USDOT Tier 1 University Transportation Center

Semi-Annual Progress Report #11

Federal Agency: Office of the Assistant Secretary for Research and Technology

Federal Grant ID #:   69A3551747130

Project Title: Maritime Transportation Research and Education Center (MarTREC)

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Submission Date: April 30, 2024

DUNS: 1914297450000

EIN: 71-6003252

Recipient Organization: University of Arkansas

Project/Grant Period: Start Date November 30, 2016
                        End Date: March 31, 2024

Reporting Period Start Date: October 1, 2023
Reporting Period End Date: March 31, 2024

Report Term or Frequency: six months

Signature:

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Maritime Transportation Research & Education Center (MarTREC) is a USDOT Tier 1 University Transportation Center funded through the Office of the Assistant Secretary for Research and Technology. Under the FAST Act, MarTREC is *working to preserve the Nation's transportation system through efficient, resilient, and sustainable maritime and multimodal logistics and infrastructure*. Our vision is to be recognized as the Nation's premier source for expertise on maritime and multimodal transportation research and education. Made up of renowned maritime transportation researchers, the MarTREC consortium are University of Arkansas (UARK), Fayetteville, AR; Jackson State University (JSU), Jackson, MS; Louisiana State University (LSU), Baton Rouge, LA; University of New Orleans (UNO), New Orleans, LA; Texas A&M University/Texas Transportation Institute (TAMU/TTI), College Station, TX; and Vanderbilt University (VU), Nashville, TN.

1. Accomplishments

1.1 Consortium-Level Accomplishments

1.1.1 Research

Research Effectiveness Metrics	Progress
# of peer-reviewed journal articles (published, accepted, submitted)	7
# of conference presentations given	12
# of students participating in transportation research projects funded by UTC	9

1.1.2 Leadership

Leadership Effectiveness Metrics	Progress
# of national and regional leadership positions held	33
# of invited talks given	3
# of leadership and research awards received	2

1.1.3 Education and Workforce Development

Education and Workforce Development Effectiveness Metrics	Progress
# of transportation-related courses offered	27
# of technician certification programs offered	6
# K-12 outreach programs offered	29

1.1.4 Technology Transfer

Technology Transfer Effectiveness Metrics	Progress
# of project deliverables submitted	8
# of technical briefs	0
# of editorial journal positions held	12

1.1.5 Collaboration

Collaboration Effectiveness Metrics	Progress
# of existing collaborative partnerships	78
# of new collaborative partnerships formed	0

1.1.6   Opportunities for Training and Professional Development
- Two students presented at professional conferences
- Two conference planning positions were held by MarTREC faculty researchers
- 33 leadership positions held by MarTREC faculty researchers
- Nine distinguished lectures presented from industry

1.1.7   Dissemination of Results (In this reporting period)
- Seven peer-reviewed journal articles
- 12 conference presentations
- One book

1.1.8   Plans to Accomplish Goals and Objectives during Next Reporting Period
- Last reporting period under Fast Act

1.2   Project-Level Accomplishments and Plans for Next Reporting Period
- 62 completed projects. Last reporting period for this grant.

