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MDSS Implementation Costs in Wisconsin

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Aurora Project 2011-04

Final Report
November 2013

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16. Abstract

Maintenance Decision Support System (MDSS) technology is a tool initially developed using Federal Highway Administration (FHWA) funding. It is designed to integrate state-of-the-art weather forecasting and pavement modeling with an agency's rules of practice for winter operations to generate recommended maintenance actions. The goal is to enhance winter maintenance decision making in order to provide more effective responses to winter weather events.

This report attempts to quantify the costs associated with the deployment of the Pooled Fund Study MDSS in Wisconsin so that other state DOTs have an idea of the various levels of deployment possible and the costs associated with each.

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MDSS IMPLEMENTATION COSTS IN WISCONSIN

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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INTRODUCTION

At the 2009 Winter Maintenance Peer Exchange in Madison, Wisconsin, a question was raised about the true cost of implementing Maintenance Decision Support System (MDSS) technology. Several state departments of transportation (DOTs) were interested in various levels of MDSS deployment. The resulting problem statement was transferred to the Federal Highway Administration (FHWA) Aurora Program Transportation Pooled Fund (TPF) for research.

This report attempts to quantify the costs associated with the deployment of the MDSS in Wisconsin so that other state DOTs have an idea of the various levels of deployment possible and the costs associated with each. This is not intended as a benefit-cost study.

BACKGROUND

MDSS is a tool initially developed using FHWA funding. It is designed to integrate state-of-the-art weather forecasting and pavement modeling with an agency's rules of practice for winter operations to generate recommended maintenance actions. The goal is to enhance winter maintenance decision making in order to provide more effective responses to winter weather events.

Numerous snow-belt states have implemented MDSS with just that goal in mind. At least two vendors now offer versions of MDSS to their customers. The prototype initially developed in 2001 by several federal laboratories has been updated continually by the National Center for Atmospheric Research (NCAR) and is in use by several agencies. Finally, a large group of state DOTs, led by the South Dakota DOT banded together to design and implement an enhanced version of the federal prototype MDSS under an FHWA Pooled Fund Study. That consortium continues to enhance the MDSS (FHWA 2011).

Since implementation, several benefit-cost studies have been conducted. The Maine DOT examined a rather rudimentary MDSS configuration in 2007 (Cluett and Jenq. 2007). They found benefits to be gleaned from MDSS, mainly by increased use of enhanced, more-accurate weather forecasts. They stated that the benefits would be greater had crews perceived the forecasts and treatment recommendations to be more accurate.

The Indiana DOT undertook a statewide MDSS implementation during the winter of 2008–2009. They produced a detailed report that did contain some cost information, but that was more oriented toward the actual implementation process (McClellan et al. 2009). The report stated that they spent approximately $370,000 through FY 09 implementing MDSS and the automatic vehicle location-global positioning system (AVL-GPS), while realizing a savings in salt application of 14.7 percent despite snow and freezing rain hours being up 18.1 percent compared to the three-year average for both.

The Wisconsin DOT (WisDOT) began implementing MDSS and AVL-GPS in 2009. The goal of this report is to examine various levels of the Pooled Fund MDSS deployment examined by

WisDOT, and to quantify the costs associated with each of these, using actual numbers when possible. From here forward, all references to MDSS refer to the Pooled Fund MDSS implemented by Wisconsin.

MDSS IN WISCONSIN

WisDOT provides an interesting case study for MDSS implementation costs. In Wisconsin, the state DOT is responsible for the maintenance of the state trunk highway network, which consists of approximately 34,000 lane-miles of interstate, US highway, and state trunk highway. However, WisDOT does not maintain this network directly. It contracts the work with Wisconsin's 72 county highway departments.

Operations vary widely among these county highway departments and range from strictly urban operations in some southern Wisconsin counties to totally rural operations in many northern counties. This wide variance in operations from county to county provides an excellent opportunity to analyze different levels of MDSS implementation across the state, along with the cost associated with each level.

Figure 1 shows the Wisconsin highway network as well as the county boundaries.

