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Project Title

Traffic Performance Modeling and Planning of Emergency Medical Response in Rural Areas

University

Colorado State University

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Research Needs

Natural hazards often cause serious consequence on the disruption of infrastructure systems in a community, such as transportation system and buildings, which greatly hinders post-hazard emergency response and early recovery efforts. Given the adverse environments including the disrupted transportation network, serious challenges are imposed to emergency medical service (EMS) to save peoples' lives timely, safely and efficiently following hazards. As the critical step towards the next-generation EMS planning such as EMS vehicle dispatch, optimal routing, and strategic planning of emergency medical centers, it is the key to understand the traffic performance and associated risks for EMS in traffic networks with adverse environments.

Research Objectives

1. Characterization of adverse driving conditions for EMS vehicles under typical hazardous events, including infrastructure disruption, road surface condition and other environmental conditions;
2. Conduct probabilistic EMS vehicle travel analysis by considering the demands due to the infrastructure interdependency and the reduced capacity;
3. Carry out a preliminary demonstration of EMS planning based on the EMS traffic performance assessment.

Research Methods

The study will firstly start with comprehensive literature review of related studies on EMS traffic studies, including travel time, safety and planning, and those on adverse environments following hazards. Secondly, representative adverse driving environments for EMS vehicles are identified for several typical hazardous events. Thirdly, multi-scale traffic performance analysis from individual roads to the whole network will be conducted for EMS vehicles. Traffic performance indices, such as travel time and accessibility of the network, will be studied. Finally, a

preliminary demonstration is conducted in terms of how to apply the developed approach to support EMS planning.

Expected Outcomes

1. A basic framework to model EMS traffic performance in a typical traffic network in a rural region under several major hazardous events by considering infrastructure interdependency and uncertainties.
2. Based on the framework, some planning strategies will be developed which can help EMS planning, such as prioritizing the EMS traffic dispatch and strategic selection of location of EMS centers, etc.

Relevance to Strategic Goals

The proposed study can improve traffic performance assessment and planning of emergency medical service in a community following major hazards, which is important for the strategic goal of "Livable community" (“Improving mobility of people and goods”) and "Safety" (“Promoting safety”) for the society.

Educational Benefits

A graduate student will involve in conducting this study and work toward the dissertation. In addition, some findings can be introduced in the transportation engineering class for graduate students and senior students in the future.

Technology Transfer

This study will be shared with the research community through publications, conference and presentations.

Work Plan

Task 1. Literature review

Extensive literature review will be conducted on the existing studied on 1) EMS safety, planning and operation; 2) adverse driving environment modeling following hazards. Interdisciplinary literatures will be studied to build the state-of-the-art of the related topics. Current challenges and the interactions between different disciplines will be identified.

Task 2. Model adverse driving environments related to EMS following typical hazards

Adverse driving environments related to EMS in rural regions will be identified for different hazards, such as possible road/bridge closure, restricted traffic, adverse road surface conditions, reduced visibility, crosswinds and failed traffic lights at intersections, etc. Time-dependent variations of the driving environment conditions will also be characterized to study the EMS service at different stages following hazards. Associated uncertainties will also be appropriately characterized based on existing studies.

Task 3. Multi-scale simulation of EMS vehicles on road segments with adverse driving environments

Advanced agent-based traffic flow simulation technique will be applied to simulate the travel time and traffic safety performance under the adverse driving environment scenarios identified in Task 2. Probabilistic simulations will be conducted to characterize the traffic performance, such as travel time and travel safety index considering main uncertainties. Following the simulations at the road level, the network performance is further assessed by considering the connectivity, travel time and potential safety risks between the EMS center and the service areas.

Task 4. Framework of network-level EMS planning

A preliminary study will be conducted to demonstrate the potential application on optimal EMS planning service in a prototype rural region for one representative hazard. The study will look into optimal routes for given hazardous conditions and at different stages of the hazard. Studies about the optimal location of EMS center and potential impact will also be carried out.

Project Cost

Total Project Costs:	$120,000
MPC Funds Requested:	$60,000
Matching Funds:	$60,000
Source of Matching Funds:	Faculty and student time, CSU