1.2.1   Maritime and Multimodal Logistics Management Projects
A Supply Chain-oriented Methodology to Analyze Performance of Port-related Multimodal Freight Infrastructure
Jim Kruse, MBA
Texas A&M Transportation Institute
August 2022-August 2023
Accomplishments: This project was built on past studies to develop a supply chain-oriented methodology to analyze performance of the port-related multimodal freight infrastructure. Specifically, the project team identified and matched the key freight corridors with ship activity to analyze what happens on relevant supply chain corridors at times of ship arrivals and departures.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Analysis of Blockchain's Impacts on and Applicability to Maritime Industry
Jim Kruse, MBA
Texas A&M Transportation Institute
May 2019-October 2020
Accomplishments: Currently, the most prominent blockchain projects in the maritime sector are initiatives by the shipping segment. However, the results presented in this research point toward the fact that ports and marine terminals have a pivotal role in the blockchain functionalities.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Changing Trade and Transportation Patterns: NAFTA, Cuba, and the US Gulf Coast
Bethany Stich, PhD
University of New Orleans
March 2018-September 2023
Accomplishments: Since the 1969 passage of the National Environmental Protection Act, transportation planning has become a complex, interdisciplinary challenge. The need to meet environmental legislation and public participation demands have revealed innumerous problems of outdated techniques.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Combining Truck and Vessel Tracking Data to Estimate Performance and Impacts of Inland Ports
Sarah Hernandez, PhD and Chase Rainwater, PhD
University of Arkansas
January 2019-October 2020
Accomplishments: This project developed a method to fuse truck and marine vessel tracking data to better estimate performance of multi-modal supply chains that use inland waterway ports**.**
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Development and Application of a Methodology for Maritime-Truck Shipments Generation Analysis
Mario Monsreal, PhD and Jim Kruse, MS, MBA
Texas A&M Transportation Institute
December 2017-March 2019
Accomplishments: Truck activity is logically connected to and generated by vessel activity at a port. In turn, vessel activity is generated by truck shipments. Although one might expect a 1 to 1 relationship between the two types of shipments, that is unlikely to be the case. This study shed light on the relationship between multimodal flows to enable agencies and organizations to increase efficiency.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Development of AIS Model of Texas Gulf Intracoastal Waterway Travel Times
Jim Kruse, MBA
Texas A&M Transportation Institute
October 2019-April 2021
Accomplishments: The focus of this research project is to perform analysis on the Texas portion of the Gulf Intracoastal Waterway (GIWW). The Texas GIWW presents a level of complexity significantly greater than rivers because of the intersections with ship channels and the fact that some barges go into and exit port areas while others pass through. Established origins and destinations. Segmented the waterway into links. Analyzed AIS data to identify vessel transits and associated transit times on the links. Developed a methodology for predicting travel times. Evaluated the effect of special conditions.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Driving Simulators as Educational Outreach for Freight Transportation
Sarah Hernandez, PhD, PE
University of Arkansas
August 2021-July 2023
Accomplishments: This project was conducted to enhance outreach efforts for middle and high school student groups for freight career awareness by using truck driving simulators. There is a shortage of truck drivers which contributes to inefficiency in the freight system. There are many complex factors leading to the driver shortage, lack of awareness of the trucking profession is one. Through outreach programs, it may be possible to attract a new generation to freight careers. A paper was submitted to the ASEE.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Evaluating the resilience of port operations to local and regional transportation infrastructure
Jim Kruse, MBA
Texas A&M Transportation Institute
December 2021-August 2023
Accomplishments: This project developed a quantitative model of the local and regional road and rail network that serves a port and the flow of goods to and from the port.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Inland Waterway Travel Time Prediction
Jim Kruse, MBA
Texas A&M Transportation Institute
November 2020-April 2022
Accomplishments: This project built an inland waterways travel time prediction model that builds on and improves existing work at the Corps of Engineers Engineer Research and Development Center.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Interdisciplinary Educational Outreach with Traffic Sensor Build Kits
Sarah Hernandez, PhD, PE
University of Arkansas
May 2019-August 2020
Accomplishments: This project designed and implemented freight oriented educational outreach activities centered on traffic sensing technologies for middle, high, and first-year college students.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Learning from USACE Open Data for Locks
Justin Chimka, PhD
University of Arkansas
August 2018-May 2021
Accomplishments: In August 2017, the USACE began to enable unprecedented data access by publishing its Open Data for Navigation online. This project sought to explore the new USACE Open Data for Locks, describe its relevant datasets and inventory their contents, identify responses or variables across relevant datasets, and diagnose efficient statistical models.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Marine Transport: Documenting the need for value-chain collaborative approaches to achieve decarbonization
Leah A. Dundon, JD, PhD
Vanderbilt University
January 2022-September 2023
This report examines the work of one value chain coalition that has emerged in the North American maritime shipping sector, Blue Sky Maritime Coalition (Blue Sky or BSMC)No single fuel or propulsion system is expected to form the basis of the decarbonization strategy across the full maritime shipping sector. Accordingly, a wide range of companies and stakeholders will need sustained structures, frameworks, and approaches to drive collaboration—Blue Sky serves an important role in this regard as it is developing and implementing such frameworks. Further study of Blue Sky, and of other existing and emerging value chain coalitions focused on sustainability, is needed to share lessons learned and to demonstrate the benefits of such coalitions to advancing decarbonization goals.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Modal Comparison Update: 2001-2019
Jim Kruse, MBA
Texas A&M Transportation Institute
March 2021-October 2021
Accomplishments: In December 2007, the Texas A&M Transportation Institute submitted a report to the U.S. Maritime Administration and the National Waterways Foundation titled "A Modal Comparison of Domestic Freight Transportation Effects on the General Public". Since that time, several updates to the

study have been performed, with the last update covering the period 2001 to 2014. Effects will cover congestion, emissions, energy efficiency, safety, and infrastructure impacts from 2001 to 2019.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Modeling Dynamic Behavior of Navigable Inland Waterways
Heather Nachtmann, PhD and Justin Chimka, PhD
University of Arkansas
August 2018-March 2024
Accomplishments: This project is expanding prior MarTREC research. A literature search and review of prior research on and implementation of container-on-barge was published in the Maritime Economics and Logistics journal (August 2021). We submitted a journal article on the value-focused framework to assess the feasibility of container-on-barge in the United States to the Engineering Management Journal in April 2023. The project ended March 2024.
Completed Project: Final project report will be submitted and distributed as per grant guidelines.

Measures of Freight Network Resiliency: An expanded data capture of Truck Drivers and Support Services under Pandemic Distress
Sarah Hernandez, PhD, PE
University of Arkansas
May 2020-September 2020
Accomplishments: The purpose of this research was to collect timely data on the impacts of the Covid-19 pandemic on truckdriver and trucking operations with a specific focus on issues that affect driver health and safety. An online opt-in panel survey was developed using the Qualtrics survey platform. The survey questionnaire contained 65 questions with skip logic dependent on responses.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Policy and Infrastructure Evaluation Model of Commodity Flows through Inland Waterway Ports
Sarah Hernandez, PhD, PE and Sandra Eksioglu, PhD
University of Arkansas
August 2020-September 2022
Accomplishments: The purpose of this project was to guide strategic investment into port capacity through the development of a policy and infrastructure evaluation model of inland waterway commodity flows.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Shipping Container Chassis in the US: The Legacy of Ocean Carriers
Bethany Stich, PhD
University of New Orleans
March 2018-December 2019
Accomplishments: Almost half of the chassis date from before 1997 and it is common at marine terminals to find chassis well over 20 years old. Newer chassis are safer, as they are outfitted with radial tires, antilock brakes, and LED lights. The evolution of key safety regulations related to chassis usage has placed the burden of compliance on the marine terminals and trucking companies.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

