A Review of Vehicle Routing Problem with Simultaneous Pickup and Delivery

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Abstract— This paper presents a review of vehicle routing problem with simultaneous pickup and deliveries (VRPSPD). VRPSPD is a variant of the VRP where both delivery and pickup demands are fulfilled simultaneously. Due to computer accessibility and increased capability in computing, algorithm development has shown major advancements. These were reflected in VRP research also. The need to improve vehicle routing, in turn, stimulates explosive developments in theory and applications of supply chain management. So without any surprise the VRP literature has grown exponentially. It is even more important to regularly assess and evaluate where the field is heading, and what should be done to improve that field’s course. This indicates the need for some form of taxonomical research.

Keywords— Put your keywords here, keywords are separated by comma.

I. INTRODUCTION

Vehicle routing problem (VRP) is a widely studied combinatorial optimisation problem in operations research and computer science. This problem was first introduced by G. Dantzig and J. Ramser (1954), which was about the routing of a fleet of gasoline delivery trucks between a bulk terminal and a number of service stations supplied by the terminal [1]. VRP is a special case of travelling salesman problem where the objective is to provide a minimum distance route thereby minimizing the cost of providing the service.

Fig. (1)

Toth & Vino, 1998 represented VRP as the following graph-theoretic problem. Let G = (V, A) be a complete graph where V = {0, 1, . . . , n} is the vertex set and A is the arc set. Vertices j = 1 . . . n correspond to the customers, each with a known non-negative demand, dj, whereas vertex 0 corresponds to the depot. A non-negative cost, cij, is associated with each arc (i, j)єA and represents the cost of travelling from vertex i to vertex j. If the cost values satisfy cij = cji for all i, jєV, then the problem is said to be a symmetric VRP; otherwise, it is called an asymmetric VRP. In several practical cases the cost matrix satisfies the triangle inequality, such that cik + cjkPcij for any i, j, kєV [2]. Fig.1 shows a typical vehicle route with three vehicles and one depot.

II. LITERATURE REVIEW.

A. Major literatures on vrp

After G. Dantzig and J. Ramser unveiled the VRP problem in 1954, many other VRP literatures were published. Clarke and Wright (1964) first incorporated more than one vehicle in the problem formulation. Consequently, this study may be considered as being first in the VRP literature as we know it [3]. Different variants of VRP were also emerged due to extensive research like VRP with pickup and delivery, VRP with time windows etc. Solomon attempted to solve VRP with time windows in his literature, M. Solomon, “Algorithms for the Vehicle Routing and scheduling problem with time window constraints” (1987) [4]. Min (1989), solved a practical problem faced by a public library, with one depot, two vehicles and 22 customers. This is considered as one of the first attempt to solve Vehicle routing problem with simultaneous pickup and delivery [5].

B. Major literatures on vrpsspdp

An extensive literature survey of the vehicle routing problem is done. Various papers related to VRP problem, different methodologies and solution techniques were investigated. It is found that VRP is a very important combinatorial optimization problem in operation research for its practical application in routing of vehicles. During the last few decades, the importance of reverse logistics has shown a rapid increase due to the environmental and economical issues. Routing of vehicles is one of the most critical issues that affect the performance of the reverse logistics. The importance of reverse logistics increased the importance of Vehicle routing problem with simultaneous pick-up and delivery (VRPSPD). So it is decided to focus on VRPSPD and its related studies.

A general assumption in VRPSPD is that all delivered goods must be originated from the depot, all pickup goods
must be transported back to the depot. Delivery and pickup goods must be met simultaneously when each customer is visited only once by a vehicle and unloading is carried out before loading at the customers (Chen and Wu, 2006) [6]. Vehicle routing with simultaneous pickup and deliveries have practical application in beverage industry, grocery stores etc. The Vehicle Routing Problem with Simultaneous Delivery and Pick-up was introduced in the literature by Min H (1989). His study considered distribution problem of a public library at Ohio with 22 branch libraries and 2 vehicles based on the central library. Vehicles serve branch libraries everyday with deliveries and pick-ups at each branch library. Vehicle routes were determined by a solution approach that based on clustering customers according to their demands and vehicle capacities first, and then solving TSP for each cluster. While determining routes for each cluster, an iterative procedure was used in order to satisfy the feasibility of the route. VRPSPD make this problem more difficult than VRPB to solve [5].

Dethloff (2001) remarked about the relationship between reverse logistics in environmental protection and VRPSPD. In this paper, the relation between this problem and other vehicle routing problems is investigated. A heuristic construction procedure is suggested. The proposed algorithm is successfully applied to a real-life problem as well as test instances introduced in the literature earlier. The heuristic approach does not include an improvement routine [7]. Salhi and Nagy (2005) proposed insertion heuristics, based on the methodology which was proposed by Golden et al in order to solve VRP-SPD. Problems with single and multiple depots were considered. The basic steps of these heuristics are constructing partial routes for a set of customers, and then inserting the remaining customers to the existing route. They introduced the concepts of weak and strong feasibility and their proposed approach allowed infeasibilities to occur while searching towards strong feasibility. In feasibilities to occur while searching towards strong feasibility [8].

Meta-heuristic approaches have been also successfully applied to solve the VRPSPD and VRPMPP. Crispim and Brandao (2005) are the first authors who attempted a meta-heuristic approach for the VRPSPD. The proposed approach was a hybrid algorithm based on tabu search (TS) and variable neighbourhood descent (VND). Initial solutions were obtained by a sweep method. If any route in the initial solution is infeasible because of the overloading of some intermediate arcs, the feasibility is established by exchanging the order of customers on the route. The improvement phase implements insert and swap as moves. Penalties were given to infeasible solutions. [9].

Gajpal and Abad (2009) develop a heuristic approach based on ant colony optimization (ACO). They introduced a two-step heuristics: In the first step the trail intensities and parameters are initialized using an initial solution obtained by means of a nearest neighbourhood constructive heuristic and an ant-solution [10].

References


