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Abstract

This paper aims to support tactical decisions in a recyclable waste collection system design through the definition of service areas in systems with more than one depot. Three types of recyclable materials are to be collected, so the problem under study is the multi-product, multi-depot vehicle routing problem. A mixed-integer linear programming model is formulated considering two alternatives constraints to eliminate subtours (Miller-Tucker-Zemlin and the Subtour Formulations). A heuristic approach to define service areas, based on the concept of borderline nodes, is also described and the solutions obtained are compared with the optimal solutions from the regular branch-and-bound method.

Keywords: Reverse logistics, Vehicle routing problem, MILP formulation, Heuristic

1 Introduction

In the recent years, reverse logistics has become one of the key functions in logistics systems, involving the flow of used products/materials from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal (Rubio et al. 2008).

This work will focus on recyclable waste collection systems design. Considering waste packaging, there are usually three types of materials used in packaging that can be recycled: glass, paper and plastic/metal. The final consumer is responsible to separate these materials and drop them in special containers. Those materials are then collected in a regular basis and taken to a treatment plant by the company responsible for the recyclable waste collection system. The design of such systems involves strategic, tactical and operational decisions. This paper aims to support tactical decisions since it focus on the definition of service areas in collection systems with more than one depot. In addition to the definition of the vehicle routes to collect the waste, it is also necessary to decide from which depot the collection is to be performed. This aspect adds one decision level to the classical Vehicle Routing Problem, where more than one product is to be collected in different routes. The resulted problem is modelled as a multi-product, multi-depot vehicle routing problem. To solve it, two approaches are presented: an exact and a heuristic method. The two methods are described and the results obtained for eight instances are compared. For the exact method, two formulations for the subtour elimination are also presented and compared.

This paper is structured as follows. After a brief review of the literature on multi-depot vehicle routing problem (MDVRP) in Section 2, we characterise generically the mathematical model in Section 3. In Section 4 we describe the heuristic approach developed. In Section 5 the computational results are presented and compared. Finally, we draw conclusions and discuss future work directions.