The Changing Legal Landscape of Intermodalism
Bethany Stich, PhD
University of New Orleans
Janey Camp, PhD, PE
Vanderbilt University
July 2021-September 2023
Accomplishments: This project investigated the ongoing legal challenges surrounding chassis. In 2020, Intermodal Motor Carriers Conference (IMCC) of American Trucking Associations and the Ocean Carriers Equipment Management Association (OCEMA) were involved in negotiations to resolve what IMCC charged were high-priced and inferior quality chassis at many of the nation's ports.
Completed Project: Final review of final report for submission

Novel Big Data and Artificial Intelligence Analytics Methods for Tracking and Monitoring Maritime Traf.
Tor A. Kwembe, PhD
Jackson State University
November 2021-December 2023
Accomplishments: This project will utilize Automatic Identification System (AIS) datasets to design scalable Maritime Traffic Monitoring and Analysis (MTMA) applications and tools. Critical applications such as the detection of anomalies, offshore and onshore attacks and data intrusions, require fast mechanisms for Artificial Intelligence (AI) analysis of thousands of events per second, as well as efficient techniques for the analysis of massive historical AIS data. An automated generation of the AutoML end-to-end pipeline model is complete. Data acquired from SPIRE. Testing complete. Module lecture series developed to teach the mathematics and statistical principles for models and model selections.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Network Science-based Analysis of the US Marine Highway Network and a Random Graph Model for the Intermodal Port Network
Natarajan Meghanathan, PhD
Jackson State University
November 2021-September 2023
Accomplishments: Marine highways in the US correspond to navigable waterways that run closer to major interstate roads in the country. Unlike the US Interstate road network and the airport network, the US marine highway network (MHN) and the US marine intermodal port network (MIPN) have not been analyzed and no results have been so far reported in the literature. We propose to analyze the MHN using algorithms for community detection, cluster analysis and centrality assessment to identify the critical marine highways and their intersection points that could potentially be a bottleneck. Collecting the distances and routes (on the marine highways) between any two intermodal ports. We have identified close to 75 major intermodal ports within the US and 16 marine highways connecting them.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Mississippi Multimodal Freight Analysis Model
Tzusheng Pei, PhD
Jackson State University
November 2021-December 2023
Accomplishments: Enable policy makers, transportation planners and logistic analysts in various federal, state, and local agencies for assessing the demand for transportation facilities and services, energy use, and safety risk and environmental concerns. Completed algorithm and development data.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Assessing Maritime Infrastructure along the Mississippi: Chokepoints and Implications for Food Security
Berneece S. Herbert, PhD
Jackson State University
November 2021-September 2023
Accomplishments: Supply chains are inherently complex due to their interdependency with critical infrastructure systems including maritime and multimodal transportation with the largest risk to agricultural trade resulting from age and inadequate or inappropriate infrastructure. It is imperative to close the infrastructure gap. We have assessed hazards to maritime infrastructure and resulting delays in agricultural trade. The second phase of the JSU-UC Berkerley program was conducted in MS supported by a total of 12 students, faculty and researchers. We focused on the transportation issues along the Mississippi River in Vicksburg with the students making recommendations. We also focused on flooding issues along the Pearl River in Jackson.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

1.2.2 Maritime and Multimodal Infrastructure Preservation Projects
A Digital Twin for Visualizing, Evaluating and Maintaining Multimodal Transportation
Haitao Liao, PhD, Shengfan Zhang, PhD, and Heather Nachtmann, PhD
University of Arkansas
August 2021-November 2023
Accomplishments: This research project will develop a digital twin that enables visualizing, evaluating and maintaining multimodal transportation infrastructure. The ultimate goal is to provide an opensource software tool and machine learning-based decision-making approaches that assist the relevant stakeholders in improving their information collection and tracking capabilities, as well as enhancing the resilience of multimodal transportation infrastructure and beyond. We have created a complete dataset for the boats and land transportation.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Multimodal Transportation Infrastructure in Mississippi
Sadik Kahn, PhD, PE
Jackson State University
April 2020 – December 2023
Accomplishments: The existence of Yazoo clay in Mississippi frequently causes distress in levee and highway embankment slopes, which are an integral component of maritime and multimodal transportation infrastructure. This project will investigate the effect of the vetiver grassroots to stabilize levee slopes at the maritime and multimodal transportation infrastructures at Mississippi. Study were presented in TRB AKG 90 Standing Committee on Stabilization of Geomaterials and Recycled Materials.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Climate Financing for Marine Transport: Analyzing the Impact of Climate Adaptation Investments in Inland Waterways
Hiba Baroud, PhD and Craig Philip, PhD
Vanderbilt University
October 2022-June 2023
Accomplishments: We developed a state-of-the-art, data-driven approach to evaluate climate financing strategies for inland waterways based on future costs of inland waterway supply chain disruptions due to climate change. The approach combines recent developments in financial analysis, climate modeling, simulation, statistical inference, and economic modeling. With this methodology in place, we can then

evaluate cases where investments in resilient, waterborne infrastructure can offer cost-effective means of mitigating projected impacts of climate change. Our project paves the way for researchers being able to quantify the return on investment from climate adaptation strategies based on economic impacts of climate change on inland waterway supply chains and can help policymakers better allocate funding for mitigating future supply chain disruptions.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Continued Study of Rapidly Deployable Soil-Cement Mixtures
Cameron Murray, PhD, PE and Michelle Barry, PhD, PE
University of Arkansas
September 2021-December 2023
Accomplishments: The maintenance and repair of maritime infrastructure is critical to maintaining important shipping channels and preventing unnecessary loss of life or economic impact from severe weather events. The fastest repair, reconstruction, and maintenance techniques may become more desirable as labor costs increase and delays become costlier. The objective of this research is to identify the properties and proportions of Belitic Calcium Sulfoaluminate (BCSA) soil-cement mixtures most effective for use in waterway structures. BCSA cement is a rapid setting, low-shrinkage cement which can be used in a similar fashion to portland cement.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

