CHAPTER-1

CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

Minerals and fossil fuels are the lifeline of modern industries. The ever-increasing demand for minerals, due to rapid industrialization and population explosion has forced the mining industry to increase production and productivity. Achieving the high production and productivity target is one of the biggest challenges for any mining industry in order to remain competitive in the global market. Dump trucks are popular means of material transport in surface mines.

A dump truck is a heavy vehicle designed for bulk transport of coal, overburden, and minerals in mines. Dump trucks are one of the widely used and capital-intensive heavy earth moving equipment in the mining industry. High-performance rates, good measurement practices, and continuous monitoring of equipment performance are mandatory for the high-cost systems to be in the business. Defining the metrics of a performance measure is essential to monitor the performance of these equipment. This research proposes a methodology for measuring the performance of a dump truck. The proposed performance measure (PM) is derived from the overall equipment effectiveness (OEE), a widely used performance measure in industrial and manufacturing industries, through modification of metrics.

The performance of various machines can be measured by different methods. For example, if one measures the performance of a computer, the computer performance metrics include availability, service time, bandwidth, relative efficiency, response time,

channel capacity, latency, performance per watt, compression ratio, speed up, processing speed, and power consumption. Similarly, if one measures the performance of an engine, then he will consider the efficiency of the engine. Traditionally, equipment performance was expressed initially in terms of availability, reliability, and maintainability. Nakajima (1988) introduced the concept of Overall Equipment Effectiveness (OEE) as a performance metric in manufacturing industries. Conceptually, OEE is expressed as the product of availability, performance and quality but the exact definition of OEE differs among experts to suit the application areas.

According to Nakajima's concept of OEE, a manufacturing site performs at the best when the site operates to the full capacity, always produces a perfect product, and never breaks down. Capacity usage, quality performance, and breakdown data will, therefore, be combined to determine the OEE. Ercelebi et al. (1999) adopted the OEE concept for measuring the performance of mining equipment. They concluded that harsh operating environment for mining equipment was the major hindrances in getting maximum output. Subsequently, Elevli and Elevli (2010) and Akande et al. (2013) have used the concept of OEE for measuring the performance of mining equipment, i.e., shovels and dump trucks. Mohammadi et al. (2017) have used the OEE concept for evaluating the performance of Bucket based Excavating, Loading, and Transport (BELT) equipment. All these researchers have translated the OEE concept from the manufacturing industry to the mining industry without altering the loss matrix and considered primarily three losses, i.e., time losses, capacity losses, and quality losses into the performance measurement. However, the system's operational effect on the environment plays an essential role in determining its performance in today's business. The external losses occurring beyond the system boundary, like environmental losses due to the operation of the mining equipment are likely to be included in the

performance metrices. This research presents a modified OEE naming as Overall Equipment Performance Indicator (OEPI) that incorporates losses across the system boundary due to the equipment operation.

1.2 STATEMENT OF THE PROBLEM

Many improvements have been done for performance measurement in the manufacturing industries. As already discussed OEE was firstly developed for the manufacturing equipments. Subsequently, different researchers have translated OEE to adapt it in various fields accordingly.

Unfortunately, some researchers tried to translate it for the heavy equipments used in the mining industry, but they could not translate it properly. This study uses Overall Equipment Performance Indicator (OEPI) which incorporates capacity performance and environmental performance in the performance metrics of the mining dump trucks. Commonly used performance measures are based on the internal losses calculation, i.e., availability, performance, and quality losses; which neglects the operational effect beyond the system boundary, i.e., external losses. The proposed performance measure presents an approach that unites time performance, capacity performance as well as environmental performance.

In addition, it was observed that there was no standard practices for establising performance benchmarks of mining equipment like dump trucks. This study has developed a reasonably practical methodology of establising benchmark value for performance of dump trucks.

1.3 OBJECTIVES AND SCOPE OF THE RESEARCH

It is well understood that the OEE concept is widely adopted in the manufacturing industry. The primary objective of the present research is to suitably translate it for mining equipment such as dump trucks by developing an appropriate methodology and tools for measuring and calculating the different components of the performance measure like OEPI. After defining the performance measures a methodology for fixing the standard value of the performance measure and development of its components.

The specific objectives of the present research are

1. Analysis of the OEE concept and modify it for the performance measurement of mining dump trucks including their operational impact on environment. Call this modified performance measure as Overall Equipment Performance Indicator (OEPI).
2. Evaluation of field data about the dump truck operations and suggest a methodology for computing components of OEPI.
3. Development of a suitable methodology of fixing benchmark values for OEPI and its components.
4. Diagnosis of the problem areas of case study dump truck subsystem and suggest suitable measures for improving the performance of the case study dump truck subsystem.

1.4 Research Questions Based on the Objectives of the Study

i. How can one define a Performance measure for mining dump trucks incorporating the environmental impact of operation of dump trucks?

ii. What is the procedure of categorizing the performance level of dump truck?

iii. How can one diagnose poor performance of a dump truck and recommend corrective measures for improving the performance through performance analysis?

1.5 CONTRIBUTION OF THE RESEARCH

By performing the literature survey, different type of losses occurring in the dump truck operation system has been identified and suitably translated it according to OEE concept employed in the manufacturing industry. This translation consists of different losses occurring in the dump truck operation system such as time losses, capacity losses, and environmental losses, i.e., external losses occurring outside the system.

The prevailing performance measures are based on the internal losses only, i.e., resource losses occurring in the system. But increasing public awareness of environmental impact of mining and stringent regulation has compelled mine management to plan each unit operation in mining to minimize its environmental impact. Therefore, there is a need to develop a performance metric which could include internal as well as external losses occurring in the system i.e. the performance metric should be holistic in nature which should consider all the losses including environmental losses, occurring due to the operation of equipment. Overall Equipment Performance Indicator (OEPI) is developed incorporating the environment impact of equipment operation indirectly. Finally, four OEPI components were calculated for estimating the performance of the dump truck operating in mines.

Furthermore, this study presents a practical approach for fixing the benchmarked value of Availability, Utilization and Overall Equipment Performance Indicator (OEPI) and demonstrates it by collected field data of dump truck operation. This work also illustrates the use of establishing performance standard to identify the bottleneck in the coal/material transportation systems.