
	Weekly
	Monthly
	No
Does the management provide adequate rest period?	
	Properly
	Partly
	Depends on the work
	No
how the management gives promotion according to the employees?	
	Experience
	Skill level
	Qualification
	recommendation
Does the management forcing to complete production target in a limited period of time ?	
	Yes
	Based on profit margin
	No
does the management provide proper training?	
	Yes
	According to skills
	According to their experience
	According to their qualification

SUPERVISOR	
Does the supervisor failed to take proper overview ?	
	Yes
	Sometimes
	No
does the supervisor failed to coordinating the activities of workers ?	
	Yes
	In a proper manner
	Sometimes

	No
does the supervisor failed to ensure rules and regulations in workplace ?	
	Yes
	Maybe
	Depend on the work pressure
	No
WORKERS	
does the workers are showing over confidence ?	
	Low confidence
	Confident
	Over confident
does the workers are aware about the safety hazards in workplace ?	
	Yes
	No
while operation does the workers fell stress ?	
	Yes
	Depends on the work
	Depends on the health
	No
does the supervisor provide adequate rest period ?	
	Yes
	Depends on work
	No
does the workers are able to concentrate during the work ?	
	Yes
	Depends on the mental health
	Depends on the physical health
	No
Did any workers use any type of smoking/drinking habitats during the work ?	
	Yes
	Sometimes
	No
Did you have any problems with your co-workers ?	
	Yes
	Partly
	No
Are you comfortable with your work atmosphere ?	

	comfortable	
	Partly comfortable	
	Dis comfortable	

4. RESULTS & DISCUSSION

Table 2: results obtained from table 1

MANAGEMENT		
Does the management are providing awareness class regarding operation ?		
	daily	0
	weekly	0
	monthly	1
	no	0
00%		
Does the management provide adequate rest period?		
	properly	4
	partly	1
	Depends on the work	4
	no	0
2.9%		
4.3%		
2.9%		
0		
how the management gives promotion according to the employees?		
	experience	5
	Skill level	2
	qualification	1
	recommendation	0
7.1%		
8.6		
4.3		
0		
Does the management forcing to complete production target in a limited period of time ?		
	Yes	1
	Based on the profit margin	7
	no	1
4.3%		
1.4%		
4.3%		
does the management provide proper training?		
	yes	7
	According to skills	2
1.4%		

		8.6%
	According to their experience	0
	According to their qualification	0
SUPERVISOR		
Does the supervisor failed to take proper overview ?		
	Yes	0
	Sometimes	0
	no	1
00%		
does the supervisor failed to coordinating the activities of workers ?		
	Yes	0
	In a proper manner	0
	Sometimes	0
	No	1
00%		
does the supervisor failed to ensure rules and regulations in workplace ?		
	Yes	0
	Maybe	5
	Depend on the work pressure	0
	No	5
0%		
WORKERS		
does the workers are showing over confidence ?		
	Low confident	1
	confident	8
	Over confident	0
8.2%		
1.8%		
0		
does the workers are aware about the safety hazards in workplace ?		
	Yes	7
	No	2
7.8%		
2.2%		
while operation does the workers fell stress ?		
	Yes	1
	Depends on the work	6
	Depends on the health	1
5.6%		
2.2%		

		5.6%
	No	6.7%
does the supervisor provide adequate rest period ?		
	Yes	3 3.3%
	Depends on the work	5 5.6%
	No	1 1.1%
does the workers are able to concentrate during the work ?		
	Yes	2 4.4%
	Depends on the mental health	4 4.4%
	Depends on the physical health	2 6.7%
	No	4 4.4%
Did any workers use any type of smoking/drinking habitats during the work ?		
	Yes	1 1.1%
	Sometimes	5 3.3%
	No	3 5.6%
Did you have any problems with your co-workers ?		
	Yes	1 5.6%
	Partly	3 5.6%
	No	4 8.9%
Are you comfortable with your work atmosphere ?		
	comfortable	4 0.9%
	Partly comfortable	5 6.8%
	Dis comfortable	2. 3%

To find out the hazards in mines/quarries with the help of the Management, supervision, and workers their conduct a survey in mines. For this work, some questionnaires were asked to those workers, management, and supervision according to the collected data it has been analyzing that what are the factors that cause human errors and hence with the swiss cheese model can find out the hazards in mine.

From Table 2, It has been observed that the management is giving awareness classes once a month and it should be once a week to reduce the cause of an accident and also it can be observe that while promoting the workers it is given that 71 % is considered for experienced and for skill level and qualification it is not considered up to experience, if all these can be considered proportionally balance the way to accident can be reduced. While analyzing the forcing mentality of management 71 % is showing that based on the profit margin, it should be changed and a proper time has to be scheduled for every work. And management is not capable of keeping a good atmosphere. And here 56.8 % of workers are partly comfortable with the work. It can be concluded that these are some of the defects by the management for the cause of management.

From the response of 46 workers, about 77.8% are aware of the safety hazards in the workplace. The remaining 22.2% result shows that they are not aware of the safety hazards. Providing more safety classes and training about safety can lead 77.8% to 100%

While operation about 62.2% feel stress depending on the work on the other hand 15.6% feel stress depending on their health and about 15.6% feel stress during their work remaining 6.7% feel no stress according to the worker's responses to the management should provide proper orientation classes for their mental health, reduce workload, reduce their work period those all can lead to reducing their stress at least partly.

According to the survey, almost 82 % of the workers are confident about their knowledge of their work. The remaining workers have less confidence in their work, so this will affect their working conditions and it may be caused to accidental conditions. Every industry must be given an adequate time for the worker's rest at regular intervals. 55.6 % of the workers say the rest period time depends on the workers. It will be affect the worker's

mental and physical health. It may lead to hazards. Over 50 % of the workers are sometimes drinking or smoking habitats during the working period. These type of habitat will affect the worker's physical health, hallucination, and loss of body control. It will lead to catastrophic hazards, so the management must take precautions against drug abuses during work time.

5. CONCLUSION

As the mining industry is growing with new technologies, new work methods, and new types of machinery, a new form of hazards will also be formed. The Swiss cheese model helps to find out the loopholes in safety measures that can lead to accidents. The Swiss cheese model is used to find out the cause of accidents in various industries including mining. Unsafe conditions in mines result in a range of accidents resulting in death and injury, studies indicate that most of the accidents that take place in mines are related to human errors. The prime factor is to reduce human errors with the help of the Swiss cheese model from human factor analysis.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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