K8 MEMES: K-8 Maritime Education Modules to Engage Students
Gary Prinz, PhD, PE
University of Arkansas
September 2021-December 2023
Accomplishments: This education development project will create entertaining, informative, and STEM promoting "plug-and-play" curriculum learning modules for K-8 educators, using maritime transportation and infrastructure related topics to teach STEM concepts. Coupling music memory, fun STEM theories, and innovative experiential demonstrations into entertaining video learning modules. Three of the learning modules have been outlined, the educational songs have been written and recorded. The educational songs have been written, recorded, and music videos have been completed.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Dredging Projects Selection when the Random Shoaling Effect is Considered
Bruce Wang, PhD
Texas A&M University
October 2019-December 2021
Accomplishments: Dredging is a constant operation to maintain the waterway shipping capacity. The goal is to achieve a maximum network capacity to support the regional and national economies within a given budget. Literature review complete. Problem formulation developed.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Economic Impact of the Gulf Intracoastal Waterway on the States It Serves
Brianne Glover, JD and Jim Kruse, MS, MBA
Texas A&M Transportation Institute
September 2017-August 2018
Accomplishments: This project reviewed existing literature on the economic value of the Gulf Intracoastal Waterway (GIWW), reviewed the importance of the GIWW to the energy industry,

examined the overall economic impact of the GIWW to the states it serves, and estimated the increases in transportation costs resulting from an immediate closure in the GIWW.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Effect of Permeability Variation of Expansive Yazoo Clay, Maritime and Multimodal Trans Infra MS
Sadik Kahn, PhD, PE
Jackson State University
September 2018-December 2019
Accomplishments: The existence of Yazoo clay soil in Mississippi frequently causes pavement distress in multimodal transportation infrastructure. Each year, fixing the pavement requires significant maintenance budget of MS DOT.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Engaging the Business and Tourism Industry in Visualizing Sea Level Rise Impacts to Trans Infra HI
Brian Wolshon, PhD, PE, PTOE
Louisiana State University
March 2018-December 2020
Accomplishments: The goal of this research was to assess the use of 3D virtual and augmented reality as a tool for improved coastal planning for better understanding of sea level rise impacts among the business and tourism industries in Waikiki. The study found that participants were better able to understand the data about flood impacts in the future due to SLR after watching a 3D video.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Evaluation of Hydrogel–stabilized Expansive Soils in Mississippi for Sustainable Maritime Infrastructure Design
Yadong Li, PhD
Jackson State University
August 2019-December 2021
Accomplishments: Expansive soil causes a variety of maritime transportation infrastructure problems, such as cracks, damage of pipeline, and the differential settlement of foundation. Results showed that cracks appeared on the surface of the hydrogel-treated Yazoo clay samples when subjected to moisture.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Fatigue Crack Control in Waterway Lock Gate Pintle Locations Subjected to Multi Modal Fracture
Gary Prinz, PhD, PE
University of Arkansas
August 2018-February 2021
Accomplishments: This research project will address multi-mode fatigue cracking within critical lock gate pintle locations. The lock gate pintle is a ball-and-socket joint that is crucial for proper gate operation but is subject to frequent fatigue cracking. Fatigue crack repair within pintle locations is particularly challenging due to the complex multi-axial loading conditions.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Green Technology Approach for Capturing Pollution Washed from Transportation Infrastructures
Danuta Leszczynska, PhD
Jackson State University
March 2018-December 2019
Accomplishments: This study produced and investigated a carbon-based substance, namely biochar, as a new material for the in-situ adsorption of pollutants carried by the storm water runoff from the roads.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Identifying Critical Waterway Infrastructure and Managing Risk Associated with Natural Disasters
Michelle Barry, PhD, PE and Shengfan Zhang, PhD
University of Arkansas
July 2020-December 2023
Accomplishments: The transportation system in the U.S. is extremely vulnerable to disruptions and delays from natural disasters. The overall goal of this research is to develop a risk assessment framework that can be used to aid decision making and mitigation strategies for maritime infrastructure deemed critical to the U.S. transportation system and economy.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Large Scale Evaluation of Erosion Resistance of Biocementation against Bridge Scour and Roadway Shoulder Erosion
Lin Li, PhD., P.E.
Jackson State University
March 2018-April 2019
Accomplishments: This project examined the feasibility of using biocementation through MICP as an erosion countermeasure. The results of this study bring an important conclusion that MICP-treated soil was weak to resist long-term erosion of exposure to outdoor environment.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Liquefied Natural Gas Phase II: The Future of LNG for the US and Gulf Coast Economies
Bethany Stich, PhD
University of New Orleans
November 2017-December 2019
Accomplishments: The continued growth of Liquefied Natural Gas (LNG) production and long-distance trade has traditionally been taken as a given by global energy analysts, who have premised their positive estimates on gas being both relatively scarce and demand for it virtually unquenchable. Despite Louisiana experiencing a new cargo export potential with LNG and the subsequent construction and pending permitting of LNG Export Terminals in diverse locations along Louisiana's shorelines, the primary finding of this report, based on the state of the current energy market, precludes the utility of a focus on LNG as an export commodity.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Liquefied Natural Gas III: Export Competition in a Well Supplied, Flow-Shifting Global Economy
Bethany Stich, PhD
University of New Orleans
March 2018-December 2019
Accomplishments: With trillions of cubic feet of shale reserves, the United States' (US) abundance of natural gas has prompted an increase in production of Liquefied Natural Gas (LNG) as an export commodity. UNOTI continues to urge that U.S. natural gas energy policy best practice is not to focus on

