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Optimization of the First-Mile Pickup Problem: A Real-Life Case Study

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Extended Abstract

This study presents an optimization model for a logistics company to solve the first-mile pick-up problem. The first-mile pick-up stage is a vital element in the entire supply chain process, as inefficiencies in this phase can lead to significant delays and increased costs throughout the entire delivery network. The first-mile pick-up problem is the problem of collecting parcels from supplier companies to the target points with minimum cost. Determining optimal routes for parcel pickup vehicles is critical to minimize operational costs while meeting all constraints. Efficient routing ensures that resources such as fuel, driver hours, and vehicle capacity are effectively managed, preventing unnecessary delays and additional expenses. In the first-mile pick-up problem, there are constraints such as determining the order of visits to companies, satisfying time windows, having fixed source-target points for routes, not exceeding vehicle capacities, observing maximum distance limits, and visiting each customer point only once. Effectively addressing these constraints is essential to ensure that the model delivers practical and actionable solutions for real-world scenarios. While similar optimization models exist in the literature, none completely matches all aspects of our problem. This limitation highlights the need for a model that comprehensively addresses the unique challenges presented in first-mile logistics. Existing approaches like the Open Vehicle Routing Problem with Time Windows (OVRPTW) [1], Close-Open Vehicle Routing Problem with Time Windows (COVRPTW) [2], Multi-Depot Open Vehicle Routing Problem with Time Windows (MDOVRPTW) [3,4,5,6], and Multi-Depot Multiple Terminal Hamiltonian Path Problem (MDMTHPP) [7,8] each address different subsets of these constraints. Among these, MDOVRPTW emerges as the closest candidate to our problem requirements, however, this model does not include routing for fixed source-target points and maximum distance constraints.

The first-mile pick-up problem is named as the multi-depot open vehicle routing problem with time windows and fixed target points (MDOVRPTW ft) and a mathematical model of the problem is created. The mathematical model of the problem was coded in IBM ILOG CPLEX Optimization Studio and applied to a real-life example. As a real-life example, the location of supplier companies and vehicles connected to a branch depot of a logistics company are considered. A distance matrix was created using the latitude-longitude information of the supplier companies in Open Route Service. This method ensures accurate distance calculations, which are crucial for generating optimal routes that align with real-world conditions. The observed total distance cost according to preferences of the vehicle drivers and the optimal total distance costs obtained from the model are calculated for three consecutive days. By comparing these results, the model's effectiveness in minimizing costs while ensuring practical feasibility is demonstrated. It is concluded that there is an average 49% improvement in the total distance cost for these three days.

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