

JOINT TRANSPORTATION RESEARCH PROGRAM

Principal Investigators: James V. Krogmeier, Purdue University, james.v.krogmeier.1@purdue.edu, 765.494.3530

Darcy M. Bullock, Purdue University, darcy@purdue.edu, 765 494.2226

Program Office: jtrp@purdue.edu, 765.494.6508, www.purdue.edu/jtrp

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Development of an Intelligent Snowplow Truck that Integrates Telematics Technology, Roadway Sensors, and Connected Vehicle

Introduction

The Indiana Department of Transportation (INDOT) manages and maintains over 28,000 miles of roadways. Maintenance of the roadways includes pavement repair in the summer as well as snow removal and de-icing in the winter. The prioritization of assets during winter storm events is crucial and impacts travel and safety. The objective of this project was to identify and develop tools for INDOT operators to effectively perform winter operation de-icing activities.

This project examined application methods and data to provide analytics and make data-driven decisions for state-wide winter operation deployment and operations. Discovery of calibration metrics partnered with fleetwide telematics enabled the development of analytic dashboards that allowed real-time evaluations and adjustments to be made during winter operation activities. These tools will allow the agency to better treat and enhance safety for road users. The advancement of a functioning automated brine applicator provided insight towards development of a functioning, intelligent snowplow.

Findings

The findings of this research were as follows.

1. Calibration of salt spreaders is important to ensure that the proper amount of salt is delivered to the roadway. The team developed and demonstrated new calibration techniques and methods, reducing the material usage and labor needed to calibrate granular de-icing equipment. Figure 1.1a shows the use of the new calibration box and Figure 1.1b

illustrates the calibration workshops held at each district. The URL in Figure 1.1 shows a time-lapse at the Crawfordsville calibration workshop and the complete calibration of a truck (Mahlberg et al., 2021).

2. When anti-icing chemicals are applied to bridge decks, the driver must turn the application on and off at each bridge. One pass on a single lane in one direction requires the driver to turn the brine application on and off approximately 100 times (Figure 1.2a). Depending upon traffic and driver workload, some applications zones may be missed, so there is variation in the number of spray zones between



Brine tanker at government center.

runs (Table 1.1). The team developed and scaled an automated precision brine applicator on two 5,500-gallon tankers (Figure 1.2b) to reduce driver workload and the potential for distracted driving.

- Effectively managing plow trucks during a winter storm requires having good knowledge of where the trucks are so that resources can be most effectively allocated. The project team successfully integrated telematics from 1,100 trucks into real-time dashboards. Figure 1.3a shows a time-space diagram (heatmap) colorized by speed for I-65 northbound direction between mile markers 200 and 262 from February 14th to February 16th, 2021. Snowplow trajectories are overlaid on the heatmap to show snow removal activities with respect to traffic speeds. Additionally, to provide context to winter operation procedures statewide, Figure 1.3b illustrates interstate traffic speeds, weather radar, truck locations, and applied materials on the roadway surfaces. A video of operations during the storm can be found in Figure 1.3. This dashboard allows operation managers to analyse storm impact and effectively deploy trucks. Figure 1.3c shows the interactive feature of the dashboard and the ability for the user to select a truck to determine location information and view the dash camera image. The URL in Figure 1.3 shows a time-lapse of plow deployment during the February 15th, 2021 winter storm (Sakhare et al., 2021).
- Development of after-action winter storm reports to provide agencies with data-driven decisions and training. This information will provide agency management with insight on deployment and evaluation measures of each precipitation event. Figure 1.4a illustrates vehicle speeds operating below 45 mph on Indiana Interstates from January 18th to February 16th, 2021. Figure 1.4b shows the deployed snowplows during that same interval.
- Generation of large-scale dynamic prescription maps for winter road treatment operations utilizing sun-shadow simulation. These prescription maps

provide agencies with a tool to increase treatment efficiently, reduce environmental impact and prioritize high-risk road segments.

Implementation

- Training and implementation of calibration practices should be continued to provide accurate data and ensure correct application amounts.
- Continued implementation and installation of automated precision controllers fleetwide to reduce driver distraction and provide consistent pre-treatment measures.
- Further testing and data validation with the telematic installer to ensure accurate data readings and evaluations.
- Develop training materials to provide agency operators and managers tools to determine operation best-practices and deployment.
- Perform simulation tests on larger road networks and include additional information including degree of shading, weather, and obstacle types to present more accurate sun radiation results.

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