Container Pickup and Delivery with Charge Planning using Diesel and Battery Electric Heavy-Duty Trucks

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Abstract

This study aims at reducing Greenhouse Gas (GHG) emissions caused by drayage operations in port areas. Due to globalization and economic prosperity, freight movements have been increasing during the past decades. In port areas, a large portion of freight movements is made by trucks, causing significant negative impacts on traffic conditions, energy consumption, and GHG emissions. In the last decade, battery-powered vehicles have become an emerging topic, but only limited research attention has been paid to Battery Electric Heavy-Duty Trucks (BEHDT) in drainage operation. Addressing this understudied but promising field, we examine the research potential of using BEHDTs for daily container movements by proposing mathematical formulations, developing solution methodologies, and building simulation testbeds to evaluate transportation systems. Meanwhile, given that the most challenging issue for using BEHDTs is the battery life, we also consider the current status and future development trend of the battery industry. We will estimate the impacts of using BEHDTs from 2022 to 2050. The freight movement problem will be decomposed into two subproblems. The first is figuring out the minimum cost flow for demand satisfaction. The second solves a bin-packing problem based on a flow solution, which also considers the BEHDTs' charging plans with range constraints. The numerical experiments are conducted with real-world data which can provide quantitative comparison in terms of truck travel costs, fleet size, and GHG emissions. Sensitivity analysis will be performed under different mixtures of diesel trucks and BEHDTs.

Keywords
Battery Electric Heavy-Duty Trucks, Drayage Operations, Emissions, Traffic Simulation, Charging Planning

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Biographies
Maged Dessouky is a Dean's Professor and Chair in the Daniel J. Epstein Department of Industrial and Systems Engineering. His research area is transportation system optimization where he has authored over 100 refereed publications. His paper "Optimal Slack Time for Schedule Based Transit Operations" was awarded the INFORMS Transportation Science and Logistics Best Paper Prize. He is a Fellow of IISE and serves as Associate Director of METRANS, a center focused on solving important urban transportation problems. He is currently area/associate editor of Transportation Research Part B: Methodological, IISE Transactions, and Computers and Industrial Engineering, and previously served on the editorial board of Transportation Research Part E: Logistics and Transportation Review, as area editor of the ACM Transactions of Modeling and Computer Simulation, and as associate editor of IEEE Transactions on Intelligent Transportation Systems. He received his Ph.D. in Industrial Engineering from the University of California, Berkeley, and M.S. and B.S. degrees from Purdue University.

Siyuan Yao is a Ph.D. Candidate in Daniel J. Epstein Department of Industrial and Systems at the University of Southern California (USC). Prior to entering the doctoral program, he received his M.S. Degree in Civil Engineering, from USC and B.Eng. Degree in Transportation Engineering from the Wuhan University of Technology, Wuhan, China. Under the direction of Professor Maged Dessouky, Siyuan has been conducting research in drayage operations

and complex system modeling with special interests in algorithm and heuristic design, empty container repositioning problems, and simulations.

Shichun Hu is **a** PhD graduated from Daniel J. Epstein Department of Industrial and Systems at University of Southern California. She is advised by Professor Maged Dessouky and her research interests are primarily vehicle routing, ride-share and supply chain optimization.