export and export alone, but rather adopt a diversified and climate responsible energy policy that focuses on the Ports of South Louisiana, the Gulf Coast, and the U.S. remaining globally competitive by investing in necessary LNG fueling infrastructure, as well as continued investment in the existing petrochemical sector of Coastal Louisiana and the Gulf Coast.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Multimodal Network Approach to the Inland and Coastal Waterway System
Bruce Wang, PhD
Texas A&M University
July 2017-January 2019
Accomplishments: This project has developed a multimodal freight network model that includes both waterway landside components in order to analyze the impact of waterway operations. Tests show that the solutions are not sensitive to these parameters. The model illustrates changing the total amount of available budget into five different scenarios, each having an amount allocated to the locks and dams.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Planning for Managed Retreat: Decision Making in the Face of Climate Uncertainty
Leah A. Dundon, JD, PhD
Vanderbilt University
January 2022-September 2023
Climate change impacts are already occurring and are likely to become more severe in the future without increased mitigation of greenhouse gas emissions (IPCC, 2018). There are now areas of the globe where climate change (especially in coastal and inland river areas) has made human habitation difficult or impossible. Accordingly, there is a recognition that a new strategy is needed to respond to climate change—managed retreat. The term "managed retreat" typically refers to the permanent relocation of people or infrastructure away from areas repeatedly threatened by climate-induced extreme weather events. The project has substantially advanced the knowledge and study of managed retreat, an important contribution in this nascent and developing field, especially as it relates to the transportation sector. Transportation planners are faced with management decisions of longlived and expensive infrastructure, and our work in this project provides knowledge, information, and useful frameworks to assist in informing those decisions. The work for this project has resulted in two papers. Two were published in peer reviewed journals (Dundon & Abkowitz, 2021; Dundon et al., 202
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Port Infrastructure Resilience through Combined Wind-Surge Demand Characterization
Gary Prinz, PhD, PE
University of Arkansas
July 2020-August 2023
Accomplishments: This project aimed to understand the interactive effects of severe wind and storm surge demands on port infrastructure and to develop hazard demand models to aid improvements to infrastructure design. An integrated analytical and experimental research approach combined information from detailed fluid-structure-interaction simulations and scaled wind-wave experiments to support port resilience.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Rapid Assessment of Internal Erosion Damage and Erodibility in Levees
Michelle Barry, PhD, PE and Clint Wood, PhD, PE
University of Arkansas
July 2020-December 2023
Accomplishments: Recent flooding events have tested our nation's levee systems and highlighted the vulnerability of our transportation system to disruptions and delays caused by natural disasters. Traditional drilling and sampling techniques only provide discrete data points. This project seeks to make a correlation between geophysical properties and vital engineering properties such as erodibility. Development of the Hole Erosion Test (HET) apparatus has been completed including the addition and calibration of an internal waterproof camera. This novel adaptation will allow for more accurate measurements and more efficient testing to be conducted, as well as potentially lead to an entirely new method for analyzing HET data. The team has identified and tested a number of benchmark samples that will provide a wide range of soil property and erosion behavior data that can be used to develop correlations capable of predicting erosion potential for a given soil. The team also collected field samples from the Crawford County levee and conducted HET and laboratory resistivity testing.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Trade-Off Analytics for Infrastructure Preservation
Greg Parnell, PhD and Ed Pohl, PhD
University of Arkansas
August 2018-December 2019
Accomplishments: The objective of this project was to develop a course that can be taught to civil engineers, industrial engineers, and the maritime and multimodal infrastructure community on the use of trade-off analytics as a tool to assist them in their infrastructure preservation efforts. This course was packaged into a webinar that can be delivered on-line for practicing professionals.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Using CSA Cement for Novel Waterway Repair Materials
Cameron Murray, PhD and Michelle Bernhardt-Barry, PhD, PE
University of Arkansas
August 2018-August 2021
Accomplishments: The goal of this study was to proportion a mortar mixture using BCSA cement suitable for underwater use. The mixture developed is expected to be suitable as a repair material. The mixture was intended to achieve a compressive strength of 4000 psi (27.6 MPa) within 3 hours when placed underwater while being self-consolidating. Mortar flow was measured as well as compressive strength for "dry-cast" and "wet-cast" specimens. A follow up project has been approved.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

