A Research Subject for the Program CSC/UT-INSA 2025

Integrated Supply Chain Design and Strategic Inventory Deployment under Supply Disruptions

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The recent global supply chain crisis, exacerbated by the COVID-19 pandemic, geo-political uncertainty, and other factors, has had a profound impact on various sectors, especially on the semiconductor industry. The 2020-2023 worldwide chip shortage affected more than 169 industries as a consequence of chip supply disruptions. This makes supply chain risk management and resilience become a prominent issue, attracting more and more attention of researchers and industrial practitioners.

A supply chain is a network of external suppliers, manufacturing plants, distribution centers/warehouses, and retail stores, through which products are manufactured and delivered to customers. In this network, the inventory of each product at each facility is generally replenished according a predefined inventory policy, and safety stock is usually placed/deployed at these facilities and used as a buffer to protect the facilities from stock-outs caused by inaccurate demand forecasting and/or poor adherence of delivery lead time by suppliers. However, in addition to the demand and lead time uncertainties, supply disruptions may happen at the suppliers, the plants, and the distribution centers/warehouses, and/or transportation infrastructures and means that connect these facilities.

A supply chain disruption is an unplanned and unanticipated event that disrupts the normal flow of goods and materials in a supply chain. A resilient supply chain is able to anticipate, prepare for, respond to, and recover from disruptions while maintaining operations at desired levels of efficiency and effectiveness. Methods we may adopt to address supply chain disruptions in order to maintain an acceptable risk level in supply chains include the consideration of supply disruptions in supply chain design (location of manufacturing plants and distribution centers/warehouses), strategic inventory deployment (safety stock placement) across supply chains, alternative sourcing and flexible logistical arrangements, product substitution, and collaboration among supply chain partners when facing disruptions.

Most studies on supply chain design and inventory deployment in the literature consider the two decisions independently or sequentially, only few studies address simultaneously supply chain design and inventory deployment by proposing and solving location-inventory models or location-inventory-routing models/problems. However, those studies either assume constant demands or do not consider strategies for mitigating and recovering from disruptions, so more research has to be conducted in supply chain design and inventory deployment with consideration of resilience requirements under supply disruption risks.

Focusing on manufacturing supply chains, this doctoral research project tries to address supply disruptions at the strategic and tactical levels by considering supply disruptions in supply chain

design and inventory deployment. Its objective is to develop integrated modeling and solution approaches for optimizing the location of manufacturing and distribution centers/warehouses and the inventory deployment at these facilities with the consideration of supply disruption risks, costs of resilience, strategies for mitigating and recovering from disruptions, and operational efficiency. More precisely, this project has the following tasks:

1. Establish stochastic programming models for the problem of integrated supply chain design and strategic inventory deployment under supply disruptions with consideration of strategies for mitigating and recovering from disruptions.

2. Develop scenario/simulation based methods and two-stage stochastic programming methods for solving the problem effectively and efficiently.

3. Implement the models and the solution methods in computer programs and evaluate them by numerical experiments on randomly generated instances and real instances.

To well conduct the research expected in this project, a candidate should have good knowledge of operations research, probability theory, and computer programming. A research experience on supply chain management will be a plus for his/her application.

The doctoral student will conduct his/her research in Logistics and Optimization of Industrial Systems (LOSI) team of Computer Science and Digital Society laboratory at University of Technology of Troyes (UTT), France. The research activities of LOSI mainly focus on logistics/supply chain management and operations management. The proposed doctoral research project well fits into the strategy of LOSI to develop models and methods for effective supply chain management. The supervisor of the future PhD student for this doctoral project, Prof. Haoxun Chen, is in the list of the top 2% of the most cited scientists worldwide in his scientific field for career-long released by Stanford University on 4 October 2023 (DOI: 10.17632/btchxktzyw.6).

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