DRISI
Caltrans Division of Research, Innovation and System Information

Research Results

Multimodal Freight in a Connected Vehicle Environment

A closer look at the transformation of the freight industry in relation to connected vehicles and impacts at the micro and macro levels.

Transportation Safety and Mobility

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Project Title:
Multimodal Freight in a Connected Vehicle Environment

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WHAT IS THE NEED?

The United States Department of Transportation (USDOT) has shown leadership and strong support in adoption of automation-related technologies which are reflected in its preamble of Intelligent Transportation System (ITS) Strategic Plan. This has spurred several private freight manufacturing companies to roll out their next generation fleet of freight vehicles, especially commercial trucks, to be integrated with ITS and connected vehicle technology (CVT) features.

While safety, mobility and environmental benefits are clearly accrued and anticipated from ubiquitous CVT exhibited by a freight vehicle at the micro level, the role of the technology in mobility and resilience building of multimodal freight operations is currently unknown or at least needs an initial investigation at the macro level for freight planning purposes. CVT has the potential to become very relevant and crucial for multimodal transportation, which involves a synchronized operation of two or more modes of freight (such as trucks, rail, air cargo and ports) responsible for transfer of essential goods and commodities on a large scale. However, very little is known about the influence of reliability of CVT network on the freight industry.

WHAT WAS OUR GOAL?

TThe goal of this this research was to understand the implications of CVT implementation for multimodal freight operations through the sequence of three interrelated objectives:

- Understanding constituents/factors for mobility and resilience of multimodal freight operations.
- Determining efficient routes for mobility and resilience with connected vehicles' network reliability.

- Estimating economic costs for CVT-induced route guidance for mobility and resilience.

WHAT DID WE DO?

The objectives of this research were accomplished with six individual tasks:

Task 1: Literature review
This task on literature review consisted of literature reviews on measures of mobility and resilience in the context of multimodal freight transportation. The goal was to identify indicators of mobility (such as congestion index) and resilience for commercial trucks, freight rail, seaport and airport.

Task 2: Modeling mobility and resilience indicators.
In this task, mobility and resilience indicators for links and nodes of a multimodal freight network system were developed. A resilience indicator value of 0 meant an extremely vulnerable link/node and a resilience value of 1 indicated a highly resilient link/node of the multimodal freight network.

Task 3: Developed connected vehicles' network reliability model for route guidance.
This task evaluated the influence of CVT on routing of the freight vehicles in the multimodal operations. This was especially critical for commercial trucks, which, unlike freight rail, have some flexibility in detouring and deviating in order to access other links and nodes of the highway network to complete a trip.

Task 4: Developing CVT-induced routes.
The reliability model from task 3 was used to construct freight routes between major origin-destination pairs over multimodal freight network system. Links and nodes with high mobility and resilience indicator values (developed in task 2) were candidates for determining routes. The routes would have minimal delays due to assistance provided by the CVT-based network reliability model. The routes developed in this task have been illustrated with examples from multimodal freight network from the Southern California region.

Task 5: Estimating economic costs of CVT-induced routes.
The freight routes examined and developed in Task 4 with help from CVT network reliabilities for Southern California region were translated into economic costs (for both mobility and resilience). The economic cost estimations included analysis for freight modes (commercial trucks, freight rail, seaports and airport) at the spatial resolution of traffic analysis zone (TAZ).

Task 6: Preparing report and other deliverables.
The research project was delivered as a final report and it consisted of all the findings documented with a proper presentation of tables and charts. An accompanying PowerPoint presentation has been developed for conveying the research results in conferences or meetings, such as ITS-California in San Francisco and the I-NUF (International Urban Freight Conference) in Long Beach, CA.

WHAT WAS THE OUTCOME?

This research had some key findings and outcomes based on the analysis of four interstates of approximately 12-mile lengths in the Southern California Region for 'without' CVT and 'with CVT' case. The findings suggest the following:

1. I-10 is expected to experience the largest percentage increase in mobility and I-710 would have the largest percentage increase in resilience with the implementation of CVT.
2. Increase in reliability of communication with increase in as many multimodal entities participating in CVT.
3. Optimum radius of sensor transmission range

with CVT is found to be at least 1500 feet and 55 feet for vehicles to be fully connected under sparse traffic conditions and congested traffic conditions, respectively, and

4. An increase in motor carrier operational costs for the 'with CVT' case.

WHAT IS THE BENEFIT?

CVT has the potential to become very relevant and crucial for multimodal transportation, which involves a synchronized operation of two or more modes of freight (such as trucks, rail, air cargo and ports) responsible for transfer of essential goods and commodities on a large scale. This research aimed to understand the implications of CVT implementation for multimodal freight operations, thereby helping the state improve its economic competitiveness, along with enhancing the safety, mobility and environmental benefits of the state's freight network.

LEARN MORE

Review the complete report.
www.metrans.org/research/evaluating-economic-mobility-and-resilience-multimodal-freight-operations-connected-vehicle

IMAGES