Int J Syst Assur Eng Manag
https://doi.org/10.1007/s13198-024-02396-7

ORIGINAL ARTICLE

Analysis of shovel fleet utilization in Sarcheshmeh Copper Mine using a smart monitoring platform

Mohammad Rezaei Dashtaki[1] · Ali Jandaghi Jafari[1] · Behzad Ghodrati[2] · Seyed Hadi Hoseinie[1]

Received: 29 December 2023 / Revised: 12 June 2024 / Accepted: 13 June 2024

Abstract Utilization of the shovel fleet as a capital-intensive and operationally important asset in open-pit mines is a key indicator for mine production analysis. This paper investigates shovel utilization in surface mining using a novel smart platform integrated with the shovel operating joystick. It utilizes a unique algorithm to identify and differentiate operational and non-operational time based on comparing real-time data and average loading cycle time. This data is then employed to calculate overall uptime and identify downtime periods. A field study was carried out on six electric cable shovels consisting of P&H 2100 and TZ WK-12, at Sarcheshmeh Copper Mine. The analysis revealed that the average utilization of the whole fleet is equal to 33%, ranging from 16 to 48%, which is dramatically lower than the mine expectations. The statistical analysis showed that in 10–13% of the operating time, the utilization is higher than 75%, which is a moderately acceptable level. Finally, according to the outcomes of the field study and the developed smart platform, it could be concluded that improvements in dispatching system accuracy, revising the grade blending strategies, increasing processing plant flexibility and improved operator training could enhance shovel fleet utilization and whole mine productivity.

Keywords Operational time · Cable shovel · Open pit mine · Delay time · Machinery

✉ Seyed Hadi Hoseinie
hadi.hoseinie@iut.ac.ir

[1] Department of Mining Engineering, Isfahan University of Technology, Isfahan 84156 83111, Iran

[2] Division of Operation and Maintenance Engineering, Lulea University of Technology, Lulea, Sweden

1 Introduction

The utilization of large machinery in open-pit mines has brought about challenges in fleet management and planning to maximize machine capacity, becoming crucial aspects of mine management and operations. Among the machines employed in open-pit mining, shovels hold particular significance in mining production. Shovels are massive machines designed for loading blasted rocks into mining trucks, playing a pivotal role in the production system of open-pit mines. Their operational indicators, including maintainability, accessibility, efficiency, and utilization, significantly impact the entire production process. Therefore, even a slight improvement in the operational indicators of shovels can yield numerous positive effects on overall mining production (Hall and Daneshmend 2003; Ozdemir and Kumral 2019; Torkamani and Askari-Nasab 2015; Samavati et al. 2018; Bozorgebrahimi et al. 2005; Arteaga et al. 2018).

There are three methods to enhance production in mines: increasing utilization, increasing investment, and a combination of both. Among these, increasing utilization is the most cost-effective approach. Given the high cost of mining equipment and machinery, optimal usage becomes imperative. Shovels, being highly expensive and critical in the mine production cycle, necessitate continuous and uninterrupted activity. Stoppages in shovel production typically arise from machine malfunctions or waiting for a truck. Machine failures impact reliability indicators, maintainability, and ultimately machine accessibility. Waiting times and other operational delays are often linked to fleet management, planning conditions, and operator skill, significantly reducing machine utilization. Improving shovel utilization in mines involves managing various delays and enhancing truck accessibility (Visser 2020; Dhillon 2008; Hoseinie et al. 2014).

Published online: 20 June 2024