Shippers' Behavior Study Through Developing and Calibrating their Utility Functions – Project 5

Deliverables and Reporting Requirements for UTC Grants Awarded in 2023 (June 2023)

Exhibit D

Recipient/Grant (Contract) Number: The University of Tennessee; Texas A&M University, Grant No. 69-A3552348338

Center Name: Center for Freight Transportation for Efficient and Resilient Supply Chain

Research Priority: Improving Mobility of People and Goods

Principal Investigator(s): Lee Han (UTK), Bruce Wang (TAMU), Yunlong Zhang (TAMU), and Kouros Mohammadian (UIC)

Project Partners: US DOT freight offices, FAF program, TxDOT freight program, Walmart R&D Center, BNSF, Oak Ridge National Laboratory

The project team members have prior and ongoing research collaborations with the listed partners and will continue to identify critical research needs and develop solution strategies in year 1 and beyond.

Research Project Funding: $183,802 Federal and $91,739 Non-Federal Funding

Project Start and End Date: 10/01/2023 – 9/30/2024

Project Description: Freight flows on a multimodal network and through alternative routes. Each mode and route decision are determined by shipper behavior. There are multiple factors behind shipper behaviors such as time, distance, cost, reliability, etc., each of which is related to the characteristics of the commodity being shipped. To effectively promote multimodal transportation requires in depth understanding of the shipper behavior, which is also critical to the planning and operations of the multimodal transportation system.

In the wake of supply chain volatility, shipper behavior study carries its additional significance. When a key infrastructure element is disrupted such as a port closeout, how would the O-D flow respond to the lockout of a major port? There may be multiple alternative routes with different set of modes of transportation. In this case, shipper behavior study would help predict the potential distribution of the network flow and assist planners and operational managers in developing proper policies and measure to serve the stakeholders better. In a broader term, shipper behavior study allows re-optimize the distribution routes and modes of major products/commodities after system disruptions due to either political or natural reasons. Re-distribution of shipments over the network is not uncommon to happen in the private sectors. For instance, when the Long Beach port is jammed with significant delay to vessels, shippers such as Walmart would need to decide whether to divert its shipments via the Panama Canal to the Gulf Coast ports. Good planning shall have prepared all the potential options and means for the private sector changes when needs arises.

In summary, shipper behavior directly contributes to the performance of transportation logistics on the national network and is therefore imbedded in the supply chain resiliency and reliability.

The objective is to understand shipper's utility function and study how to calibrate the function using machine learning techniques and with available and planned survey data.

US DOT Priorities: The project will directly support the USDOT strategic goal of Improving Mobility of People and Goods by analyzing and improving freight network resiliency. In addition, this project will help the USDOT strategic goal of Climate and Sustainability through analyzing the impact and develop solutions for intermodal facilities under extreme weather conditions. Specifically, the proposed research responds to the RD&T priorities of "Multimodal System Planning," "Network Accessibility," "Rural Transportation Infrastructure," "Mode Shift," and "Resiliency and Climate Adaption." This project will perform transformative research to study existing datasets for higher resolution enhancement potentials for freight network analysis. Innovative advanced AI models will be developed to assess the impact of and response to inclement weather events for intermodal facilities including ports and waterways.

Outputs: The project will result in 1) comprehensive survey statistics on shipper behaviors, 2) shipper utility functions for a range of commodities, 3) a machine-learning tool for quick implementation of shipper behavior prediction in parallel to the utility functions, and 4) a road map forward guiding the next phases of this line of research efforts.

Outcomes/Impacts: Freight transportation decisions are more susceptible to supply chain volatility, shifting geopolitical conditions, disrupting technological innovations, and other major or even minor "shocks" to the system. The resultant shipping decisions and their collective behaviors can degrade economic health and upend social satiability at regional or even global scales. At microscopic level, shipper decisions in routing could lead to heightened safety concerns and unexpected infrastructural expenses. The products and outcomes of this study are a definitive step towards better understanding and predictive insights of shipper behaviors under an array of scenarios. The roadmap to be charted in this study will guide future research work for making policies and taking actions at national level to guard the reliability and resilience of a strong economy from an array of "shocks" to the systems.