

ABSTRACT

This study aims to optimize container load factors to maximize profitability and safety. A mathematical model and an Adaptive Large Neighborhood Search (ALNS)-based algorithm are developed to solve the 3D Multi Container Loading Problem (3D MCLP) faced by PT XYZ, a freight forwarding company in Indonesia. The algorithms include Matheuristics (ALNS-Exact Method) and ALNS-Constructive Heuristics. The mathematical model, tested with a randomly generated dataset, demonstrated efficient handling of up to 100 items. However, while the Matheuristics approach was effective for smaller problems, it showed suboptimal solution quality for large-scale problems, particularly those exceeding 1000 items. To address these limitations, the ALNS-Constructive Heuristics algorithm is developed, incorporating strategies such as wall building, layer building, and column building.

The results indicate that the ALNS-Constructive Heuristics algorithm significantly improves container utilization and profitability. Specifically, it achieved a profit increase of up to 25.9%, a utility increase of 33.4%, and a reduction in container usage by 33.4%. The algorithm's performance was validated against real-case scenarios from PT XYZ, demonstrating its practical applicability.

This research makes a significant contribution to logistics optimization and container loading, offering a robust solution for 3D MCLP. The developed algorithms enhance the profitability and operational efficiency of freight forwarding companies and provide valuable insights into the field of logistics optimization.

Keywords: Freight Forwarder, 3D Multi Container Loading Problem (3D MCLP), Matheuristics, ALNS-Constructive Heuristics

INTISARI

Penelitian ini bertujuan untuk mengoptimalkan proses pemuatan kargo ke dalam kontainer guna memaksimalkan profitabilitas dan keamanan. Model matematika dan algoritma berbasis Adaptive Large Neighborhood Search (ALNS) dikembangkan untuk menyelesaikan 3D Multi Container Loading Problem (3D MCLP) yang dihadapi oleh PT XYZ, sebuah Perusahaan Freight Forwarding di Indonesia. Algoritma yang digunakan meliputi Matheuristics (ALNS-Exact Method) dan ALNS-Constructive Heuristics. Model matematika diuji pada dataset yang diterbitkan secara random, dan hasil menunjukkan bahwa problem hanya dapat diselesaikan untuk skala hingga 100 item. Meskipun Matheuristics efektif untuk problem yang lebih kecil, pendekatan ini menunjukkan kualitas solusi yang kurang optimal untuk problem dengan skala item lebih dari 1000. Untuk mengatasi keterbatasan ini, algoritma ALNS-Constructive Heuristics dikembangkan dengan strategi wall building, layer building, dan column building.

Hasil penyelesaian problem 3D MCLP menunjukkan bahwa algoritma ALNS-Constructive Heuristics secara signifikan meningkatkan profitabilitas dan utilitas kontainer. Secara spesifik, algoritma ini mencapai peningkatan profit hingga 45.9%, peningkatan utilitas sebesar 33,4%, dan pengurangan penggunaan peti kemas sebesar 33,4%. Kinerja algoritma telah divalidasi berdasarkan skenario kasus nyata dari PT XYZ, menunjukkan penerapan praktisnya di dunia nyata.

Penelitian ini memberikan kontribusi signifikan terhadap optimalisasi logistik dan pemuatan kontainer, menawarkan solusi tangguh untuk 3D MCLP. Algoritma yang dikembangkan meningkatkan profitabilitas dan efisiensi operasional perusahaan freight forwarder serta memberikan wawasan berharga di bidang optimalisasi logistik.

Kata Kunci: Freight Forwarder, 3D Multi Container Loading Problem (3D MCLP), Matheuristics, ALNS-Constructive Heuristics