INTISARI

Penelitian ini mengkaji masalah penjadwalan mesin paralel non-identik multiobjektif yang dikenal sebagai *multiojbetive non-identical parallel machine scheduling problem* (MO-NIPMSP) dengan fungsi tujuan meminimalkan *makespan*, total emisi karbon, dan total keterlambatan secara simultan. Meskipun penelitian tentang penjadwalan produksi sudah banyak dilakukan, masih sedikit studi yang mengintegrasikan ketiga tujuan penting ini secara simultan pada kasus ini.

Untuk mengatasi masalah kompleks ini, peneliti mengembangkan model matematika dan mengusulkan pendekatan metaheuristik baru yang dinamakan *Multi-Objective Adaptive Large Neighborhood Search* (MOALNS). MOALNS secara dinamis menyesuaikan strategi pencariannya untuk mengeksplorasi dan mengeksploitasi ruang solusi dengan efektif. Guna memaksimalkan fungsi eksplorasi dan eksploitasi, beberapa mekanisme adaptif telah dikembangkan pada penelitian ini meliputi ragam jenis operator *destroy* dan *repair*, perubahan bobot operator, dan *metropolis criterion*. Kinerja algoritma ini dibandingkan dengan algoritma pembanding yaitu *Non-dominated Sorting Genetic Algorithm* II (NSGA-II) yang kemudian dilakukan evaluasi *comparison performance metrics* mengguanakan *Spacing Metric* (SM) *Diversification Metric* (DM) *Inverted Generational Distance* (IGD), *Hypervolume Metric*, dan CPU Time.

Hasil penelitian menunjukkan bahwa MOALNS mengungguli metode yang ada dalam hal cakupan dan variasi solusi, serta menawarkan kemajuan signifikan dalam penjadwalan produksi yang berkelanjutan dalam ranah *multi-objective* untuk penelitian-penelitian selanjutnya.

Kata kunci: *Multiobjective Non-Identical Parallem Machine Scheduling Problem* (MONIPMSP), *makespan*, emisi karbon, *tardiness*, *Multiobjective Adaptive Large Neighborhood Search* (MOALNS)

ABSTRACT

This research examines the multi-objective non-identical parallel machine scheduling problem (MO-NIPMSP) with the objectives of minimizing makespan, total carbon emissions, and total tardiness simultaneously. Despite extensive research on production scheduling, few studies have integrated these three critical objectives simultaneously in this context.

To address this complex problem, the researchers developed a mathematical model and proposed a new metaheuristic approach called Multi-Objective Adaptive Large Neighborhood Search (MOALNS). MOALNS dynamically adjusts its search strategies to explore and exploit the solution space effectively. To maximize the exploration and exploitation functions, several adaptive mechanisms have been developed in this study, including various types of destroy and repair operators, operator weight adjustments, and the metropolis criterion. The performance of this algorithm was compared with a benchmark algorithm, the Non-dominated Sorting Genetic Algorithm II (NSGA-II), and evaluated using comparison performance metrics such as Spacing Metric (SM), Diversification Metric (DM), Inverted Generational Distance (IGD), Hypervolume Metric, and CPU Time.

The results indicate that MOALNS outperforms existing methods in terms of solution coverage and diversity, while offering significant advancements in sustainable production scheduling in the multi-objective domain for future research.

Keywords: *Multiobjective Non-Identical Parallem Machine Scheduling Problem* (MONIPMSP), *makespan*, emisi karbon, *tardiness*, *Multiobjective Adaptive Large Neighborhood Search* (MOALNS)