A Bi-Objective Vehicle Routing Problem with Time Window by Considering Customer Satisfaction

Masoud Rabbani, School of Industrial Engineering, College of Engineering, University of Tehran, Tehran, Iran
Mahyar Taheri, School of Industrial Engineering, College of Engineering, University of Tehran, Tehran, Iran
Mohammad Ravanbakhsh, School of Industrial Engineering, College of Engineering, University of Tehran, Tehran, Iran

ABSTRACT

The Vehicle Routing Problem (VRP) by considering Time Windows is an essential and a reality optimization problem consisting in the determination of the set of routes with minimum distance to carry goods, by using some vehicles with capacity constraint; vehicles must visit customers within a time frame. In the recent years, many numbers of algorithm have been considered to solve a single objective formulate of VRPTW problem, such as Meta-heuristic, bender’s decomposition, column generation and so on. This paper considers not only the minimum distance and the number of vehicles used to carry goods for customers. The customer satisfaction by considering the priority of the customers is considered which leads to service the customer as soon as possible. In this paper, the MOPSO and NSGAII approaches applied to solve the problem and then the authors compare the results of them; finally, they analysis the sensitivity of the capacity constraint for the vehicles.

KEYWORDS
Customer Satisfaction, Multi Objective Optimization, Priority, Time Window, Vehicle Routing Problem

1. INTRODUCTION

The vehicle routing problem is an integer programming problem that looks forward to service a number of customers with determined vehicles. It has always been represented as a problem that looks for optimum delivery or assortment of some routes from one or several depots to customers, subject to some constraints such as capacity constraint. For comprehensive details, (see, e.g., Laporte, 1992). For the first time, this problem was proposed by Dantzig and Ramser (1959), and has been studied broadly; (see, e.g., Solomon, 1987; Liu and Lai, 2009). The vehicle routing problem with time windows considers the time windows for each customer and sets the servicing of the customer to start and finish in their time windows. In the recent decade, this problem has attracted more and more attention from researchers.

Vehicle routing is an essential activity for firms in the recent decade. For instance, in the United States, transportation cost shares more or less 10% of the gross domestic product (Bowersox and Calantone, 1998). From an economical point of view, improving the routing efficiency is more important than increasing fuel prices. The vehicle routing problem regards the planning of a set of minimum-cost vehicle routes, starting from and finishing in one or more than one depots, by some vehicles with a known capacity that service a set of customers with determined demands. Each customer is serviced by only one vehicle, and all the customers must be allotted to the vehicles without

DOI: 10.4018/IJSDS.2016040102

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exceeding the vehicle capacities. The optimum routing plan of vehicles can have an essential impact on the reduction of the industries and the government costs (Tan et al., 2001). In the VRP problem, the main aim is to minimize the total cost of routes vehicles pass and also service all customers with the minimum number of vehicles used by justifying constraints. Some researchers consider other objective functions such as maximizing the service quality, reducing the total fuel consumption and balancing the route (and also consider some additional feature such as the uncertain customer demand, fuzzy and stochastic travelling times or time windows, multiple depots, heterogeneous fleet types, time dependent routings, customer satisfaction and etc. In the reality, sometimes the customers want to be serviced as soon as possible or the firms need to service the customers as soon as possible for instance in competitive situations. In a competitive situation, the accessing time to the customers changes the amount of sales, and if the vehicle arrives at a time later than its opponent, it will lose a part of its sale. In the VRPTW the vehicle is not permitted to start servicing the customer after the upper bound of the time window and also if the vehicle arrives at customers soon (before the lower bound of the time window) it should wait until the customer opens. The VRP problem with limited capacity vehicles is an NP hard problem (Archetti et al., 2011). In addition, adding time windows constraint, generally, does not reduce the complexity of the problem. Thus, VRPTW problem is an NP-hard problem (Thangiah et al., 1996). In real cases, the company deals with many customers who need to be serviced, and each customer has its own priority for the company, and needs to be serviced as soon as possible.

This paper is organized as follows: In Section 2, we give some literature review of VRPTW and in the section 3; the formulation of the model is described. In Section 4, we present the NSGAII and MOPSO algorithm to solve the proposed problem and the parameter setting for them. The verification of the model and the performance of developed approach are presented in the section 5, and finally; the concluding remarks are provided in section 6.

2. LITERATURE REVIEW

Vehicle routing problems with time windows have been broadly considering by some researchers as during the past several years. In addition, by considering studies of Solomon (1987), current advantages have been made primarily on several heuristic and Meta-heuristic approaches. Zografos and Androustopoulos (2004) has directly associated the VRPTW with transportation of goods by considering priority, they propose a bi-objective model, and a novel risk term is considered for each road segment, and the main aim on the objective function is minimizing the total travel time and the total risk. But, the considering priority for each customer does not act as a “hard” requirement. Therefore, this bi-objective model can be efficiently reduced to the cost of problem by considering the priority for each customer.

Genetic algorithm (GA) is one of a powerful Meta-heuristic method. Many of the researchers employed the GA algorithm to solve their proposed model such as Osman (1993) for VRP. Chiang and Russell (1996) for VRPTW, Kuo (2010) for time dependent VRP, and Tavakkoli-Moghaddam et al. (2011) for competitive VRPTW. And also some researchers used the hybrid for VRPTW problem such as Zhan et al. (2011); they presented a hybrid ACS with dynamic sweep algorithms. Ding et al. (2012) combined ACO with the saving algorithm and λ-interchange mechanism. Jozefowiez et al. (2009) proposed a bi objective model for the capacitated vehicle routing problem (CVRP), they attempt to minimize the total route length and balance the routes. They have used a multi objective genetic algorithm with target aiming Pareto search and also a multi objective evolutionary algorithm (MOEA) with the Elitist diversification method. Ghoseiri et al. (2010) proposed a multi objective VRPTW
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