Research Project Name: A Bi-Objective Optimization Approach for Emergency Evacuation Planning under Pandemic Settings

Recipient/Grant (Contract) Number: 69A3552348321

Center Name: Rural Safe Efficient Advanced Transportation (R-SEAT) Center

Research Priority: Improving Mobility of People and Goods

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Research Project Funding: Federal fund amount: $106,289; Non-federal matching fund amount: $53,144

Project Start and End Date: March 1, 2024 – February 28, 2025

Project Description: Different types of hazards occur quite often in different parts of the globe. These hazards may cause significant property damages, monetary losses, and human fatalities. Emergency evacuation can be extremely challenging in rural areas that may not have emergency shelters with adequate capacity in their vicinity, and transportation infrastructure may not be able to handle a large number of evacuees. Furthermore, a frequent occurrence of pandemics makes emergency evacuation planning even more challenging. Rushing to the closest emergency shelter may not be the best choice, because the closest shelters may operate at the capacity level. Overcrowded emergency shelters are expected to have a high risk of virus transmission under pandemic settings. Therefore, this project proposes a new bi-objective optimization model for emergency evacuation planning, aiming not only to minimize the total travel time of evacuees to the assigned emergency shelters but also to minimize the risk of virus transmission in the assigned emergency shelters as well. A custom multi-objective optimization algorithm is developed to solve the proposed bi-objective optimization model. Various case studies are conducted to demonstrate applicability of the proposed methodology for real-life emergency evacuation scenarios. Evacuation of populations residing in rural counties is directly considered during the numerical

experiments. The findings from this research can be used to better prepare rural populations for approaching natural hazards and ensure their safety throughout the evacuation process.
US DOT Priorities: Improving Mobility of People and Goods, focusing on rural transportation.
Outputs: The major outputs of this project include the following: **(1)** A new bi-objective optimization model for emergency evacuation planning, aiming not only to minimize the total travel time of evacuees to the assigned emergency shelters but also to minimize the risk of virus transmission in the assigned emergency shelters; **(2)** Development and application of accurate travel time functions specifically calibrated for emergency evacuation conditions, taking into account representative characteristics of evacuees, driving conditions, evacuation route characteristics, and traffic characteristics; **(3)** A custom multi-objective optimization algorithm to solve the proposed bi-objective optimization model and assist with decision making in a timely manner; **(4)** Application of the proposed methodology for real-life evacuation scenarios to showcase its efficiency and draw important managerial insights that can be useful to the relevant stakeholders for emergency evacuation planning not only in urban areas but in rural areas as well; and **(5)** A decision support system that can be used to better prepare rural populations for approaching natural hazards and ensure their safety throughout the evacuation process.
Outcomes/Impacts: This project has a variety of outcomes and significant impacts that can be summarized within the following areas: (1) Access and Transportation, (2) Efficiency, (3) Safety of Users, (4) Resilience. Furthermore, the proposed project is expected to assist with meeting some of the major goals outlined in the USDOT 2022-2026 strategic plan.
Final Research Report: N/A