1.2.3   Disaster Response and Transportation Planning for Coastal and River Valley Communities

Analysis of the Impacts of the COVID-19 Pandemic on Vessel and Cargo Movements in the U.S.
Brian Wolshon, PhD., P.E., PTOE
Louisiana State University
August 2022-September 2023
Accomplishments: This research seeks to understand changes in national and international shipping trends. We will investigate shifts in cargo movements, by commodity for both import and export operations for several ports across the US. We will also examine changes in origin/destination patterns.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Assessment of Evacuation Network Performance under Different Evacuation Scenarios
Brian Wolshon, PhD., P.E., PTOE
Louisiana State University
July 2019-September 2023
Accomplishments: Several major disasters have occurred in the United States and impacted coastal and river valley communities. The economic and societal impact of such disasters have demonstrated a need for better emergency planning, response, recovery, and adaptation.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Development and Implementation of Sustainable Transportation Resilience Indicators
Mark Abkowitz, PhD
Vanderbilt University
June 2017-March 2019
Accomplishments: This project established a protocol and method for evaluating a community's level of sustainable transportation resilience. If deficiencies exist, attention can be focused on mitigating those concerns. The project was applied to a river valley community to demonstrate proof-of-concept.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Development of Freeway Corridor Capacity Measure to Improve Transportation Resilience
Brian Wolshon, PhD., P.E., PTOE
Louisiana State University
July 2019-August 2022
Accomplishments: Natural disasters like hurricanes and floods leave coastal areas most vulnerable. Capacity is one of the most important characteristics of a freeway facility which quantifies its traffic carrying capability and is a critical component to the resilience of transportation systems.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Evacuation Behavior and its Mobility Impacts in Coastal Communities from Across the Nation
Brian Wolshon, PhD., P.E., PTOE
Louisiana State University
July 2020-September 2023
Accomplishments: Coastal communities are at risk from a multitude of potentially disruptive events. Severe weather, climate change, and sea-level rise all pose serious and long-term societal challenges. This research seeks to develop a better understanding of the travel flow principles that govern the evacuation process and its impact on the mobility of a community, for different hazard types.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Exposure to STEM: Diversity in Maritime Transportation
Rick Coffman, PhD, PE
University of Arkansas
August 2018-September 2019
Accomplishments: The goal of this education and workforce development project was to develop an educational/mentoring/advising model to open doors to all students, regardless of socio-economic background, who want to pursue careers in fields related to maritime and multimodal transportation.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Impacts of COVID Restrictions on Freight Transportation in Coastal and Intermodal Port Regions
Brian Wolshon, PhD., P.E., PTOE
Louisiana State University
February 2022-September 2023
Accomplishments: The global COVID pandemic of 2020 impacted travel patterns across the world. This research will identify and quantitatively assess the impact of COVID-related restrictions on travel activities, with a particular focus on freight and economic activity.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Informing Post Disaster Restoration through Modeling Interdependent Agriculture and Transportation Networks
Sarah Nurre, PhD, Kelly Sullivan, PhD, and Ben Runkle, PhD
University of Arkansas
August 2018-December 2021
Accomplishments: Agriculture supply chains are inherently complex due to their interdependency with critical infrastructure systems including energy, water, and maritime and multimodal transportation. We created a mathematical model to characterize multi-modal transportation flow while incorporating interdependencies between agriculture and transportation.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Informing Post-Disaster Restoration through Modeling Interdependent Agriculture and Transportation Networks - Phase II VU
Janey Camp, PhD, PE, GISP, CFM
Vanderbilt University
October 2018-November 2023
Accomplishments: While disruptions due to weather, etc. can affect any sector, agriculture is unique in its time sensitivity for planting, harvesting, etc. Agriculture is interdependent on other sectors, particularly the transport of products. This project will develop models that determine how to use transportation and coordinate restoration efforts to make ag supply chains more resilient.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Interdependency of Port Clusters during Regional Disasters
Brian Wolshon, PhD, PE, PTOE
Louisiana State University
January 2018-August 2019
Accomplishments: The research built upon prior knowledge and expanded the scientific understanding of regional disruptions to port clusters, areas of the country with multiple ports servicing the same region. The results showed that regionally, ports are more resilient to disruptive events.
Completed Project: Final project report was submitted and distributed as per grant guidelines.
International Port Dependencies and Resilience to Supply Chain Disruptions
Brian Wolshon, PhD., P.E., PTOE
Louisiana State University
August 2022-September 2023
Accomplishments: This research will further identify the most central ports in the network and determine groups of highly interconnected ports.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Modifying Ramp Management Strategies to Enhance Resiliency of Freeway Facilities
Brian Wolshon, PhD., P.E., PTOE
Louisiana State University
July 2020-September 2023
Accomplishments: Increased traffic demand of coastal areas during emergency evacuations have been shown to affect transportation systems negatively. Application of the ramp management algorithms modified by this method becomes increasingly important during emergency evacuation.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Prediction of Port Recovery Time after a Severe Storm Project
Bruce Wang, PhD
Texas A&M University
September 2022-September 2023
Accomplishments: This study will explore the relationship of potential influencing factors on port recovery under adverse storm events. Using multi-source data and applying machine learning algorithms, a model will be developed to predict the port recovery after adverse storm events. The study will benefit transportation agencies and ports by enhancing resilience, safety, and efficiency.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

