Mixed integer formulations for the Green Location Routing Problem

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Abstract

In this paper, the design of a two-echelon supply chain is studied combining location and routing decisions taking into account the CO2 emissions generated by the transportation decisions and the number of depots to open. The model aims to minimize the CO2 emissions, which are correlated to the energy consumed by vehicles, assuming it depends on the distance traveled and the load carried by the vehicle on each arc. The following constraints are considered: a single vehicle and a single depot must serve each costumer; each route must begin and end at the same depot; and demand must be fully satisfied without exceeding depot and vehicle capacities. We propose two mathematical formulations based on mixed-integer programming. The first model is inspired by the traditional formulation of the Location-Routing Problem, often presented in the literature, and it was adapted for the new objective function. The second model modifies the definition of the routing variables excluding the index associated to vehicles, and replacing it by an index for depots. A computational study is performed using adapted benchmark instances. Preliminary results show significant differences in the performance of the mathematical models when solving the problem to optimality. On average, the proposed model solved the instances 96.72 % faster than the adapted traditional formulation. Further, an analysis of the impacts of using the proposed objective function is presented. On average, the new objective function may reduce up to 35% the amount of CO2 emissions compared to the solutions considering a cost minimization objective function.

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