Proceedings of the 9th World Congress on Mechanical, Chemical, and Material Engineering (MCM'23)
Brunel University, London, United Kingdom - August 06-08, 2023
Paper No. MMME 116
DOI: 10.11159/mmme23.116

Risk Estimation of In-Pit Crushing System at the Operational Copper Mine in Kazakhstan

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Extended Abstract

Due to the existing complicated features and huge scale of operations in open-pit mining, use of the in-pit crushing and conveying (IPCC) system is more promising compared to the truck and shovel system [6]. Mine depth or scale expansion leads to an increase in the conveyance distance, hence, the performance of trucks rapidly reduces as haulage distance increases [6]. The studied copper mine has ambitions to switch from a conventional truck and shovel system to the IPCC system and at the first stage implemented the in-pit crushing (IPC) system. However, several risks associated with truck dumping delays and therefore the IPC productivity loss have been identified. The aim of this study is to produce risk estimation of the IPC system installed at the operational copper mine in Kazakhstan.

As a part of the risk estimation process, stochastic dynamic modelling methodology to examine how the IPC system will behave in the presence of ambiguous causes of delays to predict the system productivity over time has been used. The model analyses all data for the real case from which a best case scenario has been proposed. For the model input parameters, the time-tracking study of the in-pit crusher productivity and trucks haulage and dumping cycle has been produced. The time between truck arrivals, the dump time per truck, the spot time per truck, the tons per truck, the bin limit for full dumping, and the crushing rate were taken as basic input parameters. For simulation, a Poisson distribution is used for the time between arrivals, a Triangle distribution - for the dump time per truck, the spot time per truck and the crushing rate, and a PERT distribution - for the tons per truck. Only the bin limit for full dumping is assumed as a fixed value for this stage of simulation. By incorporating the dependencies between the variables into the Monte Carlo simulation, the probability of the values was evaluated using stochastic variables.

As a result for the real case, tons dumped per hour varied from 1740 to 1975, number of truck arrivals per hour ranged from 30 to 32, number truck dumped per hour ranged from 14 to 16, delay time per truck at the crusher varied between 52 and 69 minutes. The best case scenario uses the quickest the dump time per truck and the spot time per truck. Thus the best case has 3475 to 3600 tons dumped per hour, 30 to 32 trucks arriving per hour, and 28 to 29 trucks dumped per hour with the delay time per truck at the crusher 2.4 and 5.5 minutes. The best case has twice higher tone dumper per hour and 10 times shorter delays.

The developed model considered queuing issues at the in-pit crusher and can be used to analyse the impact of changing the bin size by changing the limits for full dumping and the crushing rate. The model is able to forecast the IPC system's future states and calculate the probability of various outcomes.

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