

IoT-Integrated Ambulance Allocation-Scheduling for Improved Emergency Response

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Abstract

Optimization of ambulance scheduling is a crucial factor in improving emergency responses to preserve lives. The present study introduces a novel methodology for ambulance scheduling, which incorporates the Internet of Things (IoT) to enhance resource utilization and reduce response times in emergency medical services. We have devised a dual-level program model consisting of two sub-models. The first sub-model is designed to allocate ambulances to different districts based on geographic and traffic data. The second sub-model is responsible for determining the order of visit priorities within each district, aiming to minimize the overall time required to respond to a case. Substantial enhancements in responsiveness and resource utilization were observed in comparison to traditional approaches. The present system, which is enabled by the IoT, exhibits real-time adaptability in crisis management. We present results that demonstrate the revolutionary capacity of IoT applications in Emergency Medical Services (EMS) and offer practical insights for healthcare organization managers.

Keywords

Ambulance Scheduling; Emergency Response; Internet of Things (IoT); Real-time Optimization; Resource Allocation; Bi-level Programming.

Biographies

Reza Kia is an Associate Professor in the Department of Operations Management and Business Statistics at Sultan Qaboos University, Muscat, Oman. He earned his B.Sc, M.Sc, and Ph.D. in Industrial Engineering from Mazandaran University of Science & Technology, Iran. Throughout his career, Dr. Kia has been recognized with several accolades, including the Distinguished Annual Performance in Teaching and Research Award in 2020-2021 and multiple research grants from prominent institutions like The Research Council (TRC) Oman. He is an active member of several academic and professional committees and has served as a scientific board member and session chair at international conferences. His research interests span the optimization and simulation of manufacturing and logistics systems, AI-driven decision-making, and the development of meta-heuristic algorithms, with a particular focus on green supply chains and sustainable logistics. Dr. Kia is also engaged in various industrial consultancy projects in Oman, collaborating with leading organizations such as Oman Air and Petroleum Development Oman.

Amirhossein Salehi-Amiri has started his function as a PGR and research collaborator (since 2021) and recently (since September 2022) at the Alliance Manchester Business School, The University of Manchester, UK. Amir has achieved outstanding academic accomplishments in the past few years managing to publish a significant number of papers including in well-respected and high-impact journals such as Applied Soft Computing, Computers & Industrial Engineering, Journal of Cleaner Production, and Renewable and Sustainable Energy Reviews. Amir's research and Ph.D. topics draw heavily on advanced optimization methods applied to complex mathematical problems featuring non-standard properties, such as multiple conflicting objectives, uncertainties, and constraints. Given the novelty of the mathematical problems considered, such as planning and logistics in home health care, another key part of Amir's research is to develop formal problem definitions, which he does with industry partners where possible.

Ali Zahedi is a doctoral candidate conducting research at Tecnológico de Monterrey in Mexico. His area of focus includes supply chain management, sustainable supply chains, smart cities, and the Internet of Things (IoT). Ali obtained his Master of Science degree from the University of Shiraz, Iran. The primary objective of his research is to develop highly effective and environmentally-friendly supply chain networks that integrate social and environmental conditions. Ali has authored multiple publications on subjects including closed-loop supply chain networks for industries such as walnut and avocado, IoT-based relief supply chains for pandemics, and the optimization of sales for perishable commodities. The objective of his work is to promote the concepts of circular economy and improve sustainability in supply chain management.

Navid Akbarpour is a specialist in the design of supply chain networks and the sustainable optimization of these networks and a specialist in operations research and home healthcare. He obtained a Master's degree in Industrial Engineering from Islamic Azad University in Iran, where he originated a multi-objective mathematical model specifically designed for supply chain planning. Navid has authored multiple analytical articles in renowned academic journals, including Renewable and Sustainable Energy Reviews and the Journal of Cleaner Production. His professional background encompasses positions in the distribution and quality assurance of pharmaceuticals. Moreover, he holds membership in the Young and Elite Researchers Club in Iran.