Implementing a Winter Maintenance Decision Support System

Indiana Department of Transportation's Process, Success, and Savings

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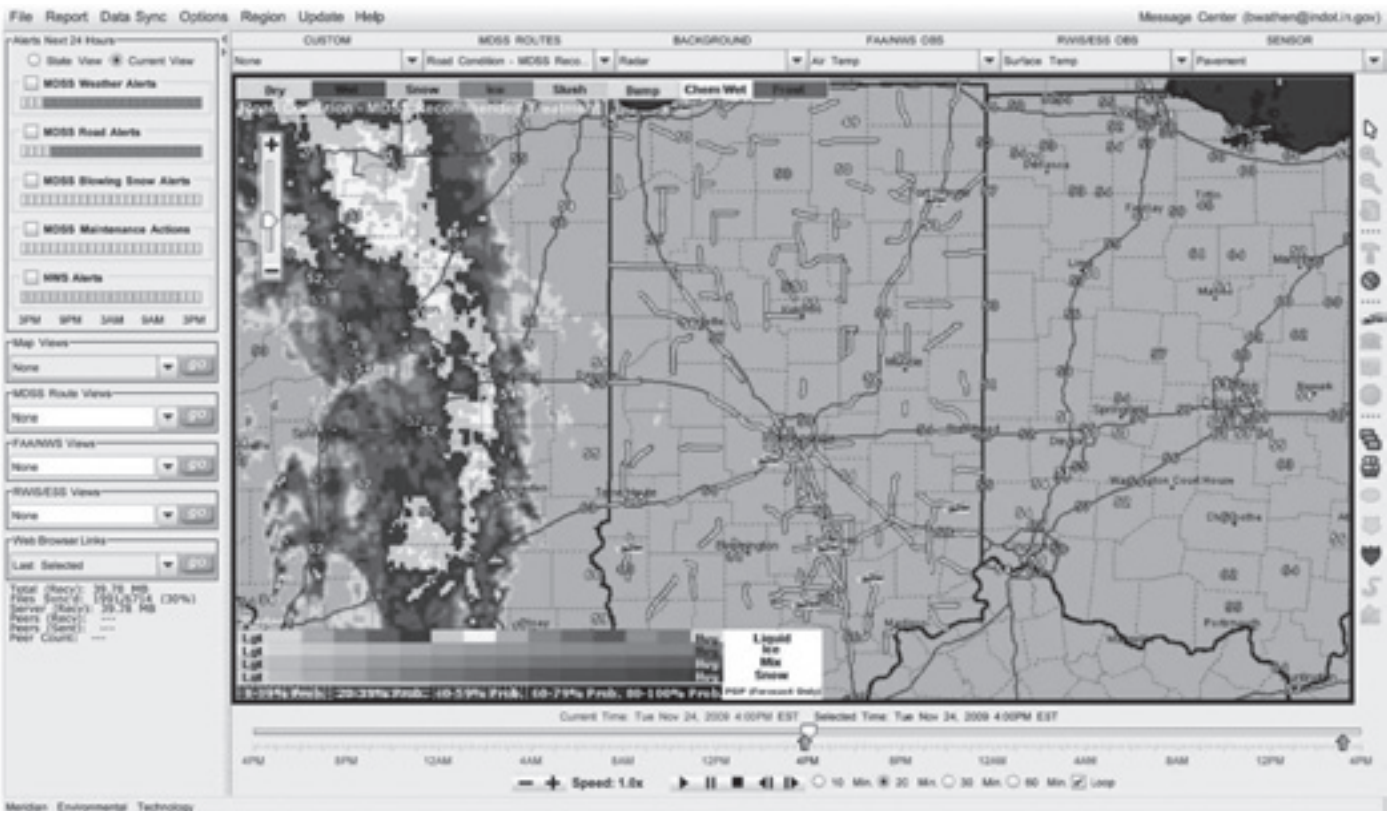
Collectively, state and local departments of transportation (DOTs) in the snow-belt states spend approximately 25 percent of their maintenance budgets—or more than $2.3 billion—annually on winter maintenance operations.[1] Even slight improvements in the efficiencies of snow and ice control operations, therefore, can save millions of dollars.

Problem

Charged with providing safe and efficient transportation for motorists, agencies apply maintenance treatments to minimize the adverse impacts of winter storms. For decades, winter maintenance decisions have depended on the experience and judgment of maintenance supervisors and personnel, who decided what treatments to apply and when to apply them. The decision makers had to rely on their knowledge of pavement conditions; the effects of previous treatments; the prevailing and forecast weather conditions; and the availability of the agency's winter maintenance techniques and resources.

Recent developments in computers and numerical modeling, however, have made possible the processing of large volumes of weather and maintenance operations data in near real-time to support and improve winter maintenance operations.

[1] Road Weather Management Program, Federal Highway Administration, http://ops.fhwa.dot.gov/weather/index.asp.



(*Below:*) MDSS map view displays weather radar and roadway conditions on a background of states and counties.

SOURCE: INDIANA DEPARTMENT OF TRANSPORTATION

Solution

In 2002, Indiana DOT joined the South Dakota, North Dakota, Minnesota, and Iowa DOTs in a pooled fund study to develop a maintenance decision support system (MDSS). The system started with a federal prototype that integrated relevant weather forecasts, winter maintenance rules of practice, and maintenance resource data to recommend appropriate road treatment strategies to maintenance managers.[2] The study now has 15 state DOTs participating, with support provided by Meridian Environmental Technology, Inc.[3]

The primary objectives of the pooled fund MDSS research project are to

- Assess the need, potential benefit, and receptivity for state and regional MDSS among participating state DOTs;
- Define functional and user requirements for an MDSS that can assess road and weather conditions, forecast weather that will affect routes, predict changes in road conditions after application of the recommended maintenance treatments, suggest optimal maintenance strategies, and evaluate the effectiveness of the maintenance treatments that are applied;
- Build and evaluate an operational MDSS that will meet the requirements of the participating state DOTs; and
- Improve the ability to forecast road conditions in response to changing weather and applied maintenance treatments (*1*).

