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Study and Analysis of Accidents Due to Wheeled Trackless Transportation Machinery in Indian Coal Mines – Identification of Gap in Current Investigation System

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Abstract

Mining is one of the most hazardous industries amongst where the rate of casualty is still very high from work place accidents. A large number of mobile mining equipment such as haul trucks, dumpers, tractors, tankers are used for different operation and such operations contribute significantly in causation of fatal and serious accidents. In this study, 33 years 'fatal accident data from Indian coal mines were analyzed from 1980. The rate of fatal accident shows a significant reduction from 1980 to 2000 but it becomes almost flat for the last 13 years since 2000. Though all the accidents were investigated and recommendation were made for preventing recurrence, there is no further reduction in the rate in last 13 years which reflects the gaps in our investigation procedure or recommendation or implementation. An effort has been made in this paper to highlight the major gaps in the existing investigating procedure and thereby making useful recommendations to ensure effective control measures in place to reduce the risk to an acceptable level.

Keywords: Accident inverstigation;Wheeled trackless Transportation

1. Introduction

As compared to other industries, the mining industry and related energy resource industries are associated with high rates of occupational injuries and fatalities. Mining is one of the most hazardous work environments in most of the countries around the globe (Sari et al., 2009; Groves et al., 2007; Bajpayee et al., 2004; Donoghue, 2004). Mining is a hazardous profession and considered as war against the unpredictable forces of nature. As a result, the mining industry continues to be associated with a high level of accidents, injuries, and illness (Maiti et al., 2004).

Accidents in mines are still continuing at some disturbing rate. The failure of people, equipment or surroundings to behave or react as expected, results in most of the accidents. Identification of different factors responsible for such failure may play an important role in accident mitigation (Paul and Maiti, 2001). Since the majority of the workplace operates and maintains large number of mobile mining equipment such as haul trucks, bulldozers and excavators in mines, it is not surprising that large number

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of accidents/incidents and injuries are associated with operation of such equipment.

According to Director General of Mine Safety (DGMS, 2013) records, there were 1174 fatal accidents and 1319 fatalities in Indian coal mines between 2000 and 2013 out of which 37.64% of fatal accidents (442) causing 34.57% of fatalities (456) due to the single cause of Transportation Machinery (other than winding in Shaft), which included: rope haulage, wheeled trackless transportation and other transportation machinery.

2. Analysis of historical data of Indian coal mines

Figure 1 shows the Trend in fatal accidents and fatality rates per 1000 persons employed (Ten yearly averages) from 1901-2010.

