



Fuzzy Multi-objective Approach to Formulate Operation Plan in Decorative Rock Mines: Chaypareh Marble Mine Case Study

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Abstract

Exploitation of decorative rock mines are expeditiously rising due to various advantages such as being cost-effective, nimble and simple processing, easy transportation, and satisfactory consuming market. As a thriving industry, mining operations are necessary to be planned systematically in terms of engineering and optimization approaches so that maximum profit is acquired through minimum utilization of resources. By applying the multi-objective linear programming model to the operations in Chaypareh-Khoy marble mine, this study provides optimized solutions for reducing energy and manpower cost while increasing profit. The model also features a fuzzy constraint to formulate the nondeterministic nature of available subsidized fuel. The developed approach results in a comprehensive operation and exploitation plan, which determines the optimum amount of extraction regarding different products, working shifts, fuel consumption amount, and the maximum earned profit. Finally, sensitivity analysis is done to investigate the effect of different objective functions on the model.

Keywords: Operation planning, Linear programming, Multi-objective decision making, Fuzzy approach, Mining.

1. INTRODUCTION

In recent years, the inflow of private and public investments to mining sector has risen due to several factors, including: economic sanctions against Iran especially in the petroleum industry, increase in the exchange rate, avoiding single product economic, major economic investments and tendency towards not depending on the petroleum industry, mineral potentials, various and abundant national mine reserves, and development of technology level which leads to simplicity and productivity of mining activities. Today, one of the most important and efficient mines is believed to be the building stone and façade. These type of mines has significantly developed considering their relative benefits, such as low investment level, nimble and simple processing, easy transportation, and proper domestic and global consuming markets.

Moreover, decorative stones of various forms and features are widely accepted and adopted as production targets. Indeed, by appropriate exploiting and processing of these reserves and resources, numerous job opportunities and significant foreign exchange earnings through exports would be provided in the society [1]. In this field, Iran is considered as one of the pioneering producers. Besides, considering issues such as stone type and color variability, there exists a better situation in Iran respect to the competing countries such as Turkey, Italy, Greece, China, Portugal, Brazil and Spain [2].

Additionally, it is noteworthy to mention that according to the utilized equipment and mining machinery like bulldozer, loader, compressor, mechanical shovel, generator and others, fuel consumption is generally considerable in the related mine sites. For this reason, analysis and planning approaches that result in cost-effective fuel consumption and optimized machinery/personnel deployment would remarkably decrease the processing costs. Besides, such approaches are able not only to prevent the waste of resources, but also to reduce the environmental destruction [3]. Hence, the feasibility of this type of studies are absolutely clear.

2. BACKGROUND AND MOTIVATION

At the time according to the regulations, mines are classified into three groups: class i (limestone, plaster, building stones and so on), class ii (iron, copper, zinc and other metals) and class iii (hydrocarbons including