Asian Journal of Computer Science and Technology
ISSN: 2249-0701 Vol.7 No.3, 2018, pp. 1-6

Multi Objective Vehicle Routing Problem: A Survey

Sandhya[1] and Rajeev Goel[2]
[1&2]Department of Computer Science and Engineering,
[1]Maharishi Markandeswar University, Ambala, Haryana, India,
[2]ACE,Mithanpur, Ambala, Haryana, India
E-Mail: sandhya12bansal@gmail.com, rcse123@gmail.com

Abstract **- In the last decades, a lot of research has been done on Multi Objective Vehicle Routing due to its rich real life applications. However, the related literature is yet not being summarized anywhere. This paper presents a broad survey on the considered problem. This paper broadly presents the objectives considered, approaches used to solve multi objective vehicle routing problem. Finally, the survey classifies the main features of recently published literature and also provides some future directions in the considered field.**
Keywords: **Vehicle Routing Problem, Multi objective VRP, Evolutionary Algorithms, Combinatorial Optimization, Discrete Optimization**

I.INTRODUCTION

Vehicle Routing Problem (VRP) [24] [26] is a NP Hard problem which is used to find the most optimal and cost effective routes for transporting goods between depot and customers by using number of homogeneous vehicles. However, this problem aims to minimize cost of solution as a single objective which is not suitable for real life instances. In real life there can be several other factors associated with a single cost. Moreover, the objectives may be conflicting in nature. For instance, in some sectors like delivery of perishable foods customer satisfaction and timely delivery is more important than cost. However, in some sectors fair distribution of work load among work is more important. In recent years, a variant of VRP called multi objective VRP (MOVRP) is proposed to deal with these real life instances. In literature [25] [3] lots of work have been done in the field of MOVRP like various solution approaches are proposed with different performance metrics, various applications areas with several objectives are proposed. However, to our best knowledge there is not a single survey paper which considers MOVRP from all aspects and along can help a reader to understand MOVRP. This paper covers definition of MOVRP along with its objectives, solution approaches used and also classifies the research work done from 2007 to 2016 by considering different parameters. Articles were selected both from journals and conference proceedings and their work is classified on various parameters. The main contribution of this survey paper is that it provides an in depth knowledge about MOVRP. After reading this paper an individual can be able to understand the MOVRP from all point of view. Moreover, the methods that are developed to solve MOVRP are widely applicable and also has a high theoretical value. Rest of the paper is organized as follows. Section 2 presents MOVRP definition, ways in which it can be applied to routing problems, objectives used and approaches used to solve MOVRP. Then based on this literature is survey in section 3. Section 4 presents the results of the survey. Finally, section 5 concludes the gaps in literature along with future direction.

II.MULTIOBJECTIVE VEHICLE ROUTING PROBLEM

This section presents the formal definition of MOVRP, ways of extension,objectives and solution approaches used for MOVRP. MOVRP is one in which overall optimization function is influenced by two or more parameters. These parameters are sometime conflicting in nature i.e there exists some trade-off between them. Formally MOVRP can be stated as [1] [2] [4]:

$$MOVRP = max/min\ F(x) = \left(f_1(x), f_2(x), \dots\ f_k(x)\right) \quad s.t.\quad x \in D \qquad (1)$$

Where $k \geq 2$ is the number of objective functions to be optimized.
$x = (x_1, x_2, \dots\ x_k)$is the decision variable vector.
D is the feasible solution space.
$F(x)$is the objective function.
The set $\Omega = F(D)$ corresponds to the feasible solutions in the objective space.

The solution to MOVRP is the set of non-dominated solution called Pareto set where Pareto dominance is defined as: A solution vector $y = (y_1, y_2, \dots\ y_k)$ dominates $(\prec)$a solution vector $y' = (y_1', y_2', \dots\ y_k')$ if y is not worse thany' in any objective function and it is strictly better in at least one objective function.Mathematically $\forall i \in \{1,2, \dots n\}, y_i \leq y_i'\ and\ \exists i \in \{1,2, \dots n\},\ y_i \leq y_i'$

MOVRP are mainly used in three ways

1. *Extending classical VRP:* MOVRP is one of the possible way to study some objectives other than initially defined. In the context problem definition remains unchanged and new objectives are added. The purpose of this category is to extend classical VRP in order to increase their practical applications. As an example we can consider some objectives like driver workload, customer satisfaction.Works of[6,8,13,19,20] can be referred.

with time windows*", IEEE Systems Journal*, Vol. 9, No. 3, pp. 1100-1113, 2015.

[21] O. Kaiwartya, S. Kumar, D. K. Lobiyal, P. K. Tiwari, A.H. Abdullah and A. N. Hassan "Multiobjective dynamic vehicle routing problem and time seed based solution using particle swarm optimization", *Journal of Sensors*, 2015.

[22] Y. Qi, Z. Hou, H. Li, J. Huang and X. Li, "A decomposition based memetic algorithm for multi-objective vehicle routing problem with time windows", *Computers & Operations Research*, Vol. 62, pp. 61-77, 2015.

[23] J. Chávez, J. Escobar and M. Echeverri, "A multi-objective Pareto ant colony algorithm for the Multi-Depot Vehicle Routing problem with Backhauls", *International Journal of Industrial Engineering Computations*, Vol.7, No. 1, pp. 35, 2016.

[24] R. Goel and R. Maini, "Vehicle routing problem and its solution methodologies: a survey", *International Journal of Logistics Systems and Management*, Vol. 28, No. 4, pp. 419-435, 2017.

[25] N. Jozefowiez and E.G.Talbi, "From single-objective to multi-objective vehicle routing problems: Motivations, case studies and methods", The vehicle routing problem: Latest advances and new challenges. Springer, Boston, MA, pp. 445-471, 2008.

[26] B. L. Golden, S. Raghavan and E. A. Wasil, eds, "The vehicle routing problem: latest advances and new challenges", *Springer Science & Business Media*, Vol. 43, 2008.

[27] J. Wang, Y. Zhou , Y. Wang, J. Zhang, C. P. Chen , Z. Zheng, "Multiobjective vehicle routing problems with simultaneous delivery and pickup and time windows: formulation, instances and algorithms", *IEEE Transactions on Cybernetics*, Vol. 46, No. 3, pp. 582-594, 2016.