

WEATHER-SAVVY ROADS



Weather-Savvy Roads Benefits and Costs

The **Weather-Savvy Roads** effort through round four of Every Day Counts (EDC-4) consists of two distinct strategies that allow State and local agencies to be proactive in managing the surface transportation system ahead of and during adverse weather events. The Pathfinder and Integrating Mobile Observations (IMO) strategies can help agencies manage road systems and inform travelers during heavy rain, snow, and other weather events that can have significant impacts on the safety, mobility, and productivity of road users.

This fact sheet describes the **benefits and costs** that agencies might expect from deployment of Pathfinder and IMO solutions. While both solutions can result in improved highway safety, mobility, and productivity, each has a unique set of benefits and costs. Examples are presented from agencies that have implemented Pathfinder or IMO.

Resources are available from the Federal Highway Administration for agencies interested in planning and conducting a detailed **benefit cost analysis** to better understand the return on their investments in specific Pathfinder and IMO deployments. Links to these resources are provided at the end of this fact sheet.

Weather-Savvy Roads Initiative

Pathfinder is a collaborative effort between the National Weather Service (NWS), transportation agencies, and support contractors to provide road weather information by sharing and translating weather forecasts into consistent transportation impact statements for the public.

IMO (Integrating Mobile Observations) involves collecting weather, road condition, and native data from government fleet vehicles' ancillary sensors. The data provides maintenance managers with an extremely detailed view of the weather and road conditions as well as asset locations along the highway network. This information supports road weather management maintenance and operations decisionmaking, including agency traveler information systems.

Benefits and Costs of Pathfinder

The benefits and costs associated with Pathfinder will vary according to the level of involvement, and scale of implementation. Specifically, the types of weather events Pathfinder addresses; the number of meetings/briefings conducted; the number of department of transportation (DOT) and NWS staff who participate; the breadth and the depth of weather support contracts; and whether increased staff participation and meeting frequency of high impact events will all influence the anticipated benefits and costs.

Pathfinder benefits include enhanced decision-making and better-informed travelers through consistent and targeted traveler information messaging, as well as the potential for reduced vehicle miles traveled (VMT), improved weather maintenance operations given less motorist impedance, and increased overall safety.

- The Wyoming DOT specifically observed improved information flow and mobility with shared resources and forecast information between DOT and NWS staff.
- A survey of 800 travelers, led in part by the Utah DOT and NWS following two winter weather events, showed that 97 percent gathered information about the event with 83 percent of individuals using multiple sources of information. Of the respondents, 66 percent modified their travel plans by changing their schedule (62 percent), changing the route (26 percent), not traveling (13 percent), or using transit (6 percent). Travelers who take actionable steps based on the information they receive will likely experience safer trips and overall improved mobility.
- The Utah DOT also reported improved snow-plow effectiveness, reduction in costs, and improvement in efficiency due to shared resources among agencies.

The **costs associated with Pathfinder** are minimal and primarily associated with the amount of time agency and weather service provider staff need to manage collaboration activities. These activities may include a relatively high number of staff members for various meetings, particularly given the geographic extent and potential impact of the weather event.

- The Colorado DOT routinely conducts 48-hour pre-storm calls with over 30 invited staff members, including State and regional operations managers and executive-level managers, depending on the severity of the storm.

Benefits and Costs of IMO

Typical **IMO benefits** include more efficient and proactive road weather operations as well as better informed transportation maintenance and operations staff, leading to improved highway safety, mobility, and productivity. Typical benefits that may result from an IMO deployment are listed below, although these will vary based on the scope of an agency's deployment.

