



5-6996-01: Snowplow Operations Management System

Background

Winter road maintenance accounts for approximately 20% of state Departments of Transportation's maintenance budgets. States and local highway agencies spend an average of \$2.3 billion on winter operations every year. Nevertheless, over 5 million vehicle crashes occur in the U.S. each year, and approximately 21% of these crashes happen in adverse weather (i.e., sleet, snow, etc.). According to the National Highway Traffic Safety Administration (NHTSA), about 5,000 people are killed and over 418,000 are injured in weather-related crashes each year. These crashes also contribute to approximately \$70.7 billion in property damages, including damage to the road infrastructure. Real-time road condition information, especially road condition images, provide valuable information for transportation operations managers in enhancing their winter operations practices.

The primary objective of this project is to develop a Snowplow Operations Management System to (1) collect and display a live feed of road condition images from tablets mounted on snowplows; (2) collect and display on-demand road condition images upon request from TxDOT staff either in the field or office for real-time analysis; (3) collect weather information that facilitates snowplow operations decisions from national weather services, to be visualized along with snowplow locations and road conditions images; (4) estimate road surface temperatures and visualize the road segments prone to icing hazards; (5) develop an easy-to-use map-based ArcGIS interface displaying the collected real-time road condition images, weather information from national weather services, road surface temperatures, and roads prone to icing hazards to improve the safety and efficiency of snowplow operations; and (6) estimate the implementation cost of the Snowplow Operations Management System for TxDOT, including the capital cost and operating cost.

What the Researchers Did

The research team developed the Snowplow Operations Management System by:

- Turning tablets into snowplow operations management devices to provide road condition images for real-time analysis.
- Collecting weather information that facilitates

snowplow operations management decisions from national weather services and visualizing it in an interactive, map-based interface.



Figure 1. A TxDOT snowplow with a mounted tablet on the front windshield

- Developing statistical models to estimate road surface temperatures using the forecasted weather data from the National Digital Forecast Database administered by the National Weather Service.
- Developing an easy-to-use map-based ArcGIS interface visualizing all collected road condition information through interactive maps and GIS layers.
- Setting up a pilot test in the TxDOT Wichita Falls district as proof of concept to evaluate the system's performance during the 2020–21 and 2021–22 winter seasons.

What They Found

With the implementation of the Snowplow Operations Management System in the TxDOT Wichita Falls district, related road condition information was provided

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Figure 2. Custom application running on a tablet to collect road condition images

to the district’s transportation managers to facilitate decision-making and planning for snowplow operations.

The research team developed an approach to turn tablets into snowplow operations management devices to automatically collect road condition images at predetermined time intervals (e.g., every 10 minutes) and transfer them to the cloud using a custom application. They processed and visualized the collected road condition images in an ArcGIS map-based interface for a predetermined period of time (e.g., one hour). They also developed a feature in the system that facilitated providing on-demand images of road conditions upon requests from TxDOT staff either in the field or office for real-time analysis.

Moreover, they identified the practical weather information that is helpful in enhancing snowplow operations decisions and integrated this information, taken from national weather services, into the map-based interface using Esri map services.

The research team also estimated road surface temperatures by developing sets of statistical models that allowed them to do so using available forecasted weather data. From extensive data collection and statistical analysis on actual road surface temperatures and ambient weather data during the winter season, the research team concluded that the ambient temperature, relative humidity, wind speed, average temperature of

the previous day, and road surface condition (wet/dry) are correlated with road surface temperatures. They also developed an approach to visualize estimated road surface temperatures for up to five days.



Figure 3. Map-based interface displaying the road conditions information during winter operations

What This Means

This implementation project helps communicate adverse road conditions, improve snowplow operational decisions, and consequently decrease weather-related crashes. Real-time images of road conditions allow transportation operations and maintenance managers to monitor road conditions visually and make well-informed decisions during snowstorms.

In addition, access to weather information from observing systems and forecast providers, along with information about road surface temperatures, provides essential information to TxDOT operations managers about possible locations of low road surface temperatures and potential ice and snow hazards on roads. This information could improve decision-making for deploying snowplows to administer anti-icing and snow-removal measures on roads during winter operations.

For More Information

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