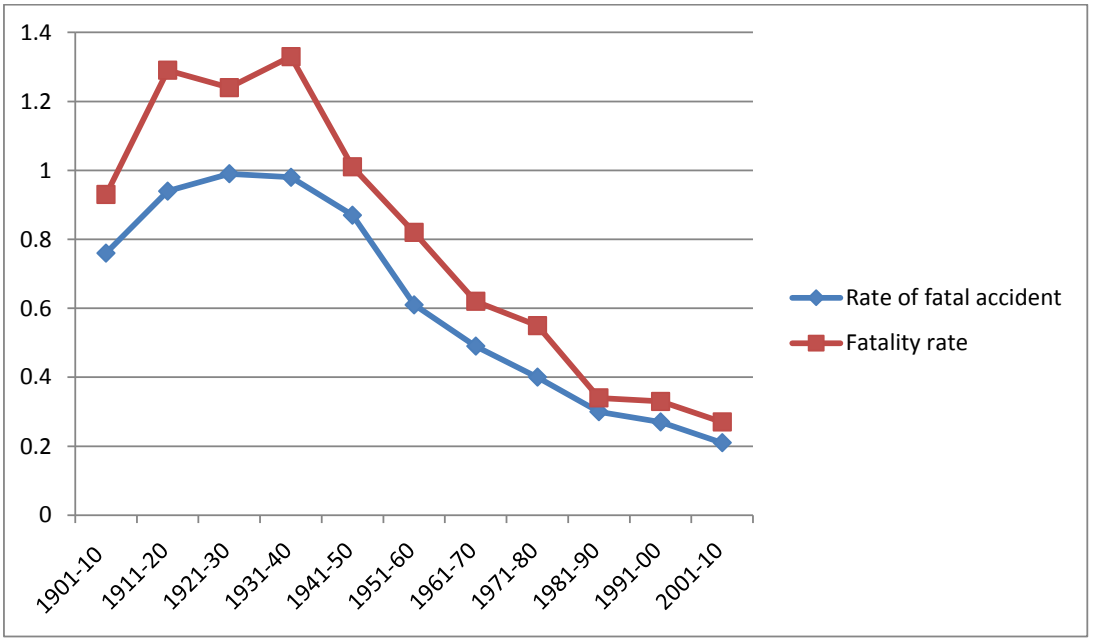

Fig.1. Trend in fatal accidents and fatality rates per 1000 persons employed (Ten yearly averages)

2.1. Observation

For coal mines, a consistent decline is observed in the 10-yearly average number of accidents per 1000 persons employed basis since the 1940 to 1980 from 0.98 to 0.3 and rate of fatalities per 1000 persons employed basis during the same period from 1.33 to 0.34. But the trend is almost flat in last 33 years since 1980. There is minor reduction in the rate since the last three decades in rate of fatal accidents (0.3 to 0.21) and rate of fatality (0.34 to 0.27).

3. Causes of coal mine accident and its analysis

When the causes of fatal accident in coal mines are analyzed for the last 43 years since nationalization of coal mines, it is clearly observed that there are five major causes, such as Ground movement, Fall other than fall of ground, Transportation machinery (other than winding), machinery other than transportation machinery and explosives which contributes almost 91% of the total accident. That is why we divided the cause of the accident into five groups and rest of causes are in one groups.

Accidents due to ground movement contributed 41%, transportation of machinery (other than winding in shaft) contributing 31% along with Machinery Other than Transportation Machinery, Explosive and Fall (other than the fall of Ground) which contributed 6%, 4% and 9% respectively.

