Models and Methods for the Location-routing Problem in the Two-echelon Transportation Systems

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Abstract: In order to reduce nuisances related to transport activities, responding to current concerns about the economy and the sustainable development, it is important to develop flexible and efficient transportation systems which must be integrated into an overall reflection combining urban planning, transportation and infrastructure.

The two-echelon location-routing problem (LRP-2E) arises from recent transportation application, especially in urban logistics. We have to simultaneously locate satellite depots (platforms) from a set of potential sites and to build vehicle routing at two levels: first-level trips serve from a main depot a set of satellites, while second-level trips visit customers from these satellites. The LRP-2E combines two types of decisions: strategic (location of satellites) and tactical or operational (construction of vehicle routing at each level of the system). The objective function to minimize is the total system cost, which includes the opening cost of the selected satellites, the fixed costs of vehicles mobilized and transportation costs for trips at two levels.

The motivation of our work is to solve this difficult problem still seldom studied in the literature. We propose solution methods, without hierarchy between the two levels, using metaheuristics, but also a branch-and-cut approach based on new mathematical formulations. The developed methods were tested on sets of instances up to 200 customers and 20 potential sites of satellites.

As a result, several instances of small and medium size have been solved optimally. In addition, the lower bounds found by a polyhedral approach can give a small average gap (about 5%) in comparison with upper bounds provided by the proposed metaheuristics.

Keywords: transportation, logistic, vehicle routing, site location, mathematical models, metaheuristic.

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