

Understanding and Modeling Middle-Mile Logistics Automation - Project 6

Deliverables and Reporting Requirements for UTC Grants Awarded in 2023 (June 2023)

Exhibit D

Recipient/Grant (Contract) Number: The University of Tennessee; University of Illinois Chicago, Grant No. 69-A3552348338

Center Name: Center for Freight Transportation for Efficient and Resilient Supply Chain

Research Priority: Improving Mobility of People and Goods

Principal Investigator(s): Bo Zou (UIC), Kazuya Kawamura (UIC), P.S. Sriraj (UIC), Jane Lin (UIC), Mingzhou Jin (UTK)

Project Partners: Illinois DOT, Amazon, and Kenco Logistics

We have will schedule regular meetings with the partners, update them our progress, and seek feedbacks.

Research Project Funding: \$266,730 Federal and \$94,902 Non-Federal Funding

Project Start and End Date: 8/16/2023 - 5/31/2024

Project Description: Middle mile logistics, particularly drayage - a specific type of middle mile operation dealing with short-distance movements between transportation hubs and nearby facilities - presents a critical component in the national supply chain. Despite representing a small fraction of the total distance covered in intermodal shipments, drayage incurs a disproportionately large share of the overall shipping cost. In addition, when drayage movements occur in urban areas, they can exacerbate congestion on crowded urban road networks. The emergence of vehicle automation offers exciting opportunities to improve the efficiency, resiliency, and sustainability of drayage operations, yet it has not received adequate research attention.

To address this gap, our project will use a mixed method approach - combining qualitative and quantitative research - to assess the potential of automation for drayage operations. On the qualitative side, we will carry out interviews and/or focus groups with stakeholders from prominent freight hubs, such as the Chicago metro region to obtain perspectives of practitioners on how automation can enhance middle-mile logistics. Through this, we aim to glean valuable insights about possible deployment scenarios, and the challenges and opportunities of automation in drayage operations.

On the quantitative front, we will develop an optimization modeling capability to evaluate the impact of automation scenarios on drayage operation performance. Our analysis will consider factors like cost, energy consumption, and emissions to comprehensively assess the benefits of automation. To ground our findings, we will apply the developed optimization model(s) to one or more case studies in the context of drayage operations in the Chicago metro region.

By combining the results of our research, we will attempt to formulate recommendations that outline the possible pathways for drayage automation and related operations management. Ultimately, the outcome of this project will help pave the way for a more efficient and sustainable drayage sector that can significantly contribute to the improvement of the national supply chain.

The objectives of this project are to: 1) develop contextual knowledge to understand the current status of (including different stakeholders involved and their roles and interdependencies in middle mile operations) and challenges and opportunities brought by automation to drayage operations; 2) develop a quantitative model to support optimal drayage operations considering new features brought by automation; and 3) to the extent possible, make recommendations for possible pathways for drayage automation and operations management.

US DOT Priorities: The project will directly support the US DOT strategic goal of *Economic Strength and Global Competitiveness* by enhancing freight movement in middle mile - a largely understudied area - in the US. In addition,

the project will help the US DOT with the strategic goal of *Transformation*, and *Climate and Sustainability*, by promoting automated vehicle deployment in drayage operations, which is expected to be operationally innovative and more efficient, saving energy and emissions. The proposed drayage solution will respond to the RD&T priorities of “*Resilient Supply Chain*”, “*System Performance*”, “*Decarbonization*”, and “*New and Novel Technologies*”.

The proposed approach mixes and integrates qualitative examination and quantitative modeling which mutually inform each other while developing the methodologies. Such a mixed-method approach breaks the silos that often exist between qualitative and quantitative researchers, thus advancing interdisciplinary research. As the critical role of middle mile logistics in the national freight transportation system is often under-appreciated by researchers and practitioners, the understanding, insights, and mathematical tools obtained and developed from this project will fill an important gap thus making a breakthrough in research.

Outputs: This project is expected to generate the following outputs: 1) *qualitative insights* from stakeholder interviews and/or focus groups about the status quo, challenges, and opportunities presented by the automation of middle-mile operations; 2) *an optimization model* that allows for evaluation of automation scenarios and their impacts on drayage operation performance, with numerical application in the context of drayage operations in the Chicago metro region; and 3) *recommendations* that are built on the qualitative and quantitative research findings and outline possible pathways for drayage automation and related operations management.

Outcomes/Impacts: The results from this research will be presented to the public and private project partners, to cultivate their understanding of middle mile automation and inform real-world decision-making on the best strategies to deploy and operate automated vehicles to enhance the cost efficiency, sustainability, and integrity and resiliency of the larger freight transportation system. The research findings will further help mitigate the negative impacts of equipment (e.g., chasses) and labor (truck driver) shortage on drayage operations, which have been prominent in the Chicago region. Given the nationally crucial role that drayage plays in the Chicago metro region, potential implementation of middle mile vehicle operation as directed by the project outputs will ultimately contribute to greater efficiency, sustainability, and resiliency of the national supply chain.

U.S. Department of Transportation

Office of the Secretary of Transportation