The Unintended Consequences of Flood Mitigation along Inland Waterways – A Look at Resilience and Social Vulnerabilities
Janey Camp, PhD, PE, GISP, CFM
Vanderbilt University
July 2020 – March 2023
Accomplishments: The objective of this project is to evaluate different flood mitigation efforts in terms of the community costs such as residential buyouts or elevation of structures. We utilized agent-based models and empirical data from select communities where significant buyouts have taken place to simulate and estimate the extent to which buyouts may negatively affect community resilience.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Towards Integrating Resilience into Everyday Transportation Practices of Coastal and River Valley Communities
Brian Wolshon, PhD, PE, PTOE and Nelida Herrera
Louisiana State University
August 2018-March 2021
Accomplishments: Coastal and river valley communities have become increasingly vulnerable to sea level rise, hurricanes, and other natural disasters. In many cases, these events force the communities to evacuate in a relatively unpredictable way. The results showed that the resilience metrics and methods implemented in this study seemed to have captured the resilience of the freeway using simulation. The results of the analysis also showed that active ramp metering improved the resilience of the freeway.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Utilizing Graceful Failure as an Opportunity for Flood Mitigation Downstream to Protect Communities and Infrastructure
Janey Camp, PhD, PE, GISP, CFM
Vanderbilt University
May 2018-March 2020
Accomplishments: In 2011, we observed how "graceful failure" through planned damages to the Birds Point Levee by the US Army Corps of Engineers was enacted to alleviate extreme flooding on the Mississippi River. This action, while flooding croplands as planned in the past, actually reduced flooding and damage to waterway infrastructure and communities downstream.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Vehicle to Infrastructure (V2I) and Vehicle to Vehicle (V2V) passenger and freight vehicle applications to enhance safety and efficiency in coastal evacuations
Brian Wolshon, PhD., P.E., PTOE
Louisiana State University
August 2022-September 2023
Accomplishments: this study seeks to address this limitation by using a driving simulator to assess and understand how drivers interact with V2V and V2I advisories during emergency evacuation scenarios.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

Visualizing Sea Level Rise Impacts in Transportation Planning
Brian Wolshon, PhD, PE, PTOE
Louisiana State University
January 2018-December 2019
Accomplishments: The goal of this research was to test and compare new technologies in community-meetings in South Florida to assess the effectiveness of 3D visualization technology, improving residents' understanding of the impacts of sea level rise on their communities and infrastructure.
Completed Project: Final project report was submitted and distributed as per grant guidelines.

2. Participants & Collaborating Organizations

Arkansas and Missouri Rail, Arkansas Trucking Industry, Arkansas Waterways Commission, Caltrans, Department of Homeland Security, HBCU Fellowship Program, INROADS, International Freight Forwarders & Customs Brokers Association of New Orleans, MARAD, MITRE Corporation, Moment AI, National Waterways Foundation, New Orleans Regional Planning Commission, NSF Regional Innovation Engines, Oak Ridge National Laboratory, Port Freeport Texas, Port of Beaumont, Port of New Orleans, Roadway Management Technologies, Seven State(s) Department of Transportation, USACE, and more

3. Outputs

3.1 Publications

Peer Reviewed Journal Articles

1. Bu, Fan, and Heather Nachtmann, "Value-Focused Thinking Assessment of Container on Barge Maritime Transportation Readiness," Engineering Management Journal, Under Review, 2024
2. Dash,I., Muscatello, R.A., Abkowitz, M.D., Mostoller, E.R., and Sewell, M., "Measuring Pedestrian Stress Response (MPSR) Using Wearable Technologies," Journal of Transportation Technologies Vol.14 No.2
3. Dundon, L., and M. Abkowitz, "Turning Managed Retreat Research into Practice Ready Tools: Needed Guidelines to Reach Stakeholders," Environmental Research Letters, Published, 2024

4. Gonzalez, Ortega, A.J., Barry, M.L., Murray, C.D, "Development of Underwater Mortar Using Belitic Calcium Sulfoaluminate Cement", Advances in Civil Engineering Materials, revision 2024

5. Mallum, Faisal and Bethany Stich, "Assessing the Impacts of Evolving Trade Policies on the Productivity of Key Maritime Hubs. Journal of Maritime Economics and Logistics," Springer Publication, Under Review, 2024

6. Mallum, Faisal and Bethany Stich, "Exploring the Interplay of International Trade Policies, Global Pandemic, and Geopolitical Conflicts on Port Productivity," Journal of Maritime Transportation Research, Science Direct Publication, Under Review, 2024

7. Stich, Bethany, Faisal Mallum, and Brittany Waggener, "Examining U.S. Transportation and Trade Policy Dynamics through the Advocacy Coalition Framework: A Case Study. Journal of Case Studies on Transportation Policy," Elsevier Publication, Under Review, 2024

Books
1. Wolshon, B. and V.V Dixit, "Planning and Management of Transportation Systems for Evacuation," Chapter TBD, Handbook of Emergency Response: A Human Factors and Systems Engineering Approach, Second Edition, ISBN: TBD, Taylor & Francis Publishing Inc., New York, 2024.

3.2 **Website:** martrec.uark.edu

3.3 **New Methodologies, technologies, or techniques -** Nothing to report

3.4 **Inventions, patents, and/or licenses -** Nothing to report

3.5 **Other products –** Nothing to report

4. **Outcomes**

4.1 **Increased understanding and awareness of transportation issues**
Awards
- Brian Wolshon, 2023 Innovator & Influencer Award, Resilient Roads Roundtable, Transportation Industry Advocacy Group.
- Hiba Baroud, Fellow of the International Science Council.
  https://engineering.vanderbilt.edu/2024/01/04/hiba-baroud-is-named-a-fellow-of-the-international-science-council/
Distinguished Lectures from Industry Partners
- Caren Kraska, "Arkansas Missouri Railroad," MarTREC Professional Advisory Board Meeting Distinguished Lecture, University of Arkansas, November 2024, 100 attendees.
- Chris Handzel, "Bus Rapid Transit," University of New Orleans, October 2023, 15 attendees.
- Dan McGrath, "Data analyses for determining transit and active transportation demand," University of New Orleans, October 2023, 15 attendees.
- Derek Chisolm and Anne Watkins, "Transportation Finance with AECOM," University of New Orleans, February 2024, 15 attendees.
- Dwight Norton, "Public Transportation in New Orleans," University of New Orleans, October 2023, 15 attendees.
- Ellen Soll, Colin Ash, Jonathan Gambino, "Planning Safe Streets for All with ATG and Volkert," University of New Orleans, February 2024, 15 attendees.

