An Integrated Mathematical Model to Optimize Truck Assignment and Dispatching in Open Pit Mines

Ramin Saebinia[1], Amin Mousavi[*1], Ahmadreza Sayadi[1]
1- Department of Mining Engineering, Tarbiat Modares University, Tehran, Iran

* Corresponding author: a_mousavi@modares.ac.ir
(Received: October 2020, Accepted: December 2021)

Keywords

Mathematical Modeling
Linear Programming
Flow Shop
Open-Pit Hauling System
CPLEX

Engkish Extended Abstract

Summary

Since a significant part of mine operating cost belongs to hauling operations, optimizing the allocation and scheduling of trucks in a dynamic system is essential and significantly affects production efficiency. So far, different models and methods have been proposed for optimizing haulage scheduling. In this paper, scheduling models have been reviewed, and a flow-shop model has been developed to optimize truck dispatching systems in open-pit mines. The proposed model has been implemented on a small-scale example, driven by a real-world case study, and results have been discussed. Numerical investigation demonstrates that this model is a powerful tool for optimizing truck scheduling and can result in an enhancement in the productivity of mining operations. The most crucial challenge that must be addressed in future work is the development of fast solution techniques to solve real-scale instances of the developed model.

Introduction

The hauling operation is responsible for a significant portion of the operating cost in an open pit mine operation. Therefore, as the main hauling machine, trucks' optimum scheduling is crucial and can dramatically affect mine production productivity. Conventionally, assignment and dispatching of the trucks are defined as two main optimization problems in scheduling hauling operations. Simulation and stepwise mathematical programming have been proposed in the literature to solve these two problems. However, a dynamic and integrated optimization model is required to optimize hauling operations of the state-of-the-art revolution in data collection systems, computational capacity, and the necessity of real-time decision-making. Therefore, this study aims to develop an integrated and single-stage optimization model to optimize truck scheduling problems.

Methodology and Approaches

In this study, the truck dispatching problem has been discussed, and a flow-shop scheduling model has been suggested as the best model to be considered for modeling open-pit hauling operations. In a flow shop problem, a set of jobs flow through several stages in the same machine order. The proposed flow shop model has been evaluated using an example from real case study data.

Results and Conclusions

The results show that job scheduling models for truck optimization can optimize haulage scheduling and truck dispatching in open-pit mines. Using the developed flow shop model, it is possible to incorporate different mining KPI’s such as production time, production productivity, and fuel consumption. This model can also provide a prototype tool for real-time scheduling. Future work is on track to develop fast and reliable metaheuristic solution techniques for this problem's large-scale instances.