Innovative Scheduling Algorithms to Improve Port Operations – Project 8

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

Exhibit D

Recipient/Grant (Contract) Number: The University of Tennessee; Texas A&M University, 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): Luca Quadrifoglio (TAMU), Bruce Wang (TAMU)

Project Partners: NC DOT, GM, UPS, Port of Houston

We are planning to contact Partners to obtain data and seek feedback.

Research Project Funding: $128,415 Federal and $64,207 Non-Federal Funding

Project Start and End Date: 8/1/2023 – 7/31/2024

Project Description: Ports have been bearing the brunt of the impact for months from the different interferences along the supply chain. The pandemic has only exacerbated an already existing problem, as ports and their operations have always been the weakest link of the supply chain network. A particularly significant part of the problem is associated with the scheduling and routing of AGVs (Automated Guided Vehicles) which are performing loading and unloading operations following specific logics. This scheduling problem is modeled with very complex mathematical formulation, inherently difficult to solve, also due to their combinatorial nature. Many significant delays occur due to lack of coordination between the vehicles and the Cranes and Trucks, at both other ends of the port logistics. This is due to uncertainty and lack of reliable forecasts of arrivals, but also to the lack of proper control mechanisms to overcome and prevent this lack of synchronization. This research project will explore these challenges and propose innovative solutions to this complex problem by developing algorithms and solution methods

This research project will explore these challenges and propose innovative solutions to this complex problem by developing algorithms and solution methods.

In particular, we have identified the following general tasks: (1) Literature review on crane operations scheduling; (2) Data gathering and understanding the status quo of crane operations; (3) Develop/Improve efficient algorithms considering special operational characteristics due to equipment and freight flow; (4) Perform a simulation study using Port data; (5) Prepare final report.

Long term implications of a successful outcome of this project will include a potential improvement of the crane scheduling operations, which is a recognized bottleneck of the freight movement worldwide. More specifically, the Port of Houston Authority will have a unique opportunity to understand the impact and the importance of conducting an efficient crane scheduling and may use the new results.

US DOT Priorities: The project will directly support the USDOT strategic goal of Improving Mobility of People and Goods, Reducing Congestion by analyzing and improving supply chain bottlenecks at port operations. In addition, the project will address the RD&T strategic goal of “Economic Strength and Global Competitiveness” by exploring and improving artificial intelligence adaptive practices to enhance port scheduling and logistics. The proposed research is planning to discover and develop alternative scheduling solutions at ports, specifically by tackling the crane scheduling problem, a well-known combinatorial optimization problem, very complex and NP-Hard in the strong sense, meaning that finding optimal solutions for it is virtually impossible. Schedulers rely on approximation algorithms for finding feasible but suboptimal solutions. The efficiency of these algorithms varies and has a high impact on the overall freight operations. An improvement of these practices will create better overall efficiency for these systems and will identify novel algorithms to advance research.

Outputs: Outputs will include needed reports, innovative algorithms, presentations at Conferences and submissions for publication in research journals.

Outcomes/Impacts: Long term implications of a successful outcome of this project will include a potential improvement of the crane scheduling operations, which is a recognized bottleneck of the freight movement worldwide. Authorities will have a unique opportunity to understand the impact and the importance of conducting an efficient crane scheduling. The availability of novel and more efficient tools for crane scheduling operations as outcome to this research would give decision makers an alternative option to current operations.