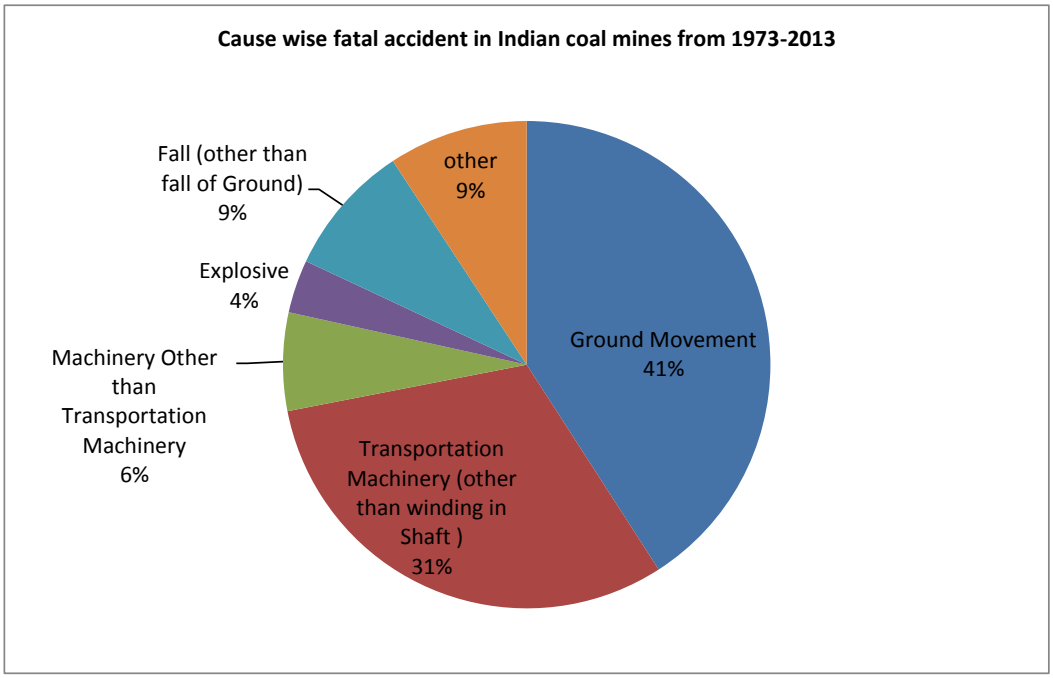

Fig.2. Cause wise fatal accident in Indian coal mines from 1973-2013

Observations

- Number of fatal accidents due to ground movement involving roof fall and side fall accidents are 2285 during the year 1973-2013. Roof fall and side fall accidents accounted for about 41% of all fatal accidents during this period.
- There is 1735 number of accident due to Transportation Machinery (other than winding in Shaft) which resulted into 31% of total accident during the period 1973-2013.
- Machinery Other than Transportation Machinery, Explosive and the fall (other than fall of Ground) resulted into 364,197 and 490 number of accidents which is equivalent to 6%, 4% and 9% of the total accidents respectively during this period.
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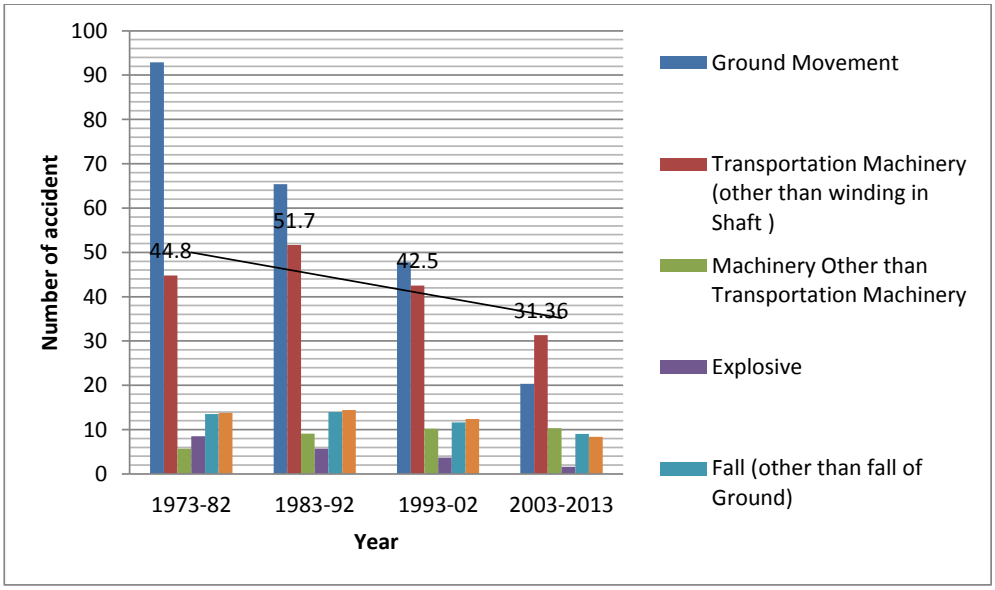

Fig.3 Trend in Cause wise fatal accident of Indian coal mines from 1973-2013 (Ten yearly averages)

Observations

- The trend of accident due to ground movement is decreased gradually from an average of 92.9 to 20.36 per year.
- Accidents due to ground movement in Indian coal mines have significantly reduced in last two decades.
- But rate of accidents due to transportation of machinery (other than winding in shaft) increased (51.7) in the next decade after nationalization (1983-92) and thereafter slightly reduced in the next decade (1992-2002). Though the rate of accidents reduced further in the current decade since 2003 (31.36 per year), but it is the most dominating factor in Indian coal mines in the current decade.

4. Analysis of accidents due to trackless transportation machinery (wheeled)

Last thirty three years of fatal accident due to dumper and wheeled trackless transportation (truck, tractor, tanker) machinery data of Indian coal mining industry have been further analyzed. Five yearly average rate of accidents per year due to wheeled trackless transportation machinery since 1980 have been plotted in figure 4.

