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HEURISTIC APPROACHES TO VEHICLE ROUTING WITH BACKHAULS AND TIME WINDOWS

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Scope and Purpose—Vehicle routing with backhauling is aimed at constructing routes for delivery trucks that must visit both customers and suppliers. Starting from a central depot, the goods are first delivered to the customers. Then, new goods are collected from the suppliers and brought back to the depot. This collection of goods after the deliveries is called backhauling. Quite often, companies with private truck fleets find that the fleet would not be justified economically if it was used only for deliveries due to excessive deadhauling. Rather, the savings obtained by bringing back goods from suppliers (instead of using a common carrier) can drastically reduce the cost of transportation. In this study, we consider a variant of the problem, where a time window or time interval is found at each customer/supplier location in order to constrain the service time. Namely, the vehicle cannot arrive at a customer/supplier location after its time window. Furthermore, the vehicle must wait if it arrives before the time window. A route construction heuristic and various route improvement heuristics are described for this problem and are shown to produce solutions that are close to the optimum.

Abstract—The vehicle routing problem with backhauls and time windows (VRPBTW) involves the pickup and delivery of goods at different customer locations, with earliest and latest time deadlines, and varying demands. The demands are serviced using capacitated vehicles with limited route time. Moreover, all deliveries (linehauls) must be done before the pickups (backhauls). The objective of the problem is to service all customers while minimizing the number of vehicles and distance traveled. In doing so, the capacity and route time constraints of the vehicles and the time window constraint at each customer should not be violated. In this paper, we describe a route construction heuristic for the VRPBTW, as well as different local search heuristics to improve the initial solutions. The heuristics were tested on 45 problems of size 25, 50 and 100, previously reported in the literature and whose optimum is known in most cases. In addition, the heuristic was tested on 24 newly created problems of size 250 and 500. The solutions produced by the heuristics are within 2.5% of the known optimal solutions on average. Copyright © 1996 Elsevier Science Ltd

1. INTRODUCTION

The vehicle routing problem with backhauls (VRPB) is an extension of the classical vehicle routing problem (VRP). In the VRPB a set of capacitated vehicles are to be routed from a central depot to deliver and pickup goods at different customer locations. Typically, the vehicle is loaded at the depot in order to service the delivery points (linehauls). Then, new goods are collected at the pickup points and brought back to the depot (backhauls). The objective of the problem is to minimize the number of vehicles and/or the total distance to service all customers, without violating the capacity and the maximum route time of each vehicle. Moreover, the backhauls must necessarily be serviced after the linehauls in each route. This additional constraint comes from practical considerations, since it is often inconvenient to rearrange the delivery loads onboard in order to accommodate new pickup loads. When all customers are linehauls (or backhauls), this problem reduces to the classical VRP.

Problem-solving methodologies for the VRPB are mostly derived from previous work done on the VRP. Surveys on classifications and applications of the VRP can be found in [1–4]. For the VRPB, Casco

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