INTISARI

Optimasi sangat penting dilakukan pada proses distribusi untuk menghasilkan rancangan distribusi yang efektif dan efisien mengingat panjangnya proses rantai pasok dan besarnya proporsi biaya logistik terutama biaya transportasi. Hal tersebut tidak terlepas pada distribusi komoditas beras yang merupakan komoditas bahan pangan utama di Indonesia. Permasalahan distribusi tersebut dapat diselesaikan menggunakan model *Heterogeneous Capacitated Vehicle Routing Problem* (HCVRP). HCVRP merupakan model optimasi dalam permasalahan rute yang menggunakan beberapa jenis kendaraan yang bersifat heterogen dan terbatas dalam segi kapasitas. Terdapat dua tujuan yang bersifat saling *trade-off* yang digunakan, yaitu meminimasi biaya transportasi yang terdiri dari biaya sewa kendaraan dan pajak emisi karbon yang dihasilkan, dan biaya dari *shrinkage cost* akibat kerusakan beras. Penentuan kedua tujuan tersebut mempertimbangkan faktor cuaca dan emisi karbon yang dihasilkan selama proses distribusi. Berdasarkan aspek tersebut, penelitian ini mengimplementasikan model *Multi Objective Heterogeneous Capacitated Vehicle Routing Problem* (MO-HCVRP) dengan mempertimbangkan *shrinkage cost* dan emisi karbon yang dihasilkan. Permasalahan tersebut kemudian diselesaikan menggunakan metode metaheuristik yang dikembangkan, yaitu *Multi Objective Adaptive Large Neighborhood Search* (MOALNS). Untuk mengetahui performa dari metode yang diajukan, hasil set solusi yang dihasilkan kemudian dibandingkan dengan set solusi hasil dari metode *Non-dominated Sorting Genetic Algorithm* II (NSGA-II). Perbandingan performa keduanya didasarkan dari lima indikator yaitu, *Hypervolume, Inverted Generational Distance, Spacing Metric, Diversification metric*, dan CPU-*Time*. Dari perbandingan kelima indikator tersebut, didapatkan bahwa MOALNS yang diajukan unggul dalam dua indikator yaitu *Hypervolume* dan *Inverted Generational Distance*. Hal tersebut menunjukkan MOALNS dapat menghasilkan *Front Pareto* yang lebih baik dalam aspek *convergence* dan kedekatannya terhadap *True Pareto Front*. Sedangkan NSGA-II unggul dalam dua indikator yaitu, *Spacing Metric* dan *Diversification Metric* yang menunjukkan *Front Pareto* yang dihasilkan lebih baik dalam aspek persebaran atau *diversity* dalam *search space.*

Kata kunci: *Heterogeneous Capacitated Vehicle Routing Problem, Multi Objective, Shrinkage Cost, Carbon Emission, Multi Objective Adaptive Large Neighborhood Search* (MOALNS), *Non-dominated Sorting Genetic Algorithm* II (NSGA-II)

ABSTRACT

Optimization is crucial in the distribution process to obtain an effective and efficient distribution plan, given the length of the supply chain and the significant proportion of logistics costs, particularly transportation costs. This is especially relevant for the distribution of rice, which is the main food commodity in Indonesia. The distribution problem can be addressed using the Heterogeneous Capacitated Vehicle Routing Problem (HCVRP) model. HCVRP is an optimization model for routing problems that involve several types of vehicles that are heterogeneous and have limited capacity. There are two trade-off objectives used: minimizing transportation costs, which include vehicle rental cost and carbon tax, and minimizing shrinkage cost due to rice damage. Determining these two objectives takes into account weather factors and the carbon emissions produced during the distribution process. Based on these aspects, this research implements the Multi Objective Heterogeneous Capacitated Vehicle Routing Problem (MO-HCVRP) model, considering shrinkage costs and carbon emissions. This problem is solved using the metaheuristic method developed, namely Multi Objective Adaptive Large Neighborhood Search (MOALNS). To assess the performance of the method used, the resulting set of solutions is compared with those obtained from the Non-dominated Sorting Genetic Algorithm II (NSGA-II) method. The performance comparison between the two methods is based on five indicators: Hypervolume, Inverted Generational Distance, Spacing Metric, Diversification Metric, and CPU-Time. From the evaluation of these five indicators, it is found that MOALNS is superior in two indicators: Hypervolume and Inverted Generational Distance. This indicates that MOALNS can produce a better Pareto Front in terms of convergence and closeness to the True Pareto Front. Meanwhile, NSGA-II is superior in two indicators: Spacing Metric and Diversifications Metric, indicating that the resulting Pareto Front is better in terms of distribution and diversity in the search space.

Kata kunci: *Heterogeneous Capacitated Vehicle Routing Problem, Multi Objective, Shrinkage Cost, Carbon Emission, Multi Objective Adaptive Large Neighborhood Search* (MOALNS), *Non-dominated Sorting Genetic Algorithm* II (NSGA-II)