Observations

- There was minor reduction in the rate of accidents in the period from 1980 to 2000 (47.2 to 38.8)
- There was a sharp drop in the next five years from 38.8 to 28.4.

But since 2000 it's almost flat and there has not been any reduction in yearly average figure of around 28.3.

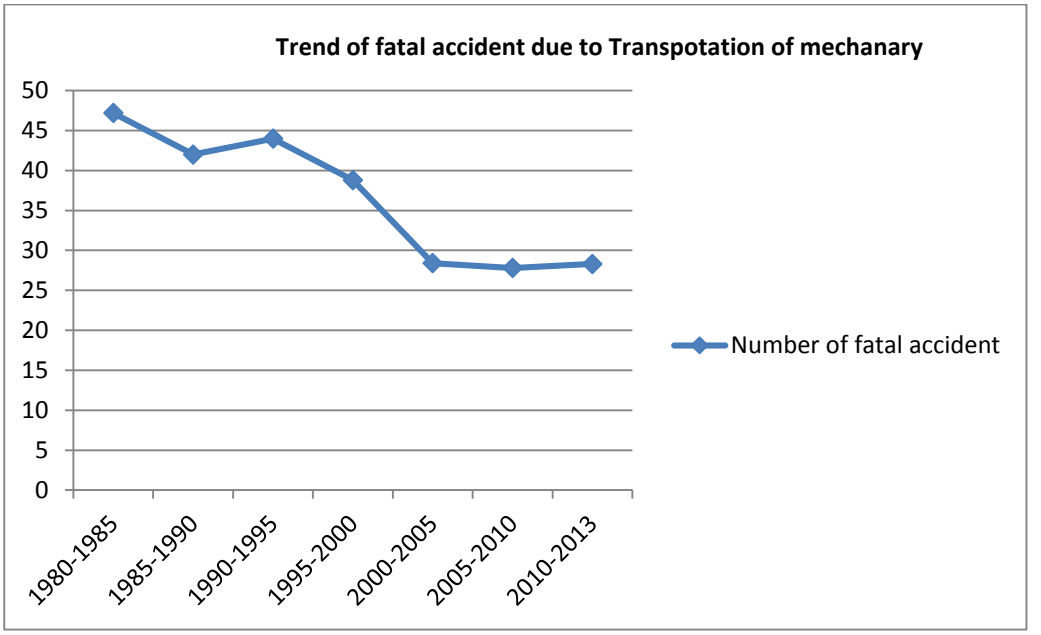

Fig.4 Trend of fatal accident due to transportation of machinery in Indian coal mines from 1980-2013 (five yearly averages)

The year wise fatal accidents due to trackless transportation machinery (wheeled) has been plotted in figure 5.

