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Electric Vehicle Routing Problem with On-Demand Charging System

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Abstract

Many logistics operators predominantly rely on diesel-powered vehicles for their delivery services. However, the adverse external effects of internal combustion engine vehicles have led governments and city authorities to enact more stringent regulations governing freight transportation within urban areas. These initiatives promote the transition to alternative fuel vehicles, with a primary focus on electric vehicles (EVs). Consequently, it is anticipated that EVs will make up a substantial portion of logistics operators' vehicle fleets. Inadequate charging infrastructure has been a significant impediment to the widespread adoption of EVs. Charging at the depot is a practical solution in real-world logistics operations due to limited recharging infrastructure in many regions and the uncertainty surrounding charger availability. While there may be numerous public recharging stations in the area, not all are suitable for commercial vehicles, especially trucks. Furthermore, some companies prefer charging their EVs at their depots due to factors like high energy costs at public stations. Nevertheless, this approach can result in operational inefficiencies, especially for deliveries in peri-urban and rural areas. To address this, offering charging services for EVs, such as deploying mobile chargers (MCs), can enhance the efficiency of EV usage. In other words, a flexible recharging system with an on-demand mobile charging approach can be recommended. We introduce the Electric Vehicle Routing Problem with On-Demand Charging System to tackle these challenges. MCs recharge EV batteries at customer locations along their routes when necessary. We have developed a matheuristic algorithm that combines the variable neighborhood search (VNS) and an exact method.

Keywords
Electric vehicles, mobile charging, variable neighborhood search, matheuristic.

Biographies
İhsan Sadati is instructor & researcher at Sabanci University. He received his Ph.D. in Industrial Engineering and Operation Management (IEOM) from Koç University. He received his BS and MS degrees in Industrial Engineering from the University of Tabriz and Urmia University, Iran. His research interests are Operations Research, Mathematical Optimization, Vehicle Routing problems, Green Logistics, Heuristic Optimization, and currently, he is mainly focusing on Green and Electric Vehicle Routing Problems.

Bülent Çatay (Senior Member, IEEE) is a Professor of Industrial Engineering and founding director of the Smart Mobility and Logistics Laboratory at Sabanci University, Istanbul, Turkey. He received his B.Sc. degree in Industrial Engineering from Istanbul Technical University and his Ph.D. degree from the University of Florida. He worked as a consultant at IBM Microelectronics in Burlington, Vermont in 1997 and as a visiting lecturer at the University of Florida during 1999-2000. He joined Sabanci University in 2000. His research interests include transportation and logistics systems, sustainable transport planning, electromobility, and applied optimization.