

Project Title: Intermodal Logistic System Network Design with Expedited Transportation Services

Principal Investigator:

Xiaopeng Li, Civil and Environmental Engineering, Mississippi State University (MSU), (662) 325-7196, xli@cee.msstate.edu.

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Project Summary:

The accelerating globalization trend in many industries mandates a global supply chain network system that connects suppliers, manufactures and customers across nations via intermodal transportation. A comprehensive network design planning framework is critical to the capacity, efficiency and reliability of such a global supply chain system. Most studies on logistics network planning however are based on simple and deterministic assumptions of day-to-day supply chain operations. For example, commodity shipments are often described by simple assignments or deterministic network flows, where only one mode of transportation is available and uncertainties from traffic demand and shipment lead times are completely ignored. In many real-world cases, such models are unrealistic and suboptimal due to their oversimplification of dynamic and stochastic nature of supply chain operations (Melo et al. 2009). Hence there is a need to integrate into logistics system design more realistic operational-level factors that determines the performance of a supply chain network system in a long run.

The performance of a network logistic system is in fact largely affected by uncertainties in demand rate and transportation lead times. Fluctuating customer demand and stochastic lead time significantly increase the chance of depleting inventory at a supply chain facility, which can cause very costly and adverse events such as lost sales and production disruptions. To prevent such adverse events from happening, a common practice at a facility is to use expedited transportation services to get products delivered immediately when its on-hand inventory is about to be empty. Such expediting services however are usually expensive (e.g., the air transportation mode), and regular transportation services (e.g., trucking or intermodal modes), which usually take a much longer lead time but have a much cheaper rate, are used most of the time when on-hand inventory is relatively sufficient. From a network perspective, the availability of transportation modes and their shipment lead time lengths and variability highly depend on plant facility locations and product supplier selections, which are usually determined as early as in the network planning and design stage. Hence, the network design decisions will highly influence many operational issues including strategies of using expediting services and coping with uncertainties from both demand and supply sides. This highlights the need for an integrated network design framework that considers all these coupled operational issues, in particular shipment service configurations and associated uncertainties in an intermodal transportation environment.

The research objective of this project is to establish a logistic system network design framework that integrates one-time investment planning with long term supply chain operations and management under an uncertain intermodal transportation environment. We will integrate different transportation modes and inventory management strategies into network design decisions so as to improve the long-term performance of the designed system. In particular, this framework will address how to configure proper expediting services to compensate unreliable regular transportation services without increasing too much system cost, and how the adoption of expediting services affect network location planning and traffic flow allocation decisions.

This success of this project will significantly advance the freight logistics network design and planning methodologies by optimizing the use of multiple transportation modes and coping with widely encountered uncertainties in logistics operations. The research outcome will help several industries (including the manufacturing industry) that suffer losses from suboptimal supply chain network design and imbalanced utilization of different transportation modes find a solution to improving the efficiency and reliability of their logistics network systems. It will also enrich education by adding new course materials and influencing diverse groups of students.