

ABSTRAK

ANALISIS PROBABILISTIK UNTUK OPTIMASI KOMBINASI ALAT MUAT DAN ANGKUT MENGGUNAKAN SIMULASI MONTE CARLO

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PT Graha Prima Energy merupakan perusahaan kontraktor pertambangan yang menghadapi ketidakpastian operasional berupa fluktuasi *cycle time*, *delay time*, dan kondisi cuaca sehingga produktivitas aktual sulit mencapai target produksi. Penelitian ini bertujuan menganalisis distribusi probabilitas *cycle time* alat muat dan alat angkut serta menentukan *fleet requirement* dan nilai *Match Factor* yang optimal menggunakan metode kuantitatif berbasis simulasi Monte Carlo. Hasil penelitian menunjukkan bahwa reduksi hambatan *cycle time* dan peningkatan efisiensi kerja dari 60–70% menjadi 80% mampu meningkatkan produktivitas alat secara signifikan. Evaluasi *Match Factor* menunjukkan perlunya penyesuaian jumlah alat angkut dari 8 unit menjadi 7 unit sehingga diperoleh nilai *Match Factor* optimal pada rentang 0,85–1,15. Hasil simulasi Monte Carlo menunjukkan produktivitas *excavator fleet* 1225 memiliki nilai P10 sebesar 470,53 BCM/jam, P50 sebesar 609,74 BCM/jam, dan P90 sebesar 771,49 BCM/jam, sedangkan *fleet* 1226 memiliki nilai P10 sebesar 617,33 BCM/jam, P50 sebesar 744,94 BCM/jam, dan P90 sebesar 894,52 BCM/jam. Untuk alat angkut HD465 *fleet* 1225 diperoleh nilai P10 sebesar 58,61 BCM/jam, P50 sebesar 64,19 BCM/jam, dan P90 sebesar 68,82 BCM/jam, sedangkan HD465 *fleet* 1226 memiliki nilai P10 sebesar 56,33 BCM/jam, P50 sebesar 61,72 BCM/jam, dan P90 sebesar 67,17 BCM/jam. Dengan demikian, pendekatan probabilistik melalui simulasi Monte Carlo efektif digunakan untuk meningkatkan produktivitas dan keserasian kerja alat muat dan alat angkut pada kegiatan penambangan.

Kata kunci: Distribusi, *Match Factor*, Probabilistik, Produktivitas, Simulasi Monte Carlo

ABSTRACT

PROBABILISTIC ANALYSIS FOR THE OPTIMIZATION OF THE COMBINATION OF LOADING AND HAULING EQUIPMENT USING MONTE CARLO SIMULATION

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PT Graha Prima Energy is a mining contractor facing operational uncertainties in the form of fluctuations in cycle time, delay time, and weather conditions, making it difficult to achieve production targets. This study aims to analyze the probability distribution of cycle times for loading and transport equipment and to determine the optimal fleet requirements and Match Factor values using a quantitative method based on Monte Carlo simulation. The results show that reducing cycle time bottlenecks and increasing work efficiency from 60–70% to 80% can significantly boost equipment productivity. The Match Factor evaluation indicates the need to adjust the number of haulage vehicles from 8 units to 7 units to achieve an optimal Match Factor value within the range of 0.85–1.15. Monte Carlo simulation results show that the productivity of excavator fleet 1225 has a P10 value of 470.53 BCM/hour, a P50 value of 609.74 BCM/hour, and a P90 value of 771.49 BCM/hour, while fleet 1226 has a P10 value of 617.33 BCM/hour, a P50 value of 744.94 BCM/hour, and a P90 value of 894.52 BCM/hour. For the HD465 fleet 1225, the P10 value was 58.61 BCM/hour, the P50 value was 64.19 BCM/hour, and the P90 value was 68.82 BCM/hour, while the HD465 fleet 1226 had a P10 value of 56.33 BCM/hour, a P50 value of 61.72 BCM/hour, and a P90 value of 67.17 BCM/hour. Thus, the probabilistic approach using Monte Carlo simulation is effective for improving the productivity and coordination of loading and haulage equipment in mining operations.

Keywords: Distribution, Match Factor, Monte Carlo Simulation, Probabilistic, Productivity