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Development of a new method for maintainability and downtime analysis of mining machinery

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Shovels are universally acknowledged as vital machinery in surface mining production systems, and enhancements to this equipment substantially augment operational mine output capacity. Extending the length of continuous operation is a cost-efficient strategy that may result in significant productivity improvements, as it is directly linked to the fleet's reliability and maintainability. This research analyses the maintainability of a fleet of ten rope shovels in an open-pit copper mine, consisting of three separate models. To this end, repair data for all ten shovels over two years were analyzed, and maintainability models were assigned to each shovel. The results indicate that all shovels are predominantly maintained in less than 45 h, and 80% of repairs can be accomplished within a single shift, which is operationally understandable and manageable for the entire crew. Alongside maintainability research, a novel quantitative method has been established to examine the composition of downtimes based on primary categories of action: pre-repair actions, repair actions, and post-repair actions. Analysis of 25 mechanical and 25 electrical failures revealed that repair duration was almost 50% of the overall downtime. The residual time was allocated to multiple tasks, including vehicle arrival, delays, requisite preparations, diagnostics, and performance testing and validation. Approximately 30% of the overall downtime stemmed from the duration needed for transportation from the repair facility to the machine and operational delays. The findings established a foundation for recommending a viable approach to enhance the maintenance and repair conditions of the Shovel fleet at the copper mine under consideration.

Keywords Shovel, Repair action, Availability, Maintenance

Nowadays, in the complex global minerals industries market, due to high competition and dynamic supply-demand trends, it is crucial for the companies' directors to strategically plan and efficiently implement their resources through lean processes to get higher business values. Even though the mineral reserve is the most valuable resource of a mining company, a large fleet of capital-intensive machinery is known as the most valuable asset of a mining company. Thus, maintenance plays a crucial role across the mines as it directly impacts the machinery performance, fleet operational capacity, and mine productivity[1–3].

As the most important machine in the mine operation chain, shovels directly affect the mine production rate and machinery fleet productivity. Therefore, boosting the shovel availability in a cost-effective way under an optimized maintenance program could assure its performance along with the whole ore delivery to the mine crusher.

Availability in heavy machinery can be attributed to two key factors: reliability and maintainability. Reliability refers to various machine components' design and material choices that lead to equipment durability. At the same time, maintainability is associated with repairing and maintaining infrastructure, involving numerous factors such as personnel capabilities, technology, tools, and more[4–6].

One effective method for optimizing availability is analyzing repair processes and identifying bottlenecks in maintenance and repair procedures to minimize maintenance lead time[7,8]. In this article, a case study was conducted on several shovels in a large copper mine (Sarcheshmeh Copper Mine in Iran) to analyze the primary components of maintenance time based on a series of unit activities, to present the findings for potential improvements in the mine's overall availability and efficiency. The primary objective of this paper is to assess the maintainability of the Shovel fleet in the Sarcheshmeh copper mine and provide recommendations for its enhancement. The findings of this research will contribute to the development of more efficient maintenance

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