- Jeff Roesel, "Leading Our Growth and Development: An Inside Look at the Regional Planning Commission," University of New Orleans, March 2024, 28 attendees.
- Marin Stephens and Joanna Farley, " Transit-Oriented Communities with RTA and City of New Orleans," University of New Orleans, February 2024, 15 attendees.
- Randy Guillot, "A View from Every Level: President, Owner, Operator on Supply Chain Trucking," University of New Orleans, March 2024, 20 attendees.

4.2   Passage of new policies, regulation, rulemaking, or legislation - Nothing to report

4.3   Increases in body of knowledge - *Conference Presentations*
1. Abkowitz, Mark "Tennessee Department of Transportation: PROTECT Investment Prioritization Strategy," Transportation Resilience 2023: International Conference on Extreme Weather and Climate Change Challenges, November 2023
2. Holliday, Stephen, "Truck Parking," AT045 Committee Meeting, November 2023
3. Holliday, Stephen, "Truck Parking," LaTREC Meeting, February 2024
4. Holliday, Stephen, "Truck Parking," PAL Board Meeting, Port of New Orleans, November 2023
5. Holliday, Stephen, "Louisiana State's Hydrogen Perspective and Truck Parking," TRB, January 2024
6. Johnson, Paul, "Analyzing the Impact of Climate Adaptation Investments in Inland Waterways," Society for Risk Analysis Annual Meeting, December 2023 Invited
7. Li, Scott, Y. Zhang, and B. Wang, "Ranking Port Impact for Incoming Tropical Cyclones: A Recommendation Algorithm," TRB Annual Meeting. January 2024. Washington DC
8. Prinz, Gary, "Controlling Fatigue and Fracture in Steel Structures During Extreme and Repeated Loads," Rowan University, Glassboro, NJ, January 2024, Invited
9. Prinz, Gary, "K8-MEMES project learning module music videos," Rowan University, Glassboro, NJ, January 2024
10. Stich, Bethany and Faisal Mallum, "Examining Transportation and International Trade Policy Dynamics Through the Advocacy Coalition Framework: A Case Study of the Lower Mississippi River Ports," TRBAM-24-05267, NASEMI TRB, January 2024
11. Stich, Bethany, Janey Camp and Faisal Mallum, "Chassis: The Bottleneck to Trade and Transportation," TRBAM-24-04134, NASEMI TRB, January 2024
12. Wolshon, Brian "Route Diversion as Resilience Strategy: Driver Preference and Behavior," International Industry-Academia-Research Application Cooperation Conference (Engineering and Technology), Beijing, People's Republic of China, November 2023. Invited

4.4   Improved processes, technologies, techniques, and skills
- Assessment of critical transportation extreme weather and climate change adaptation state of the practice and planning needs
- Analysis of factors affecting bicycle and pedestrian crash severity; Use of computer vision for traffic safety analysis
- Use of smart watches to identify stressful mobility locations

4.5 Enlargement of the pool of trained transportation professionals
- 2023 Student of the Year: Bailey Bullock is an urban planner specializing in transportation and geographic information systems (GIS). Bailey holds a Bachelor of Arts in Sociology with a minor in Linguistics and a Certificate in Teaching English to Speakers of Other Languages from Mississippi State University, which led her to spend two years as an English Teaching Assistant at

universities in Colombia through the U.S. Department of State's Fulbright Program. Her experiences with car-free mobility in Colombia motivated her to pursue the Master of Urban and Regional Planning, Master of Science in Transportation, and Graduate Certificate in GIS at the University of New Orleans. As a graduate research assistant at the UNO Transportation Institute, Bailey participated in research and projects related to active transportation infrastructure, community engagement, intermodal chassis, and international trade. Currently, Bailey practices as an urban planner with ViewPro GIS, empowering planners to leverage sophisticated tools to guide sustainable and equitable development in their communities.

- Six programs, 33 classes, and 1381 individuals completed transportation certified courses in the areas of Asphalt, Aggregates, Concrete, Traffic signals, Soils, and Stormwater Management
- Three students graduated with a PhD

4.6   Adoption of new technologies, techniques or practices -Nothing to report

5.   Impacts

5.1   Effectiveness of the Transportation System – Nothing to report

5.2   Technology Transfer – nothing to report

5.3   Increase in the Body of Scientific Knowledge
- Eight projects completed in period
- 12 Editorial positions

5.4   Transfer of Results
- MarTREC Annual Professional Advisory Board Meeting held November 2 and 3, 2024.

5.5   Commercialization of Technology – Nothing to report

5.6   Underrepresented Groups
- 29 k-12 Events (this is outside of the summer camp season)
  - 2,512 students participated
  - 34% female population
  - 31% under-represented population

5.7   Development and Dissemination of New Educational Materials – Nothing to report

6.   Changes/Problems
- We have concluded the project reporting and expensing of our no-cost extension approved by USDOT approved until March 31, 2024. We are currently working on the close-out process.

7.   Special Reporting Requirements – This report exists due to the six month extension that was granted to MarTREC by USDOT.