Legend

Interstate Highway

US Highway

State Trunk Highway

Figure 1. Wisconsin highway network by county

WisDOT planned for a three-phase deployment of MDSS and AVL-GPS as follows:

I. All counties having any interstate highway: winter 2009–2010

II. Statewide, with MDSS forecast services for four to five "representative" winter maintenance routes in each county: winter 2010–2011

III. Statewide, with all routes programmed into the system in order to track material usage: winter 2011–2012

In Phase I, few counties had AVL-GPS technology installed on winter maintenance vehicles. The first winter was intended as a "breaking-in" period in which county highway departments would familiarize themselves with the MDSS technology. In Phase II, AVL-GPS implementation was the major focus, along with increased use of the MDSS software. Phase III was more behind-the-scenes programming in anticipation of someday being able to use MDSS to track winter maintenance activities.

WisDOT joined the MDSS Pooled Fund in late 2009. The version of MDSS that was deployed is that developed for the Pooled Fund by Iteris. WisDOT staff felt at the time that this was the most advanced MDSS option available.

As of April 30, 2013, 47 of Wisconsin's 72 county highway departments (65 percent) had either implemented or agreed to implement AVL-GPS technology. Almost all had at least experimented with MDSS. Figure 2 shows the counties that have deployed AVL-GPS shaded (in green).

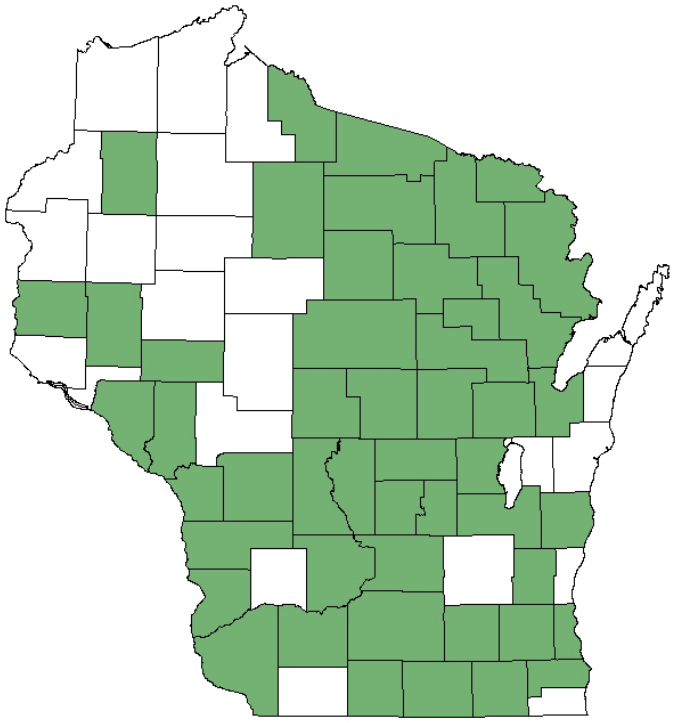

Figure 2. Wisconsin counties that have deployed AVL-GPS as of June 1, 2013

Only two Interstate counties (Kenosha in the southeast and Jackson in west central Wisconsin) have not yet decided to use MDSS technology as a tool. Current MDSS use varies widely around the state. Statistics indicate that many counties are using the software extensively, while others go months without looking at the data.

LEVELS OF MDSS IMPLEMENTATION

WisDOT examined two levels of MDSS implementation prior to deployment. The first uses MDSS only, without any AVL-GPS data being supplied to the system. The second uses the same MDSS deployment, but with AVL-GPS data being supplied to the system. Table 1 compares the advantages and disadvantages of each option.

Table 1. Advantages and disadvantages of each MDSS implementation level

Method	Advantages	Disadvantages
No AVL-GPS	• Relatively inexpensive • Quicker deployment • Less technology	• No vehicle data feedback into MDSS • Treatment recommendations not based on what was actually done previously

Method	Advantages	Disadvantages
With AVL-GPS	• Vehicle feedback goes into MDSS • Treatment recommendations continually updated based on actual treatments done to roads	• Higher cost • More vehicle maintenance required because of additional sensors in harsh environment • Longer deployment time

This table pertains only to MDSS. Certainly, AVL-GPS offers many additional advantages on its own, such as vehicle position and engine performance tracking.