- **Material savings.** Reduced salt and sand usage is one potential benefit of IMO deployment. Real-time information about road weather conditions and fleet vehicle locations can help maintenance staff make better decisions about material application.
 - ▶ The Michigan DOT estimated a 25 percent reduction in salt usage with the installation of automatic vehicle location (AVL)/global positioning system (GPS) equipment and use of a maintenance decision support system (MDSS), which was about \$2.1 million in annual savings for 340 trucks.
 - ▶ The Minnesota DOT noted that internal data sharing and reporting helped them better understand how maintenance actions yielded cost savings. Specifically,

plow operators input the amount of chemical applied by route at the end of each shift, which can be gathered from the AVL screen and used to compare recommended versus applied chemical amounts. Other available reports include speed while applying chemicals, average precipitation, end of shift report, material usage by route, and sander status reports, which can be queried. These reports support a Minnesota DOT Salt Sustainability effort that will track material usage in a more efficient manner.

- **Agency efficiencies.** These may include improved reporting, reduced time spent on relaying, better situational awareness, reduced response to emergencies, and engine diagnostics and idling information. Real-time information about resource consumption that is more comprehensive and accurate provides agencies with the data needed for decisionmaking.
 - ▶ The Michigan DOT estimated an annual savings of \$680,000 due to staff time saved by automatic system reporting.

Over time, additional IMO-related benefits are anticipated, such as reduced equipment usage and reduced legal costs from small tort claims, although these benefits have not yet been documented. For instance, location awareness and decision support system may improve dispatch and routing such that IMO-equipped vehicles incur a lower VMT and costs for operation. Agencies that have AVL-equipped vehicles may also have reduced legal costs from small tort claims regarding incidents allegedly involving agency vehicles given the availability of car location data.

Typical **IMO costs** can include AVL equipment, sensor equipment, communications services, development and implementation of systems to gather, interpret and present data for action, and

systems operations and maintenance. There are many ways an agency can choose to deploy IMO that would impact costs. For instance, instrumenting a higher number of vehicles may result in discounts as more units are deployed. Finally, costs will vary based on the number and types of sensors mounted on each automobile.



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Consideration should be given to the life-cycle costs of equipment selected for deployment. For instance, consumer-grade products are less ruggedized than comparable industrial-grade products and have a shorter product life such that manufacturer support often wanes and replacements become difficult to procure. Additionally, the long-term costs of industrial-grade commercial off-the-shelf (COTS) components will be lower. A custom-designed system could have a lower initial cost, but will require personnel with unique skills to design, build, and operate the hardware and software components of the system. A COTS-based system will involve a significant amount of custom software development at first, but after design and installation, costs will be significantly limited to maintenance and upgrades.

Specific IMO cost components to consider include:

- **AVL equipment and road weather sensors, plus installation.** This upfront cost includes the cost to purchase, install, and calibrate the equipment.
 - ▶ The Nevada DOT IMO hardware component costs totaled \$4,500 per vehicle. This hardware included air and surface weather sensors, a hall effect sensor, and material sensor, as well as the dedicated short-range communications (DSRC) radio, cable modem, data acquisition, cabling, and backplane fabrication. Additionally, qualified personnel took one to two days per vehicle for installation, depending on the complexity of the installation into a specific vehicle type and the experience of the installing personnel, also cost impacts for vehicle out-of-service time.



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- ▶ The Michigan DOT hardware component costs totaled \$3,000 per vehicle for 340 vehicles, and included GPS, connections, Controller Area Network (CAN) bus, and atmospheric sensors. Installation costs for staff time and cost impacts for vehicle out-of-service time should also be considered.

