A systematic review of cut-off grade optimisation approaches illustrating benefits and limitations of their application in the mining industry

J Githiria[1], *C Musingwini*[2] *and B Mutandwa*[3]

1. Senior Lecturer, School of Mining Engineering, University of the Witwatersrand, Johannesburg 2050, South Africa. Email: joseph.githiria@wits.ac.za (presenting/corresponding author)
2. Professor, School of Mining Engineering, University of the Witwatersrand, Johannesburg 2050, South Africa. Email: cuthbert.musingwini@wits.ac.za
3. Lecturer, School of Mining Engineering, University of the Witwatersrand, Johannesburg 2050, South Africa. Email: bright.mutandwa@wits.ac.za

Keywords: cut-off grade (COG); net present value (NPV); mine planning; bibliometric analysis; R-Biblioshiny™ software; VOSviewer™ software.

ABSTRACT

Cut-off grade (COG) is a criterion used to distinguish ore from waste material in a mining operation. It directly affects cash flows generated by the operation and consequently, the economic value of the operation which is generally measured using the net present value. Lane's COG approach developed in the 1960s is considered pioneering work for determining optimal COGs and has been applied widely in the mining industry. However, Lane's approach does not account for factors such as commodity price volatility, variable operating costs associated with mining operations and grade uncertainty that are encountered in actual mining practice. This is why research on COG optimisation continues to try and develop approaches that can holistically incorporate all factors affecting COG for realistic application in mining operations. This paper traces modifications to COG optimisation theory since the 1960s obtained from studies that have applied either exact or metaheuristic approaches along the mine value chain and reveals that there has been growth in the adoption of metaheuristic approaches in COG optimisation. This paper also illustrates the benefits and limitations of using these approaches in determining optimal COGs. Relevant articles related to COG optimisation were extracted from the Scopus and Web of Science as primary databases since these databases provide extensive and authoritative coverage of academic research. The articles from both databases were first merged into an Excel data file and duplicates removed before undertaking bibliometric analysis using R-Biblioshiny™ software and then using VOSViewer™ software to visualise the results. The results suggest that the future research directions on COG optimisation should focus on metaheuristic approaches to foster improved adoption by the mining industry.