World Academy of Science, Engineering and Technology
International Journal of Industrial and Manufacturing Engineering
Vol:17, No:07, 2023

Joint Replenishment and Heterogeneous Vehicle Routing Problem with Cyclical Schedule

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Abstract : This paper is developed based on a real-world decision scenario that an industrial gas company that applies the Vendor Managed Inventory model and supplies liquid oxygen with a self-operated heterogeneous vehicle fleet to hospitals in nearby cities. We name it as a Joint Replenishment and Heterogeneous Vehicle Routing Problem with Cyclical Schedule and formulate it as a non-linear mixed-integer linear programming problem which simultaneously determines the length of the planning cycle (PC), the length of the replenishment cycle and the dates of replenishment for each customer and the vehicle routes of each day within PC, such that the average daily operation cost within PC, including inventory holding cost, setup cost, transportation cost, and overtime labor cost, is minimized. A solution method based on genetic algorithm, embedded with an encoding and decoding mechanism and local search operators, is then proposed, and the hash function is adopted to avoid repetitive fitness evaluation for identical solutions. Numerical experiments demonstrate that the proposed solution method can effectively solve the problem under different lengths of PC and number of customers. The method is also shown to be effective in determining whether the company should expand the storage capacity of a customer whose demand increases. Sensitivity analysis of the vehicle fleet composition shows that deploying a mixed fleet can reduce the daily operating cost.

Keywords : cyclic inventory routing problem, joint replenishment, heterogeneous vehicle, genetic algorithm
Conference Title : ICIMSE 2023 : International Conference on Industrial and Manufacturing Systems Engineering
Conference Location : Tokyo, Japan
Conference Dates : July 17-18, 2023