World Academy of Science, Engineering and Technology
International Journal of Industrial and Systems Engineering
Vol:18, No:06, 2024

The Location-Routing Problem with Pickup Facilities and Heterogeneous Demand: Formulation and Heuristics Approach

Authors : Mao Zhaofang, Xu Yida, Fang Kan, Fu Enyuan, Zhao Zhao

Abstract : Nowadays, last-mile distribution plays an increasingly important role in the whole industrial chain delivery link and accounts for a large proportion of the whole distribution process cost. Promoting the upgrading of logistics networks and improving the layout of final distribution points has become one of the trends in the development of modern logistics. Due to the discrete and heterogeneous needs and spatial distribution of customer demand, which will lead to a higher delivery failure rate and lower vehicle utilization, last-mile delivery has become a time-consuming and uncertain process. As a result, courier companies have introduced a range of innovative parcel storage facilities, including pick-up points and lockers. The introduction of pick-up points and lockers has not only improved the users' experience but has also helped logistics and courier companies achieve large-scale economy. Against the backdrop of the COVID-19 of the previous period, contactless delivery has become a new hotspot, which has also created new opportunities for the development of collection services. Therefore, a key issue for logistics companies is how to design/redesign their last-mile distribution network systems to create integrated logistics and distribution networks that consider pick-up points and lockers. This paper focuses on the introduction of self-pickup facilities in new logistics and distribution scenarios and the heterogeneous demands of customers. In this paper, we consider two types of demand, including ordinary products and refrigerated products, as well as corresponding transportation vehicles. We consider the constraints associated with self-pickup points and lockers and then address the location-routing problem with self-pickup facilities and heterogeneous demands (LRP-PFHD). To solve this challenging problem, we propose a mixed integer linear programming (MILP) model that aims to minimize the total cost, which includes the facility opening cost, the variable transport cost, and the fixed transport cost. Due to the NP-hardness of the problem, we propose a hybrid adaptive large-neighbourhood search algorithm to solve LRP-PFHD. We evaluate the effectiveness and efficiency of the proposed algorithm by using instances generated based on benchmark instances. The results demonstrate that the hybrid adaptive large neighbourhood search algorithm is more efficient than MILP solvers such as Gurobi for LRP-PFHD, especially for large-scale instances. In addition, we made a comprehensive analysis of some important parameters (e.g., facility opening cost and transportation cost) to explore their impacts on the results and suggested helpful managerial insights for courier companies.

Keywords : city logistics, last-mile delivery, location-routing, adaptive large neighborhood search
Conference Title : ICCIE 2024 : International Conference on Computers and Industrial Engineering
Conference Location : San Francisco, United States
Conference Dates : June 03-04, 2024