- ▶ The Minnesota DOT IMO cost of the AVL unit totaled \$2,550, including touchscreen, cables, mounting platforms, antenna, and CAN bus module. Adding a plow camera kit and pavement sensor cost the Minnesota DOT an extra \$1,130.
- ▶ The Kansas DOT reported a cost of \$3,500 per vehicle to purchase and install an in-vehicle unit with a GPS receiver, data modem, and mobile data terminal, plus \$600 per vehicle for road and air temperature sensors.
- **Decision support software development and integration.** These costs will vary based on the degree to which existing resources at the agency are leveraged. The use of an expert commercial service provider may lower these costs, but could introduce other service-related costs. Additional expenses associated with software licenses such as MDSS commercial product costs should also be considered.
 - ▶ The Nevada DOT incurred minimal back-end equipment costs since existing resources were used. However, software development costs for the initial IMO system were the most significant component of the overall system cost, totaling about \$1.5 million over six years of working with a university partner on AVL and decision support software.
 - ▶ The Michigan DOT estimated annual MDSS forecasting costs of \$240,000 for the winter season.
- **Roadside equipment.** Some agencies could incur costs to deploy roadside equipment, if DSRC is selected as a communications platform.
 - ▶ The Nevada DOT incurred DSRC hardware costs of about \$2,000 per site for the radios, antennas and other associated infrastructure costs, plus \$3,000 per site for installation.

- **Staff training and coordination.** This cost value primarily represents a cost for training and coordination before and during the initial deployment, although there may be smaller, ongoing costs for refresher courses or as new capabilities are deployed.
 - ▶ The Nevada DOT IMO effort included collaboration with peer agencies, National Center for Atmospheric Research (NCAR), and Federal Highway Administration (FHWA) totaling three meetings per year that required staff time. In an effort to institutionalize IMO at the Nevada DOT, a two-day training session was conducted for five DOT staff members.



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- **Communications costs.** This is a recurring cost, and will vary depending on what communications technology an agency chooses. If cellular communications are used, consideration should be given to cellular data plans that share data usage across many devices in the organization, which may be more economical than a flat fee per device per month plan.
 - ▶ The Nevada DOT monthly cellular data plan cost about \$15 per unit.

- ▶ The Michigan DOT communications cost averaged \$110 per month per vehicle during the winter season, which includes cellular charges as well as MDSS usage, server space, and data management costs.
- **Operations and maintenance costs.** These recurring costs include routine equipment repairs and software upgrades that may be necessary. Routine maintenance performed during the off-season may be more efficient for agencies, while operations costs will more likely be incurred during the winter season.
 - ▶ The Nevada DOT has budgeted about \$40,000 annually to gather and archive the data, and additional operations and maintenance costs are anticipated for equipment and software.

Available Resources

- **Tool for Operations Benefit Cost Analysis (TOPS-BC).** TOPS-BC is a spreadsheet based on a decision support tool developed by the FHWA Office of Operations. It is intended to provide support and guidance to transportation practitioners wanting to conduct benefit cost analysis of the wide range of Transportation System Management and Operations strategies, including road weather management. The tool may be used to analyze more detailed benefits and costs associated with individual IMO and Pathfinder deployments.
- **Road Weather Management Benefit Cost Analysis Compendium.** The compendium provides information about benefit cost analyses conducted around the country for specific road weather management technologies and operational strategies. There are 27 case studies presented in the compendium, and each addresses one or more specific benefit cost analysis concepts or procedures.

- **Collaboration Across the Road Weather Enterprise: The Pathfinder Project.** This document presents best practices and guidance for transportation agencies to implement Pathfinder and improve coordination with the NWS and other weather service providers.
- **IMO project reports from the Minnesota DOT, Michigan DOT, and Nevada DOT deployments.** These documents provide details on the technology deployed, costs, and findings.
- **Clear Roads 14-01: Synthesis on GPS/AVL Equipment Used for Winter Maintenance.** This synthesis features options available (systems and components) for different GPS/AVL systems available, including how well each performs and systems requirements and constraints.
- **Clear Roads 12-06: Plug and Play Initiative.** This effort provides the Universal In-Cab Performance Specifications and Communications Protocol to support a plug and play approach to integrating electronic devices and sensors on plow trucks.
- **Clear Roads 14-04: Plug and Play Initiative: Phase II.** Available documents define a standardized set of data (attributes and units of measure) available from winter operations equipment and identify standards for the transmission of data from vehicle to point location.



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