

ABSTRAK

PENJADWALAN KEMAJUAN LUBANG BUKAAN MENGUNAKAN *CONSTRAINT PROGRAMMING* DI TAMBANG BAWAH TANAH

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PT Aneka Tambang Tbk UBPE Pongkor mengoperasikan tambang bawah tanah emas di Ciurug dengan metode *overhand cut and fill*. Pada triwulan pertama 2025, sasaran kemajuan tunnel 38,4 m/bulan tidak tercapai akibat penggunaan peralatan mekanis yang tidak optimal dan ketiadaan penjadwalan jangka pendek terperinci, sehingga diperlukan pendekatan optimasi untuk mencapai sasaran kemajuan akses 115 m pada triwulan kedua 2025 di Blok 4 *Central* (B4C), *Ramp Down A Selatan* (RDAS), *Raise Manual 8* (RM8), dan *Ramp Up RC 6 Central* (RURC6C).

Penelitian ini menggunakan pendekatan kuantitatif dengan studi literatur, observasi lapangan pada Februari-Maret 2025 untuk data siklus kerja, dan pemodelan *constraint programming* (CP) menggunakan Google OR-Tools CP-SAT solver guna mengoptimalkan alokasi dua unit *Jackleg Drill* YT29A dan dua unit *Wheel Loader* XCMG LW300KN, dengan rancangan 3D menggunakan Micromine *Origin and Beyond* berdasarkan dimensi 4,5 x 4,5 m untuk *tunnel* dan 3,5 x 2,5 m untuk *raise*.

Hasil penelitian menunjukkan efisiensi alat bor 75,18% dan muat-angkut 68,18%, dengan kebutuhan dua unit alat masing-masing mencapai kemajuan 49,86 m/bulan. Penjadwalan CP menghasilkan kemajuan total 167,552 m (143,175 m *tunnel*, 24,377 m *raise*), dengan distribusi: April (RDAS 12,450 m, B4C 24,900 m, CRM7-8 8,300 m, RM8 12,830 m, RURC6C 0 m), Mei (B4C 12,865 m, RDAS 25,730 m, RURC6C 9,130 m, RM8 11,547 m), dan Juni (RDAS 24,900 m, RURC6C 24,900 m). CP efektif mengoptimalkan penjadwalan dengan prioritas B4C, CRM7-8, RM8, RDAS, dan RURC6C.

Kata kunci: *Constraint Programming*, Kemajuan Konstruksi, Penjadwalan Tambang, Tambang Bawah Tanah, Tambang Emas.

ABSTRACT

SCHEDULING OF DEVELOPMENT ADVANCEMENT USING CONSTRAINT PROGRAMMING IN UNDERGROUND MINING

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PT Aneka Tambang Tbk UBPE Pongkor operates an underground gold mine at Ciurug with the overhand cut and fill method. In the first quarter of 2025, the tunnel advancement target of 38.4 m/month was not achieved due to suboptimal use of mechanical equipment and the absence of detailed short-term scheduling, necessitating an optimization approach to meet the 115 m access advancement target for the second quarter of 2025 at Blok 4 Central (B4C), Ramp Down A Selatan (RDAS), Raise Manual 8 (RM8), and Ramp Up RC 6 Central (RURC6C).

This research employs a quantitative approach, including literature studies, field observations in February-March 2025 to collect cycle time data, and constraint programming (CP) modeling using Google OR-Tools CP-SAT solver to optimize the allocation of two units of Jackleg Drill YT29A and two units of Wheel Loader XCMG LW300KN. The 3D design was developed using Micromine Origin and Beyond, based on dimensions of 4.5 x 4.5 m for tunnels and 3.5 x 2.5 m for raises.

The study yielded an efficiency of 75.18% for drilling equipment and 68.18% for loading-hauling equipment, with a requirement of two units each to achieve an advancement rate of 49.86 m/month. CP scheduling resulted in a total advancement of 167,552 m (143,175 m tunnel, 24,377 m raise), distributed as follows: April (RDAS 12,450 m, B4C 24,900 m, CRM7-8 8,300 m, RM8 12,830 m, RURC6C 0 m), May (B4C 12,865 m, RDAS 25,730 m, RURC6C 9,130 m, RM8 11,547 m), and June (RDAS 24,900 m, RURC6C 24,900 m). CP effectively optimized scheduling with priorities assigned to B4C, CRM7-8, RM8, RDAS, and RURC6C.

Keywords: Constraint Programming, Gold Mining, Tunnel Advancement, Underground Mining, Scheduling.