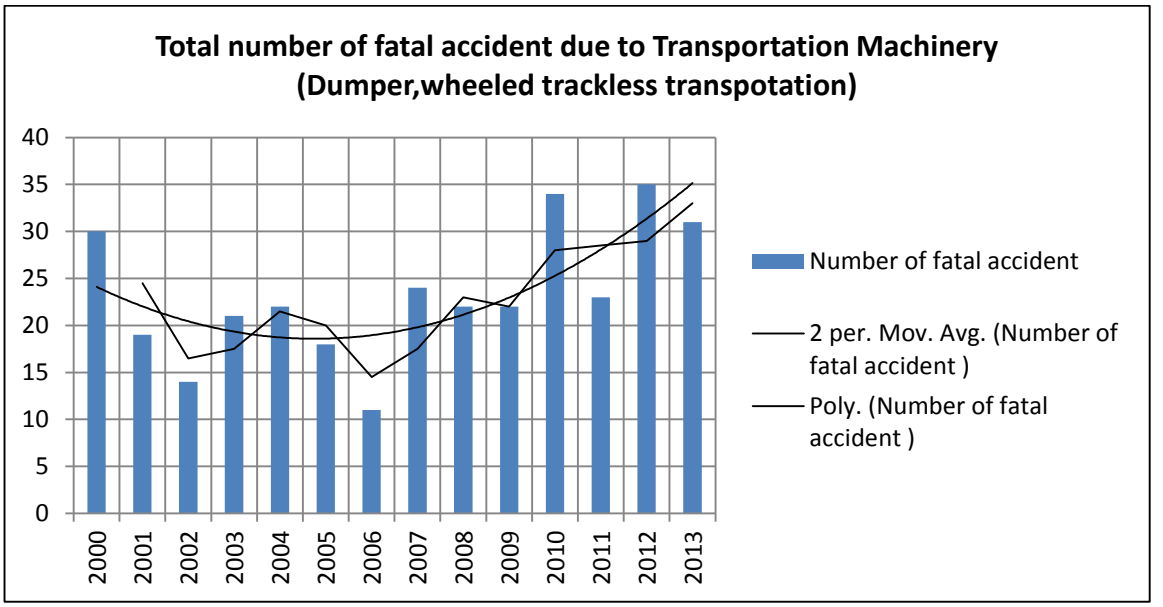

Fig.5 Trend of total number of fatal accidents due to transportation of machinery (Dumper, wheeled trackless transportation)

Observations

- The trend does not have any consistency.
- The overall trend is slightly dropping in the period from 2000 to 2006, ranging from 30 to 11 but thereafter increasing to 35 in 2012 and 31 in 2013.

4.1. Summary of observations of accidents due to trackless transportation machinery (wheeled)

- Average number of accidents due to trackless transportation machinery (wheeled) in last 33 years is quite high ranging from 47.2 to 28.3 per year.
- Average rate of accident is almost flat in last 13 years since the new Century.
- The year wise figure shows there is an increasing trend in last 6-7 years.
- Four or five main causes are repeated.
- Though each and every accident is investigated by multiple agencies and recommendations are made for implementation, there is no indication of improvement in this front. This is quite concerning.
- It is also important to consider the growth potential in opencast coal mines in the near future, which may further worsen the scenario unless due care is taken to handle large fleet of such equipment with safety.

In view of the above observations and the criticality of increasing fleet size of wheeled transportation machinery in coal mines, further analysis of the accidents were carried out.

5. Analysis of accidents due to dumpers

As observed in figure-5, number of fatal accident due to dumpers is still very high and which is not at an acceptable level. For further analysis of the accidents, the major causes were further analysed on the basis of mode of accident like reversal run over, front run over, lost control, collision and other causes.

These five sub-causes of dumper accidents in last 13 years were analysed and shown in the figure-6.

