Towards Responsible Mining: ESG-Integrated Multi-Objective Optimisation in Sublevel Stoping Production Scheduling

 Wali Ullah1, Micah Nehring2, Mehmet Kizil3, Peter Knights4

1. PhD student, School of Mechanical and Mining Engineering, The University of Queensland, St Lucia, QLD 4072, Australia. Email: g.ullah@student.uq.edu.au

2. Lecturer, School of Mechanical and Mining Engineering, The University of Queensland, St Lucia, QLD 4072, Australia. Email: m.nehring@uq.edu.au

3. Associate Professor, School of Mechanical and Mining Engineering, The University of Queensland, St Lucia, QLD 4072, Australia. Email: m.kizil@uq.edu.au

4. Professor, School of Mechanical and Mining Engineering, The University of Queensland, St Lucia, QLD 4072, Australia. Email: p.knights@uq.edu.au

Keywords: Multi-objective optimisation; ESG; Production scheduling; Sublevel stoping

# ABSTRACT

This conference presentation introduces a comprehensive multi-objective optimisation model developed to improve production scheduling in sublevel stoping mining operations by incorporating Environmental, Social, and Governance (ESG) considerations. The model addresses three important objectives: maximising Net Present Value (NPV) to ensure economic feasibility, minimising carbon emissions to align with environmental sustainability goals, and minimising ground vibration levels to enhance worker safety and reduce impacts on nearby communities. Using the Non-dominated Sorting Genetic Algorithm II (NSGA-II), this study demonstrates an efficient approach to managing the inherent trade-offs among these objectives, facilitating a balanced outcome that aligns with modern sustainable mining practices.

A case study of a sublevel stoping mine is utilised to validate the model's effectiveness and practical applicability. This case study highlights how the proposed optimisation framework enables decision-makers to visualise a Pareto front representing various optimal solutions, from which a compromise solution can be selected based on specific priorities. This multi-objective approach allows for more informed decision-making that is consistent with responsible mining principles by reflecting the trade-offs between economic and environmental impacts, as well as social risks.

The findings highlight the potential of ESG-driven optimisation in mining, offering a structured and practical means to harmonise financial, environmental, and social objectives. By providing a comprehensive framework for integrating ESG considerations into production scheduling, this model advances the field of sustainable mining, contributing to the sector’s ability to achieve ethical and sustainable outcomes. The proposed model represents a step forward in achieving sustainable and ethical outcomes in underground mining practices and sets a foundation for future advancements in ESG-aligned optimisation models.