Going Statewide

As part of the pooled fund MDSS effort, Indiana DOT conducted field trials for three winters, starting in 2005–2006, adding routes and improving communications processes each year. A significant finding from field trials was that participating subdistricts reduced salt use from 10 to 30 percent compared with the use in neighboring areas. Indiana DOT's Fiscal Year (FY) 2008 budget for salt exceeded $20 million—even a 10 percent savings in salt use would have a positive impact on the DOT's budget. The Indiana DOT administration therefore decided to implement the MDSS statewide during the winter of 2008–2009 (*2*).

Indiana DOT developed and provided training on the use of the MDSS to winter maintenance personnel throughout the state. The statewide implementation of the new system required a significant change in the department's winter maintenance procedures and a change in the mindset of the employees. The reasons for the change in the approach were communicated throughout the organization, to gain early acceptance at all levels.

Feedback mechanisms were created to assure that input from employees at all levels received appropriate consideration. The MDSS was introduced at the Indiana DOT Snow and Ice Conference in September 2008 to ensure that all employees received the same message.

Training Modules

Indiana DOT's implementation team developed training modules to provide the working knowledge to support successful implementation of the MDSS. The training modules included the following:

- Graphical User Interface Module—presenting the screen views of the MDSS for maintenance employees;
- Quality Assurance–Quality Control Module—presenting a checklist to assure that the system is functioning properly and to foster a sense of trust in, and ownership of, the MDSS by employees;
- Snowplow Drivers' Classroom and Hands-On Module—reviewing the operation of equipment for automatic vehicle location (AVL) and mobile data collection (MDC), installed in the snowplow trucks; and
- Mechanics Module—detailing the installation of AVL and MDC equipment in the snowplow trucks.

Starting Up

The MDSS used by maintenance employees in winter maintenance operations connects to a central server that continually transfers current and forecast weather data, conditions for all routes in the state, advisory messages, and available maintenance actions. The MDSS functions as a window to past, present, and future weather and highway conditions, as shown in the map view on page 35.

Indiana DOT equipped 10 percent of the state fleet with AVL and MDC units, and a vendor provided training at a total cost of $529,000. The newly equipped trucks and their routes were used as rep-

[2] FHWA Road Weather Management Program Publications, http://ops.fhwa.dot.gov/weather/resources/publications.htm.
[3] Development of Maintenance Decision Support System, www.pooledfund.org/projectdetails.asp?id=240&status=6.

TABLE 1 Comparison of Indiana DOT Salt Use for FY 2008 and FY 2009

Statewide	FY 2008 Tons	FY 2009 Tons	Difference in Tons	Savings @ $53/ton
Salt Usage	558,274	329,804	228,470	$12,108,910
Normalized Salt Usage	518,078	329,804	188,274	$9,978,536

TABLE 2 Comparison of Indiana DOT Overtime for FY 2008 and FY 2009

Statewide	FY 2008 Hours	FY 2009 Hours	Difference in Hours	Savings @ $23.33/hour
Overtime Compensation	226,484	168,210	58,274	$1,359,591
Normalized Overtime Compensation	210,177	168,210	41,967	$979,136

resentative samples for the state. A few problems arose during implementation—equipment failure and errors in predicting storm start times and the types and amounts of precipitation—but all were resolved quickly.

Because winters vary from year to year, the observed data were normalized by determining three-year averages of salt use and of the hours of snow and freezing rain during each July 1 to June 30 fiscal year. The information about salt use came from management systems, and the hours of snow and freezing rain were obtained from measurements at five different National Weather Service sites in the region. The goal was to generate reports of salt used per hour of snow and freezing rain for each of the six DOT districts and for the state. In addition, researchers tracked worker overtime compensation during the winter operations.

Benefits

Indiana DOT realized that the MDSS is a tool that forecasts weather conditions; recommends chemical and mechanical treatments; assists management in providing a consistent level of service throughout the state; and provides proactive planning for forecast storms. The AVL and MDC units provided timely input on each truck's activity, such as its spread rate, speed, and plowing, and cameras installed in the trucks provided managers and others with a view of the field conditions—known as ground-truth readings. This information assisted in coordinating efforts among all involved in winter operations.

A comparison of FY 2008 and FY 2009 revealed that implementation of the MDSS saved Indiana DOT $12,108,910 by reducing salt use by 228,470 tons (40.9 percent) and another $1,359,951 by reducing overtime compensation by 58,274 hours (25.7 percent). When normalized for varying winter conditions, Indiana DOT's savings came to $9,978,536 through reduced salt use and $979,136 through reductions in the need for overtime (see Tables 1 and 2, above). The efficiencies gained by optimizing the maintenance strategies for snowplow routes produced a total savings in material and labor of $10,957,672 during the 2008–2009 winter season.

Implementation of the MDSS statewide has generated a significant net savings in the first year, and Indiana DOT anticipates a continued accrual of benefits annually, as the MDSS continues to be integrated into standard operational procedures.

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2. McClellan, T., P. Boone, and M. A. Coleman. *Maintenance Decision Support System (MDSS): Indiana Department of Transportation (INDOT) Statewide Implementation—Final Report for FY09*. Indiana Department of Transportation, Indianapolis, 2009.

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Suggestions for "Research Pays Off" topics are welcome. Contact G. P. Jayaprakash, Transportation Research Board, Keck 488, 500 Fifth Street, NW, Washington, DC 20001 (202-334-2952; gjayaprakash@nas.edu).