PURDUE UNIVERSITY | Krannert School of Management

Supply Chain and Operations Management Seminar

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Toward Disruption-Dependent Demand: A Unified Framework for Reliable Facility Location Design

Friday, October 30, 2020 | 10:00—11:30 am

Bio

Mengying Xue is a postdoctoral researcher at Krannert School of Management, Purdue University. She got her PhD in Industrial Engineering Department, Tsinghua University, Her research focuses on integrating theoretical modeling and data analytics in supply chain management. Her research interests span the following areas: data-driven analytical approach, optimization modeling and algorithm, economic and game-theoretical analysis, and their applications in operations management, marketing and energy interfaces.

Abstract

This paper develops a robust optimization framework for reliable uncapacitated facility location problems under supply disruptions and disruption-dependent demands. The risk of demand changes after disruptions is critical to the supply chain reliability, but has not been sufficiently investigated in previous related studies. The objective is to minimize the fixed costs and the worst-case expected shipping and penalty costs out of all disruption distributions, whose moments information is known within a given uncertainty set, and all demand change rates, subject to interval uncertainties. This framework subsumes existing reliable facility location models, including stochastic, interdiction median and distributionally robust models. Our unified framework also facilitates a better understanding of how moments information (possibly with errors) of disruptions can be used to improve the cost efficiency of the supply network while preserving its reliability.

We prove that the well-known distance ordering rule remains valid for optimal customer assignments in our general setting, and the worst-case disruption distribution and demand change rates can be derived in closed forms. We show that our framework is equivalent to a constrained supermodular function minimization problem. We propose a fast approximation scheme by leveraging a batch greedy algorithm, and establish the associated analytical bounds. These results contribute to the discrete optimization literature by providing novel greedy bounds for a class of non-monotone supermodular minimization problems over non-independence systems. To solve the problem to optimality, we build on its supermodularity to develop a mixed-integer linear program formulation, which admits an efficient constraint-generation algorithm and a scalable integer-programming-based heuristic.