MarTREC
Maritime Transportation Research & Education Center

MarTREC UTC Project Information Form
USDOT Tier 1 University Transportation Center
Agency ID or Contract Number 69A3551747130

Project Title: **International Port Dependencies and Resilience to Supply Chain Disruptions**
Project Abstract (Brief Description): The ability to identify and analyze spatiotemporal relationships is critical for cargo vessel shipments, understanding supply chain dynamics, diagnosing port congestion, and making effective recommendations. The spatiotemporal dependencies between different international shipping partners is an important aspect in understanding port supply and demand. The main limitations of the existing analytical methods in transportation research are that they fail to capture directional or nonlinear dependencies. The current techniques for evaluating ports rely on statistical relationships of individual ports and not the dependencies among shipping and receiving ports. Here, we propose using two novel causal discovery algorithms for the first time for extracting the spatiotemporal dependencies of operational performances between international ports using large volumes of real-world port traffic datasets. We propose a data-driven approach to analyze the cargo ship network, representing a complex system defined as the network of ports that are connected by links of vessel travel paths. This research will further identify the most central ports in the network and determine groups of highly interconnected ports. Next, we will develop an alternative functional network of ports in which a directed link (or edge) connects two ports to capture the directional dependency between their activities. In particular, we will use information-theoretic approaches, such as transfer entropy on time series data to quantify the directional relationships. The transfer entropy approach is model-free and has an advantage over simple cross-correlation which is restricted to linear and non-directional assumptions. We will finally analyze the properties of the functional network using graph-theoretic measures. Specifically, we will compute 'centrality measures' to identify the influential ports and 'global measures' to analyze the dynamics and detect the common critical properties. In other words, the goal is to obtain a high-level description of the structure of the system through the analysis of low-level relational data, where the high-level description identifies various kinds of patterns in the set of relationships. This work will find applications in resolving supply-chain related issues in the cargo ship network.
Describe Implementation of Research Outcomes: The main objective of this project is to find applications in resolving supply-chain related issues in the cargo ship network. To do so, we will use port vessel entry and clearance data to develop our maritime network and use information-theoretic approaches to quantify the directional relationship between ports and also analyze the properties of the functional network using graph-theoretic measures.
Impacts/Benefits of Implementation: *To be determined upon conclusion of the project:*
Web Links: martrec.uark.edu
Budget (Funding) Amounts & Source(s) (US DOT +Match(s) =Total Costs): MarTREC $88,160 and cost share $45,218
Project Start and End Dates: 04/01/2022-09/30/23 complete
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