Improving haul truck availability by braking system failure prediction using advanced data analytics

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The aim of this article is to introduce a haul truck availability improvement multi-objective computer model developed by using artificial intelligence methods (AIMs) to complete predictive analytics for haul trucks' braking system.

This model will be developed as an online service or a software package, working with existing data collection and analysis systems to predict serious and catastrophic failures in haul trucks' braking systems. This model makes a priority list for future maintenance activities to reduce unscheduled mishaps, avoid catastrophic failures and provide a platform for ongoing proactive maintenance. All recommendations created by the model will be filtered and sent to operators, supervisors and mine managers for making better decisions (Figure 1).

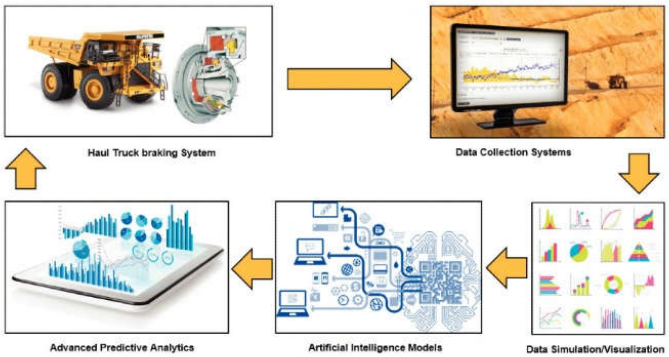

Figure 1. Developed multi-objective computer model using artificial intelligence methods to complete predictive analytics for haul truck's braking system

Haul trucks move the main part of mine materials in open-cut mines. One of the most important components of trucks is the braking system. This system plays a primary role in a haul truck's availability and, as a result, mine productivity. Moreover, between 30 and 40 per cent of total open-cut mines' costs are on scheduled and unscheduled maintenance annually. Based on the collected data from some big open-cut mines in the United States and Australia, the main part of maintenance costs is just for haul truck repair. Furthermore, one of the effective means of increasing safety in open-cut mines is improving haul truck activities in the fleet.

There are different data collection systems installed in haul trucks that are connected to a control room to monitor a truck's components performance. These developed systems transfer a million bytes of data in just a couple of seconds. All developed analytic computer models prepare different types of online and offline graphs, tables and reports for operators, supervisors and managers. These reports do not assist a person on site, as the information that shows the problem is unintelligible unless you are a machine expert. The reports do not provide recommended actions, so even if you are an expert, you still have more work to do. It is for these reasons that the main part of reporting from developed software packages is ignored, and we still see the premature failures in open-cut mines. Many actual alarms are not resolved in a timely way, leading to equipment damage and potential health, safety and environment (HSE) risks. Drivers and supervisors are

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inundated with alarms, many of which are spurious.

The developed computer model has been validated in two surface mines in the United States and Australia. The first mine is a copper mine located in Arizona, and represents one of the largest copper reserves in both the United States and the world, having estimated reserves of 3.2 billion tonnes of ore grading 0.16 per cent copper. The second mine is a coal mine located in Queensland, Australia. The mine has coal reserves amounting to 900 million tonnes of coking coal, and is one of the largest coal reserves in Asia and the world. It has an annual production capacity of 13 million tonnes of coal. Some results of using the developed model in two of the abovementioned mines are illustrated in Figure 2.

The achieved results show that the haul-truck availability has been improved by about 14 per cent in Mine 1 (copper mine, Arizona, United States) and 17 per cent in Mine 2 (coal mine, Queensland, Australia). Modelling and validation have been completed based on the real mine-site data sets collected for CAT 793D in both mines.

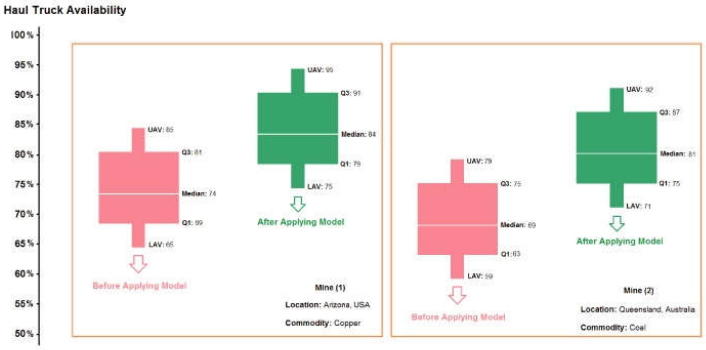

Figure 2. Haul truck availability improvement by using the developed model

- **UAV: Upper Adjacent Value**
- **Q3: Upper Quartile (75th Percentile)**
- **Q1: Lower Quartile (25th Percentile)**
- **LAV: Lower Adjacent Value**

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