

Drone Scheduling for Last-Mile Disaster Relief Logistics

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Abstract

Climate change, urbanization, and environmental degradation have contributed to the growing frequency and severity of natural disasters, including hurricanes, floods, and earthquakes. A persistent challenge in disaster response is the rapid and efficient delivery of humanitarian aid, particularly in areas where ground infrastructure has been damaged or destroyed. Recent advances in drone technology have improved range and payload capacities, making autonomous drones an increasingly viable last-mile delivery solution. Furthermore, the use of electric drones supports sustainability objectives by reducing carbon emissions relative to conventional delivery methods. This study proposes an electric drone-based logistics framework for last-mile humanitarian aid delivery from a central distribution hub to disaster-affected areas. A mixed-integer linear programming (MILP) model is formulated to optimize drone scheduling and coordination, while incorporating constraints related to payload capacity, battery management, travel distance, dynamic departure times, variable travel durations, and demand fulfillment. The objective is to minimize total operational costs and delivery times, improving disaster responsiveness. The proposed model enables efficient and adaptive resource allocation in disrupted environments, improving the speed and reliability of aid delivery. This work contributes to the development of disaster response systems by providing an optimization framework that demonstrates the potential of electric drone technologies to advance resilience and sustainability in humanitarian logistics.

Keywords

Optimization, Scheduling, Drones, Last-Mile Delivery, Disaster Response

Biographies

Marwen Elkamel is a Post Doctoral Fellow at the Department of Industrial Engineering & Management Systems at the University of Central Florida. He obtained a Bachelor degree with distinction in Economics with a minor in Management Studies from the University of Waterloo, Ontario, Canada and a Master of Science degree in Management (Business Analytics track) from the University of Central Florida. He received his Ph.D. in Industrial Engineering from the University of Central Florida in 2023. Before starting his PhD, he worked as a data analyst for WeCare tlc. During his undergraduate studies, he served as a Research Assistant at the Waterloo Institute for Sustainable Energy (WISE). He was involved in two different projects that encompassed the acquisition and summary of data and preparation of computer programs to simulate processes and to make appropriate conclusions. During his PhD studies, he has been preparing machine learning models for electricity consumption with the consideration of socio-economic factors. He was also involved in a project that dealt with power resources scheduling and planning. He is currently focusing on modeling and optimizing the Urban Food-Energy-Water Nexus in order to find more efficient ways to supply water, energy and food and manage natural resources that can aid in sustainable energy development and improved water and food security. He is a member of IEOM, IFORMS, and the Institute of Industrial & Systems Engineering. He has published several journal and conference papers in the areas of modeling, simulation, optimization, and big data analytics.

Charles Major: Academics; received a Graduate Degree in Emergency and Crisis Management in 2023 and bachelor's in emergency management in 2019 from the University of Central Florida (UCF); Orlando, Florida. He also received an associate degree in Logistics in 1996 from the Community College of the Air Force and an Associates Business Administration in 1983 from the St Johns River State College. Active-duty United States Air Force for 27 years and was awarded a nine level in Material Management and Logistics. Current position; Engineering Instructor at the UCF Department of Industrial Engineering and Management Systems. Areas of interest; Disaster mitigation research using history and simulations, Rocket launch, Aerospace and Spaceport logistics. Experience; international military materiel management logistics, acquisition, contracting, safety/risk and emergency management experience on U.S. and allied installations. Recent research; Presented the SciTech conference paper; "Key Considerations for Developing Cost-Effective and Efficient Future Spaceports" at the American Institute of Aeronautics and Astronautics 2025 conference SciTech in Orlando, Florida. Currently researching the Air Force Research Laboratory Rocket Cargo logistics system for the United States Space Force. Prior responsibilities include the Air Force Logistics Management Agency-researching Department of Defense logistics and initially setting up a USAF logistics ERP system. Other responsibilities include the Operational Research and reporting of all U.S. weapon system logistics support for HQ DLA, Dover AFB Section Chief; Inventory Accountability, Superintendent Materiel Control NATO Base Keflavik, Chief of Logistics; Det 1 RAF Akrotiri, Cyprus, United State Military Mission to Saudi Arabia; Chief of Equipment and Enterprise Risk Manager.

Luis Rabelo earned a BS in Electro-Mechanical Engineering from the Technological University of Panama (1983), an MS in Electrical Engineering from the Florida Institute of Technology (1987), and a Doctorate in Engineering Management from the University of Missouri, where he also completed a postdoctoral fellowship in Nuclear Engineering. He holds dual MS degrees in Systems and Management from MIT. Dr. Rabelo has worked with the Advanced Technology Group at Goodrich and Honeywell Laboratories. He served as a NASA Fellow (2002–2005) and Project Manager (2009–2011). Currently, he is a Professor and Undergraduate Coordinator in the Industrial Engineering and Management Systems Department at the University of Central Florida. Dr. Rabelo has authored over 300 articles and a book on Artificial Intelligence. He has advised 39 Master's and 29 PhD students. His accolades include the 2004 Best Scientific Article of the Year from the Society of Automotive Engineers, the "ONE NASA" distinction (2006), and the Fulbright Distinction (2008). He was named Distinguished Alumni by the Technological University of Panama in 2008 and received the HENAAC Award in Education in 2011. He also earned the Forest R. McFarland Award from SAE in 2013 and 2018, and the SAE Russell S. Springer Award in 2017 for his work on modeling space operations systems.

Mansoor Mollaghasemi is an Associate Professor of Industrial Engineering & Management Systems at the University of Central Florida. She received her PhD in Industrial Engineering from the University of Louisville. Her areas of expertise include simulation modeling and analysis, optimization, multiple criteria decision making, neural networks, and scheduling.