ABSTRACT

A 2L-3D-HMCLP FRAMEWORK USING ADAPTIVE LARGE NEIGHBORHOOD SEARCH (ALNS) HEURISTIC WITH DYNAMIC TWO-LEVEL OPTIMIZATION FOR SOLVING SPACE EFFICIENCY IN FIRST-MILE DELIVERY

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The rapid expansion of Indonesia's e-commerce sector has intensified the demand for logistics optimization, particularly in first-mile deliveries from factories to distribution centers. This thesis addresses the Two-Level Three-Dimensional Heterogeneous Multi-Container Loading Problem (2L-3D-HMCLP), focusing minimizing total costs by balancing space efficiency across many and diverse types of carton boxes and containers, while adhering to real-world constraints such as family unity.

This study proposes a novel integrated, two-level Global Optimization framework using Adaptive Large Neighborhood Search (ALNS) and Extreme Point heuristic for geometrical packing. Its performance is then compared against the sequential, one-level Local Optimization approach established by Prietno et al. (2025). The Local framework optimizes item packing into cartons until reaching a fixed optimal arrangement, which cannot be re-optimized later during carton packing into containers. On the contrary, Global Optimization allows both one-level changes (carton rearrangement in containers) and two-level changes (item rearrangement in cartons) at any iteration, and is equipped to dynamically decide the best optimization-level at any iteration. Experimental results indicate that Global method has significantly greater search ability as it found absolute minimum costs in 84% of instances, also mirrored by consistent 40%–80& high Average Rate of Improvement (ARI) across different problem characteristics. Conversely, Local Optimization method demonstrates better execution time ranging less than 2 minutes against complex instances, but is more prone to stuck in smaller search space. Overall, these findings suggest that a multi-level approach is essential for large-scale logistics planning where global cost reduction outweighs near-instantaneous processing.

Keywords : Container Loading Problem, Family Unity, Adaptive Large Neighborhood Search, Two-Level Optimization, Extreme Point Heuristic