The Impacts of Increased Adverse Weather Events on Freight Movement

Assessing the resilience in port truck operations during a major hurricane using an adaptable framework

Highlight | Dec. 2020

Project No. 19ITSUTA02

PI: Dr. Kate Kyung Hyun (UTA)

POP: Aug. 2019 – Feb. 2021

Freight transportation is a major economic backbone of the United States and is vital to sustaining the nation's economic growth. This study addresses an important national freight mobility goal to enhance the resilience of the port transportation operations in the event of extreme weather events. An adaptable resilience assessment framework is developed to evaluate the impact of a disruptive event on transportation operations. The framework identifies dynamic performance levels over an extended period of an event including five distinct phases of responses-staging, reduction, peak, restoration, and overloading. Evaluating response systems and resilience of port truck activities during severe weather events such as Hurricane Harvey represents the first step for designing plans that support a fast system recovery that minimizes the economic, social, and human impacts.

Background

Severe weather events impact port operations and port truck traffic and cause economic losses. Due to global climate change, adverse weather events, which include flash floods and hurricanes, continue to become more frequent and severe. The Port of Houston, located in the fourth-largest city in the US is the busiest U.S. port in terms of foreign tonnage, and sixteenth-busiest in the world. Hurricane Harvey had a significant impacts on the operations of different terminals in this port.

Disaster events definitively impact the freight transportation system; however, the spatial and temporal extent of these impacts vary by geographic locations and type of events. This uncertainty and variation require in-depth investigation and more effective resilience metrics to provide accurate estimates of impacts for practical applications. Most of the studies focus on measuring the vulnerability and resilience of the transportation network and providing recovery strategies to optimize the performance of the network during and after disruptive events.

Project Summary

This project aims at characterizing the port truck movements by identifying operational patterns by associated industry and service types and evaluating system response during adverse weather events. The research focuses on identifying (i) truck activity from the port of Houston, (ii) capturing truck flow disruptions due to Hurricane Harvey, and (iii) identifying flow changes and recovery process during and immediately after the adverse events. This study uses metric based GPS data to represent individual trip characteristics such as travel time, origin-destination (OD), major route choice, and industry type. The study applies the developed framework in Houston as the major destination (or origin) of freight or the intermodal point of the shipment. Identified truck flows categorized by their service (trip) type represents truck operation between the port and their final destinations. To understand the interactions of truck behavior to the flow disruptions due to flooding, flow disruptions and activity changes before and after the Hurricane Harvey are captured

Status Update

Performance metrics developed in this study assess operational resilience across different response phases during disruptive events, which create unique conditions and level of impacts over time. Figure 1 shows a performance profile based on daily volume trends between an origin and a destination (OD). This framework uses any type of performance measures or ODs that provide continuous operational attributes such as travel time, speed, or performance index (e.g., volume/capacity). Based on these performance levels, six points of impact (A to E) determine five distinct response phases, including staging, reduction, peak, restoration, and overloading phases. Based on the operational profiles and a set of rules that determines six disruption phases, this study develops performance metrics to evaluate the resilience and adaptability of freight operations

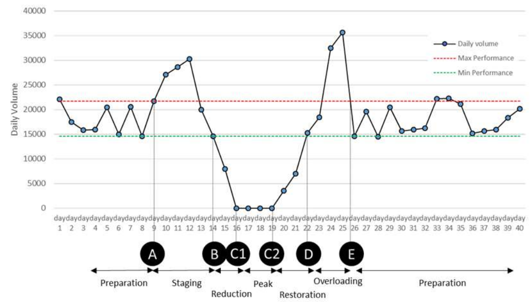

Figure 1. Performance profiles and phases.

This study showed that a short proactive response before a disaster results in a long recovery period with over 250% increases in volume between a port terminal to its regional destinations. Trucks serving local facilities show stable and shorter response phases while regional operations maintain a prolonged staging or overloading phases to handle the excess demands especially for significant multi-day disruptive events.

This study uses the resiliency framework to quantify the economic impacts from hurricane Harvey and directly translates the changes in truck activity (i.e., volumes) to economic outputs. Figure 2 shows the important metrics used to estimate economic impact and five zones (1 to 5). The economic analysis shows that the increased economic gain during a proactive or reactive stage could substantially alleviate the losses due to impaired port operations.

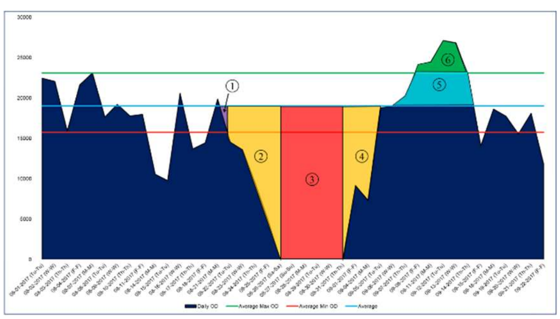

Figure 2. Different zones used to estimate the economic impacts during a disruption period.

Impacts

This major benefit of this study is development of an adaptable framework to evaluate resilience of freight operations during a disruptive event. This study highlights the importance of staging and overloading phases since proactive or reactive responses during the phases describe resilience and adaptability of the operation. The extent of flexibility in operational capacities such as instantaneous volume increases during a short period of staging phase or an extended overloading phase shows how much adaptable capacity and flexibility the system provides to recover from the disruption. The framework quantifies cross-sectional and total impacts from disruptions by estimating performance changes across a different phase.

The methodology allows agencies or freight industry to understand how well a system prepares for a disaster and responds to minimize the impacts from a disruptive event. This flexible structure allows the framework to be applicable to any disruptive events that cause significant operation changes for an extended period.

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

Learn More

For more information about Tran-SET, please visit our website, LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Dr. Momen Mousa (Tran-SET Program Manager) directly at transet@lsu.edu.