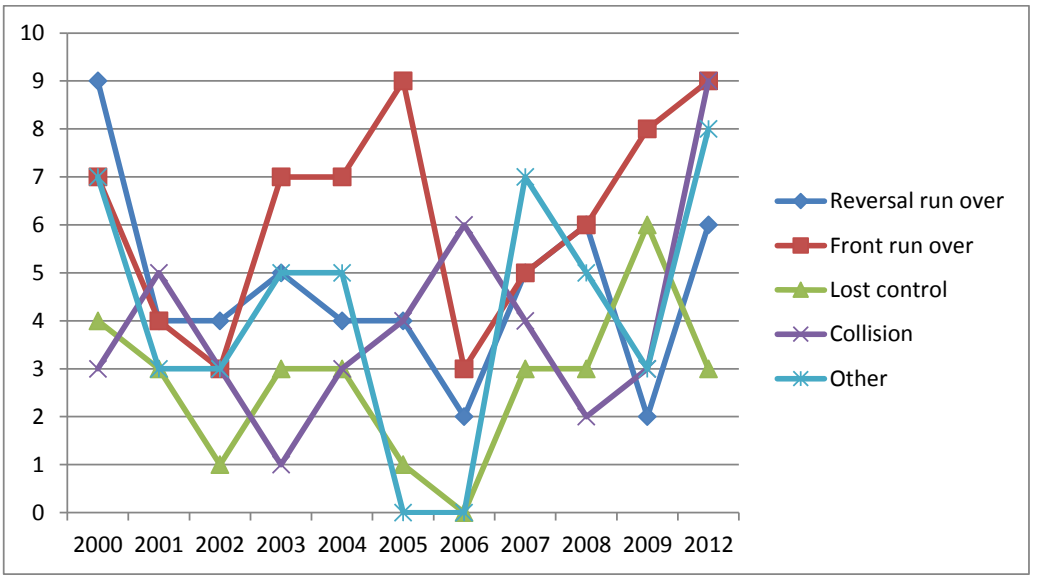

Fig.6. Trend of dumper accident, according to its mode of action

Observations

- There is no consistent trend in the sub-causes resulting into fatal accidents.
- It shows that the activities are not controlled properly and accidents are left upon chances.
- The identified controls are either not effective or not being implemented properly.
- Reversal of the dumper contributes 21% of dumpers accident where as 29% and 18% of the dumper accidents are due to front run over and collision of the dumpers.

5. Case studies

The cause analysis and recommendation of all the accidents due to dumpers in last 13 years were further studied and reviewed to find out the gaps in the whole process of investigation, recommendation, implementation and follow-up. In this paper two case studies, one from reversal run over and other from collision have been presented below.

5.1. Accident-1 (reversal run over)

5.1.1. Brief description

In an open cast coal mine “While a front-end loader operator was in conversation with his co-worker positioning himself behind a tipper, he was run over by the tipper being reversed for loading crushed coal near feeder breaker thereby inflicting serious bodily injuries to which he succumbed while being shifted to hospital for treatment”.

5.1.2. Identified causes

- The tipper operator was not mind full at the time of reversing.
- The tipper operator was not able to see the rear due to fine dust generated near the feeder breaker, which was not suppressed effectively
- Loading operation in the feeder breaker output was not kept under the supervision of a competent supervisor.

5.1.3. Responsibility

The Manager, Assistant Manager and tipper operator were held responsible for the accident.

5.1.4. Gaps

- Why the person (deceased) was present there?
- Was there any documented procedure for reversal?
- Was there any procedure for separation like "NO GO ZONE" for approaching or working in the vicinity of mobile machines?
- Were the operator and co-worker aware of such No Go Zone procedure?
- What was the system of ensuring skill and competency of the tipper driver or his helper?
- Were they trained and properly inducted into the workplace?
- Were they physically fit for work on that day? Were they under influence of drug or alcohol? Were they fatigued?
- Was there any other source of distraction for the driver which led to the uncontrolled operation of the tripper?
- What was the mechanical condition of the truck? Was it functionally in order to be operated?
- Is there any procedure for pre-start checking of the tipper or other mobile equipment in the mine?
- Was there any audio-visual warning system provided in the tipper for reversing? Was it working properly?
- How was the weather or visibility condition?
- Whether there was any dust suppression system near feeder breaker?
- Whether the controls against dust were effective?
- Whether other task conditions like work pressure, trip-based earning of contractor's operators etc. resulted in unsafe operation by the operator?
- Whether there was adequate supervision for the job?
- Was the supervisor competent enough to identify hazards?
- Whether there was any history of similar incident?
- Whether such incidents were investigated and recommendations implemented?
- Whether any risk assessment was done before such job?

These are some of the issues which need to be examined during the investigation. Without investigating into these issues, perhaps the investigation outcome cannot be effective to prevent re-occurrence. It is too simplistic to hold the co-worker (deceased) and operator responsible for such unsafe act without ascertaining the organizational factors that led to such unsafe work condition or unsafe practice. More important is to identify the underlying or latent causes leading to such unsafe behaviour. Based on root cause analysis during investigation, fruitful recommendations can be made and there must be a mechanism for implementation and follow-up of all such accidents to prevent recurrence.

