MarTREC
Maritime Transportation Research & Education Center

**BIL MarTREC Tier 1 UTC Project Request Form**
Project 7012

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| **Submission Date**: 12/2/2024 |
| **Lead Recipient/Grant Number**: University of Arkansas / 69A3552348331 |
| **Principal Investigator Institution**: University of Arkansas |
| **Center Name**: Maritime Transportation Research and Education Center |
| **USDOT Research Priority**: Preserving the Existing Transportation System |
| **Primary USDOT Strategic Goal** (*select drop down*): Safety |
| **Principal Investigator(s) with ORCID(s) and Contact Information**: *Haitao Liao (lead PI) 0000-0003-1050-7086, Shengfan Zhang 0000-0001-9866-7177, Heather Nachtmann 0000-0002-8104-3816.* |
| **Project Partners:** *N/A* |
| **Project Type** (*select drop down*): Advanced Research |
| **Project Research Topic Type** (*select drop down*): Maritime Sustainable and Resilient Infrastructure |
| **Transportation Modes Involved** (*check all that apply*): ☒Waterway ☐Road ☐Rail ☐Pipeline ☐Other |
| **Research Project Funding**: Federal funding amount $166,937, non-Federal funding amount $83,570, Total funding amount $250,507, with $6000 Technology Transfer within the federal funds. |
| **Project Start and End Dates** (Format month/day/year to month/day/year): 1/1/2025 to 6/30/2026 |
| **Project Title**: A simulation and decision-support tool for vulnerability reduction in hazardous material transportation via the U.S. IWTS |
| **Project Abstract (Brief Description)**: Stakeholders are faced with challenges in tracking and managing freight movement, evaluating human-infrastructure interactions (e.g., navigation, lockage), and suggesting alternative solutions in response to contingencies. On the other hand, vessel operators need to have good situational awareness to quickly and effectively avoid hazards and accidents. Among various types of products, hazard materials constitute a great portion of shipments. Such materials can be found in many forms on the U.S. inland waterway transportation system (IWTS), including petroleum products (e.g., diesel fuel, asphalt), chemicals (e.g., fertilizers, pesticides), and household and consumer products (e.g., paints, adhesives). Indeed, petroleum products make up over 75% of waterborne shipments. Compared to highways, rails and other modes of transportation for hazard materials, the waterways have the heaviest shipments. To minimize economic losses while ensuring safety and security during hazardous material transportation, it is invaluable to develop a computerized tool for sharing information and evaluating the impacts of a sequence of decisions, such as voyage planning and rerouting, on freight movement, costs and risks. With previous support from the NSF and MarTREC, this research team has developed an advanced NetLogo-based simulation tool that enables visualizing, evaluating and maintaining multimodal transportation infrastructure. This research project seeks to advance the simulation- and machine learning-based tool to help involved personnel understand how the IWTS currently performs, assess potential risks, and respond to various accidents and disruptions, especially those involving hazard material shipments. The goal is to provide an open-source software tool and machine learning-based decision-making approaches that assist the relevant stakeholders and operators in tracking hazardous material movement, making timely decisions, and enhancing the safety of the U.S. IWTS and beyond. The research findings to be achieved will be broadly disseminated to researchers and practitioners through research publications and presentations. The team will promote real-world applications of the tool by working with MarTREC partners and collaborators. |

**USDOT Priorities**: *According to the Incident Summary Reports powered by the Hazmat Intelligence Portal maintained by the Office of Hazardous Material Safety, USDOT Pipeline and Hazardous Materials Safety Administration, there are a total of 125 water transport incidents during 2014-2023, with an economic loss of $5,942,724. Among these, 55 incidents occurred during "in transit", and the associated commodities include flammable liquids (class 3 hazmat), environmentally hazardous substances, etc. This research project seeks to develop a simulation- and machine learning-based decision-support tool that helps involved personnel understand how the IWTS currently perform as well as predict and respond to various accidents and disruptions involving hazard material shipments considering planned and/or unplanned interactions among human, infrastructure, and nature.*

**Outputs (results of the work performed**): *The expected outcomes/deliverables of this project include: (1) a simulation- and machine learning-based tool for visualizing and mimicking the operation of IWTS and for evaluating the impacts of proactive and reactive actions or natural events on the vulnerability of IWTS, (2) statistical and optimization models and machine learning tools related to data analytics and decision making for providing short- and long-term operation strategies, and (3) publishable case studies and documentations that illustrate the applications of the computerized tool and its impacts on human and environmental safety. We will seek stakeholder involvement, particularly U.S. Army Corp of Engineers, to ensure the success of this project. We will seek feedback on calibration and validation to ensure the practicability of the computerized tool.*

**Outcomes/Impacts**: *The proposed methodology and support tool will be able to provide real-time decision support and impact assessments for incidents involving hazardous materials. Through analyzing historical data and simulating extensive scenarios, the resulting tool will be able to warn the involved stakeholders of the need for precaution, provide incident assessments for the sections impacted by various disruptions, and offer a sequence of optimal actions before and/or after such incidents.*

**Technology Transfer Activities**: *We seek to discuss our ideas with the DOT Pipeline and Hazardous Materials Safety Administration, and Office of Hazardous Material Safety. In addition, we will work with MarTREC to call for a brainstorming meeting to discuss our proposed work and guide our model building, ensuring the usability of the proposed tool to benefit various stakeholders. We will proactively seek stakeholder involvement, particularly USACE, to ensure the success of this project. We plan to meet with the USACE decision makers, learn in depth from USACE's current models and guidelines, and work closely with USACE engineers on model calibration and validation to ensure the practicability of the computerized tool. We will invite stakeholders to test our computerized tool as the research moves forward. The PI will also seek assistance from Technology Ventures at U of A to discuss possible collaboration opportunities for technology transfer. Research papers will be another important means for disseminating our research findings.* Five *percent of the budget will be used to support the proposed technology transfer activities.*

**Final Research Report**: Upon completion of the project, provide a URL link to final report will be provided

**Project Deliverables**: ☒ PI agrees to submit all deliverables within 4 weeks after the project end date.

**Data Management Plan (DMP**): ☒ PI has reviewed and agrees to adhere to MarTREC DMP. Proposed project DMP must be attached to the submission email along with this form.

**Center Director Approval Signature and Date**: Heather Nachtmann 12.23.24