WisDOT decided that to obtain optimum performance from MDSS, it would try to outfit as many counties as possible with AVL-GPS. To fund this deployment, WisDOT used several intelligent transportation system (ITS) earmarks authorized by Congress. Because of Wisconsin's unique relationship with the county highway departments, each county had the option to accept or reject the funding of AVL-GPS deployment. Those that did not accept the funding provide an excellent cost comparison with those that did.

Level 1: No AVL-GPS Deployment

The cost calculation for this category is straightforward. It is essentially the cost of configuring and operating the MDSS without any associated AVL-GPS equipment. Thus, costs are broken out into one-time start-up costs and ongoing operations and maintenance costs.

One-Time Start-Up Costs

To implement the Pooled Fund MDSS, configuration data must be provided for each route. These data consist of the following:

- Route start and end points
- Average annual daily traffic, separated into automobiles and trucks
- Highway speed limit
- Highway lane width
- Plow route cycle and traversal times
- Level of service
- Hours of operation
- Pavement characteristics

Most of these data were readily available within WisDOT, with the exception of plow route information. WisDOT worked closely with the county highway departments to acquire these data. Significant WisDOT staff time was expended compiling all of the information into a useable format. While this cost is difficult to estimate, it did require the equivalent of one full-time employee for approximately two months.

Once the data were compiled, they were sent to Iteris for incorporation into the MDSS. Between Phase I (interstate highways) and Phase II ("representative" routes in each county), 400 plow routes were entered into MDSS. At a unit cost of $142.62 per route, the total configuration cost for these 400 routes was $57,048. All MDSS routes had this basic cost associated with them.

Training is both a start-up cost and an ongoing one. For the initial training, WisDOT arranged a total of 13 sessions statewide. WisDOT provided laptop computers for all trainees. Iteris and WisDOT personnel presented the training in a total of eight locations. Iteris charged a total of $7,700 for their portion of the training. Two WisDOT personnel assisted in presenting the sessions, for a total of 24 person-days. If we assume a rate of $50 per person-hour, the total cost to provide training would be approximately $10,000.

Table 2 summarizes the MDSS start-up costs.

Table 2. Summary of MDSS start-up costs

Item	**Unit Cost**	**Total Cost**
Compile Route Information	$50/hour	$16,000
Configure MDSS	$142.62/route	$57,048
Iteris Training	$7,700	$7,700
WisDOT Training	$50/hour	$10,000
Total		**$90,748**

Ongoing Costs

The Wisconsin MDSS has five ongoing costs:

- *Forecast Support*. MDSS requires weather forecast information. It can ingest any digital forecast. For ease of implementation, WisDOT chose to continue receiving that forecast information from Iteris. The annual cost for this service is $64,000.
- *Weather Alerts*. WisDOT requires alerts sent to cell phones or email as part of the MDSS service. The annual cost for this service is $18,000.
- *MDSS operations*. The annual cost for Iteris to operate the WisDOT-configured MDSS is $90,000.
- *Training*. WisDOT considers annual training (both refresher and continuing education) essential to efficient use of the MDSS. The total cost between Iteris and WisDOT is about $10,000.
- *Pooled Fund Membership*. While membership in the MDSS Pooled Fund is not mandatory, WisDOT considers it essential to stay abreast of what other states are doing with the program. The annual cost of membership is $25,000.

Summing all of these costs, the annual cost to operate the basic MDSS is approximately $207,000.

Level 2: Basic MDSS Plus AVL-GPS

The cost calculation for this category isn't quite as straightforward. It most certainly includes all start-up costs listed in Table 2. However, AVL-GPS implementation took several forms in Wisconsin because of the many different snow plow configurations employed by the county highway departments.