5.2. Accident-2 (collision case)

In a open cast mines "while a dumper was parked in extreme left side of the empty lane of haul road, another speeding dumper dashed the standing dumper from behind meeting head to tail collision in such a way that right rear body of standing dumper pierced into the cabin of speeding dumper and got smashed in which operator of the speeding dumper received serious bodily injuries to which he succumbed almost instantly".

5.2.1. Identified causes

- The dumper operator was not able to see the empty standing dumper properly.
- There was "no code of practice" as required under the rule and regulation.

5.2.2. Responsibility

The dumper operator and co-worker were held responsible for the accident.

5.2.3. Gaps

- Why the empty Dumper was parked at that location?
- Was there any parking procedure in the mine?

- Does he (Dumper operator of parked Dumper) understand the hazard of parking in the active circuit of haul road?
- Was there any designated and properly maintained parking area?
- What is the level of skill, efficiency and experience of the Dumpers (both) operator?
- Was there any procedure for ensuring skill and competency of equipment operator?
- Was there any source of distraction for the driver which led to uncontrolled operation of the truck?
- Were they physically fit for work on that day? Were they under influence of drug or alcohol? Were they fatigued?
- How was the weather or visibility condition?
- What was the operating condition of the Dumper?
- Is there any procedure to check the Dumper condition before starting it?
- Whether the risk of nose-tail collision assessed and was there any control against such collisions?
- Whether there was any procedure for effective communication to make the operators of heavy vehicle or machinery aware of presence of other vehicles including Light vehicles or pedestrians in an active circuit?
- Whether there was any history of similar accident?
- Whether such incidents were investigated and recommendations implemented?
- Whether there was adequate supervision for the job?

5.2.4. Gaps analysis

The analyses of the findings on the gaps of the above case studies are as follows:

- The accidents are of very common and repetitive in nature.
- In most of the cases, direct causes or unsafe act was identified as main cause and persons who were directly involved in the accidents, including the deceased, were held responsible for the accidents.
- The direct causes were identified to be the causes for accidents and no efforts were made to identify the latent, indirect or underlying causes.
- The organizational factors like task condition, supervision, risk assessment and development of safe work procedure, ensuring competency for performing a job etc. were not examined while identifying causes of the accidents.
- Risk assessment was not carried out before all routine or non-routine type of activities and adequate controls were not identified or in place before undertaking such job.
- Lack of skill, competency and fitness for duty of the operators or work persons were not examined.
- Human error or non-compliance of statutory provisions was identified as causes of accidents in most of the cases. But what led to human error or non-compliance were not examined.
- The real objective of accident investigation through identification of root causes and implementation of corrective measures could not be achieved through such superficial accident investigation.
- There is a strong need to review the effectiveness of current accident investigation methodology and introduce the concept of objective assessment of latent causes for unsafe act or behaviour.

6. Discussion

From the analysis of the accidents in Indian coal mines in last four decades, it is observed that accidents due to wheeled trackless transportation system are a major contributing factor. More alarming is the fact that in last 12-13 years, the rate of accidents due to this cause is more or less stagnant. In spite of all the actions deriving from the investigations, things have not been improved. Population of mobile transportation machinery and equipment will be increasing in the future keeping pace with production target of opencast mines. Hence the problem will be further complicated. It is essential to learn from the mistakes or from the accidents. But through the case studies, it is revealed that accident investigation in Indian mines is mainly focused at Human Error or Non-compliance of statutory provisions. In most of the cases only the direct causes have been identified to fix responsibilities and making recommendations. This approach is proved to be grossly ineffective because of the fact the system deficiencies still remain undetected or unidentified during such investigations and the recommended actions may not suitably

address the root causes. That is why similar accidents are repeated. Accidents are the result of multiple causes or defects in the system. It becomes the investigator's job to uncover the root causes (defects) in the system. Fixing the system, not the employee, is the heart of the investigation. To prevent accidents, the system must work more safely. This thinking results in long-term fixes: Less expensive to implement and maintain.

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