

Cut-Off Grade Determination of Iron Ore Mines Considering Sustainable Development Costs

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ABSTRACT

Cutoff grade is one of the most important factors in production mine planning and design of open pit mines. Considering the indicators of sustainable development in the calculation of Cutoff grade leads to the sustainable design of the mine and is the biggest opportunity to reduce the adverse effects of mining activities. Until recently, only economic indicators were considered in the calculation of the cutoff grade. In recent studies, environmental indicators have also been implicated, but research that considers social factors has not been reported. Therefore, in the present study, a new model has been developed to calculate the cutoff grade, which includes all three criteria of sustainable development. To carry out the study, the costs related to sustainable development were entered into the break-even cutoff grade formula and the proposed model was validated with the information related to Choghart Iron Ore Mine. The results show that the sustained development costs included in the estimation of the Choghart Iron Ore Mine account for only 5% of the total costs, and the results of the sensitivity analysis show that these costs have the least impact on the determination of cutoff grade. The findings also show that the impact of sustainable development costs in Choghart Mine has increased the percentage of the cutoff grade by 5.5% and may not have much effect on the results. Therefore, the results of the implementation of the proposed model in this research show that by using this method, a big change has not been achieved in the percentage of the cutoff grade. Also, some of the environmental and social problems of the project, taking into account the sustainable development costs, and spending the lowest percentage of the cost will be decreased.

KEYWORDS

Cutoff Grade, Sustainable Development, Environment, Social, Choghart Iron Ore Mine

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1. Introduction

Cutoff grade is one of the most important factors in production mine planning and design of open pit mines. Different definitions for cutoff grade have been presented over the years, but these definitions have not changed so much, and finally, all these definitions have sought to provide a boundary to separate or distinguish ore and waste. Considering the indicators of sustainable development in the calculation of cutoff grade leads to the sustainable design of the mine and is the biggest opportunity to reduce the adverse effects of mining activities [1]. Until recently, only economic indicators were considered in the calculation of the cutoff grade. In recent studies, environmental indicators have also been implicated, but research that considers social factors has not been reported. Therefore, in the current research, a new model has been developed to calculate the cutoff grade, which includes the social criterion in addition to the economic and environmental criteria of sustainable development.

2. Methodology

In this study, by influencing the costs and incomes of sustainable development, a new model is provided to calculate cutoff grade. In order to include the environmental and social effects in the selection of the cutoff grade, it is necessary to present the social and environmental advantages and disadvantages in the form of an economic model. In this regard, the costs and revenues from the activities related to reducing the negative environmental and social effects of mines should be added as the costs and revenues of sustainable development to the mining cutoff grade models. In the following, the expected costs and incomes are given.

Environmental aspect including:

- Cost and income from mine restoration/rehabilitation
- Cost and income from the recovery of waste
- The cost of reducing air pollution
- The cost of reducing water pollution

Social aspect including:

- The cost of training the mine's personnel, their families and local people

The new model presented in this article is created by adding these costs and incomes to the base model/economic model.

3. Results and Discussion

The model proposed in this research was implemented in Choghart Iron Ore mine. The cutoff grade in this mine was first calculated using the base

model/economic model. In the second step, the cutoff grade was calculated with the impact of sustainable development costs and incomes. The findings indicate that the cutoff grade increases by 5.5% compared to the cutoff grade without sustainable development criteria, which reduces the extraction amount/production. The shrinking of the minable reserve means a shorter life of the mine and a decrease in its economic desirability. However, this reduction is only achieved as a result of the 5.5% increase in the cutoff grade compared to the previous model, and it may not have much effect on the results. The results also show that the sustained development costs included in the estimation of the Choghart Iron Ore Mine account for only 5% of the total costs (Fig. 1), and the results of the sensitivity analysis show that these costs have the least impact on the determination of cutoff grade.

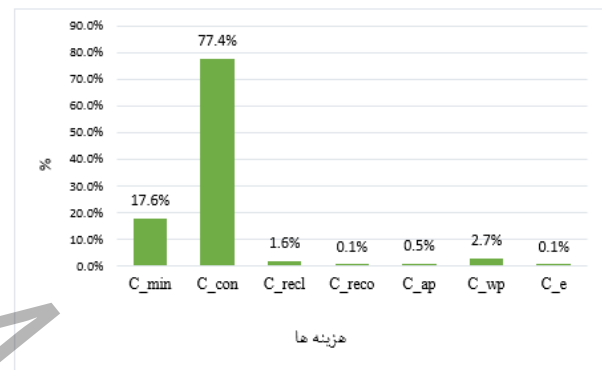


Figure 1. The share of sustainable development costs and other costs in the cutoff grade amount of Choghart mine

4. Conclusion

Determining the optimal cutoff grade in open pit mines is complex and has a significant impact on the profitability of a project, the amount of produced waste and the ultimate pit limit. Mine design should be based on sustainable development principles, so mine design without considering sustainable development criteria will be an incorrect design. Cutoff grade is one of the most important factors in production mine planning and design of open pit mines. Considering the indicators of sustainable development in the calculation of Cutoff grade leads to the sustainable design of the mine and is the biggest opportunity to reduce the adverse effects of mining activities. Therefore, in this study, by adding the costs and incomes of sustainable development to the base model/economic model, a new model is proposed and provided to calculate the cutoff grade. Then, this new model implemented in Choghart Iron Ore mine. The results show that the sustained development costs included in the estimation of the Choghart Iron Ore

Mine account for only 5% of the total costs, and the results of the sensitivity analysis show that these costs have the least impact on the determination of cutoff grade. The findings also show that the impact of sustainable development costs in Choghart Mine has increased the percentage of the cutoff grade by 5.5% and may not have much effect on the results.

5. References

[1] P.M. James, The miner and sustainable development, Mining Engineering, 51 (1999).

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