Most county highway departments had Force America controllers installed on their vehicles, but these controllers were of many different vintages and such that no two counties were exactly alike. Because of this disparity, there was no one standard configuration that could be procured. WisDOT required the counties that accepted the AVL-GPS funding to obtain installation estimates before signing a funding agreement with WisDOT. Once an agreement was in place, funding was allocated to the county for AVL-GPS installation.

The basic AVL-GPS installation generally consisted of the components shown in Table 3.

Table 3. Summary of AVL-GPS installation components and costs

Item	Unit Cost	Number Purchased	Total Cost
AVL-GPS location technology	$900	944	$849,600
Auger sensor	$1,000	944	$944,000
Tailgate spreader sensor	$700	944	$660,800
Plow up/down sensor	$200	944	$188,800
Air/pavement temperature sensor	$1,000	944	$944,000
Communications equipment	$1,500	74	$111,000
Total	**$5,300**	**944**	**$3,698,200**

In many cases, a county did not have the proper Force America controller required to feed data into the AVL-GPS. In those cases, WisDOT also paid to upgrade the controllers and, in some cases, this involved major expenditures. These expenditures ranged in cost from $4,000 per vehicle to $20,000 for older vehicles, which formerly used cables instead of electronic equipment to control the salt distribution and plow functions of the truck.

In the most extreme cases, new hydraulic cabling was installed. These installations required a significant amount of labor (hours). Upgrading some of these very old systems may have led to an even greater benefit in cost and material savings than using MDSS alone. WisDOT did not specifically track the cost of labor and parts separately.

Table 4 shows the cost information for AVL-GPS installation, including all labor and controller upgrade costs.

Table 4. AVL-GPS installation costs, including labor and controller upgrades

AVL-GPS Cost	Cost
Total (parts and labor)	$5,544,306
Average Per Truck	$5,818
Median Per Truck	$5,804
Highest Per Truck (entire county plow fleet)	$19,213
Lowest Per Truck (entire county plow fleet)	$2,884

For a more complete evaluation, operational costs must also be considered. To facilitate timely delivery of truck data to MDSS, WisDOT elected to use cellular modem communications between the vehicle and PreCise's data server. The cost for the service and associated data processing is $35 per month per vehicle. In WisDOT's case, that amounts to approximately $400,000 per year. In an effort to control costs, WisDOT has encouraged some counties to feed data back to PreCise via WiFi service where available, which is much less expensive but not as timely.

One potential cost that was not part of the initial MDSS plan in Wisconsin is a technology licensing fee. The fee is the result of a patent issue between Iteris and another vendor. A licensing fee of $40 per month per truck is now being charged for every vehicle feeding AVL-GPS data into MDSS. Due to the total cost of this additional fee, WisDOT has scaled back how many vehicles feed data into MDSS. This fee was not in place when WisDOT originally implemented MDSS and was not part of WisDOT's initial implementation cost. It is, however, a cost that any potential MDSS implementers should be aware of when estimating the implementation and operational costs of MDSS deployment.

SUMMARY

WisDOT deployed two versions of the Pooled Fund MDSS. The full version ingests AVL-GPS data and the other uses MDSS as a standalone system with no AVL-GPS data feed. The cost to WisDOT was approximately $90,000 for the initial statewide deployment. This cost includes items such as route configuration and user training. The cost of the enhanced version of MDSS that includes AVL-GPS feeding truck information back into MDSS was approximately $5.5 million to deploy on 900 vehicles, or about $5,800 per vehicle. The ongoing cost for the enhanced MDSS is about $200,000 per year for the MDSS portion and $400,000 per year for AVL-GPS.

ADDITIONAL RESEARCH

The next recommended step is a detailed benefit-cost analysis. An initial benefit-cost study for AVL-GPS was done following the first winter of implementation (Santiago-Chaparro et al. 2012). It showed a benefit-cost ratio of between 1.05 and 1.89. Now that this technology has been in place for several years, an additional study including both MDSS and AVL-GPS is recommended.

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