



TECHNICAL SUMMARY

Technical Liaison:

Jim Foldesi, St. Louis County
FoldesiJ@co.st-louis.mn.us

Administrative Liaison:

Alan Rindels, Mn/DOT
Alan.Rindels@state.mn.us

Principal Investigator:

Diwakar Gupta, University of Minnesota

LRRB COST:
\$45,000



The Workforce Deployment Tool is designed to limit “dead time” on the road by optimizing operators’ routes and schedules given particular conditions.



RESEARCH SERVICES

OFFICE OF POLICY ANALYSIS,
RESEARCH & INNOVATION

Optimal Workforce Planning and Shift Scheduling for Snow and Ice Removal

What Was the Need?

Cities and counties fighting winter storms must contend with shrinking budgets, smaller workforces, and high equipment and fuel costs while keeping Minnesota’s roads safe for winter travelers. In the face of these challenges, agencies are eager to find ways to increase the efficiency of winter operations.

Winter maintenance managers juggle multiple, and sometimes competing, factors when deploying snowplow operators to fight a winter storm. Limited resources, work rules, overtime costs and the uncertainty of storm conditions may all affect how and where operators are deployed.

Decision support tools that aid in the flexible deployment of a snowplow fleet and its operators can lead to a more uniform approach to snow and ice removal, improve services and lower costs. Tracking and measuring the effects of how snowplow operators are deployed also provide data for state and county administrators to support recommendations for cost-effective crew hiring and retention plans.

What Was Our Goal?

The objective of this research was to develop a decision support tool to determine the optimal-size snow removal crew to employ given information about weather conditions, service level objectives, regular and overtime wages, and other agency characteristics. The system would recommend plowing routes and priorities among road segments.

What Did We Do?

St. Louis County in northeastern Minnesota served as the test case for data analysis, model development and creation of the decision support tool.

Researchers began by gathering data to populate a software-based model that generates recommended plow routes and deployments. They developed five typical storm scenarios to test this model by combining weather data and snowplow operator logs. The most frequently occurring storm type based on weather data produces about 2.5 inches of snow, lasts six hours and occurs when the pavement temperature is just below freezing.

Other data inputs for the model include average annual daily traffic (AADT) counts, sand and salt application rates, available crew size, hourly wage rates, earliest start time, maximum work time without a break, average snowplow speeds and road surface type.

Researchers also built a snowplow route network that groups road segments based on road type, AADT counts or road length. Each group within the network represents a single pass of the plow that can be plowed and sanded with a single payload of material.

What Did We Learn?

Using the algorithms and models developed in this project, researchers created the Workforce Deployment Tool and tested it using data from St. Louis County’s snow and ice removal program. Within six months, cost savings were achieved with reduced use of deicing chemicals.

The Workforce Deployment Tool, which uses historical storm patterns and data about an agency’s snow removal operations to determine crew size and plowing routes, enabled immediate savings in St. Louis County by helping to reduce overtime costs and the amount of deicing chemicals used.

“As budgets tighten and operating costs rise, it becomes more difficult to provide the same level of service the public expects. By recommending more effective use of limited resources, the Workforce Deployment Tool will help us meet that challenge.”

—Ronald Garden,
Deputy Public Works
Director, St. Louis County

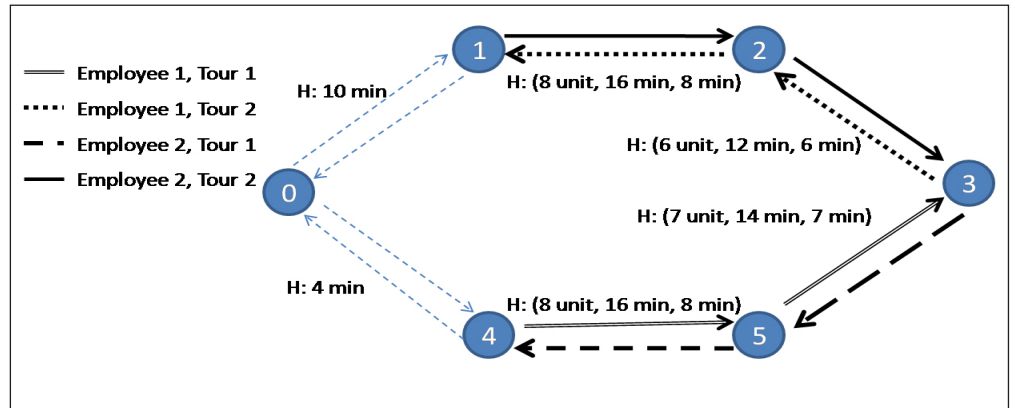
“Using historical storm patterns and data about an agency’s snow removal operations, the Workforce Deployment Tool determines the optimal crew size based on estimates of the plowing time needed to meet an agency’s level of service goals.”

—Diwakar Gupta,
Professor, University of
Minnesota Department
of Mechanical
Engineering

Produced by CTC & Associates for:

Minnesota Department
of Transportation
Research Services Section
MS 330, First Floor
395 John Ireland Blvd.
St. Paul, MN 55155-1899
(651) 366-3780

www.research.dot.state.mn.us



This graphic shows a road network with eight road segments that need to be plowed during a high-intensity storm. Circled numbers are the end points of the road segments, with 0 denoting the depot. Data in parentheses are the sand/salt requirements, active travel time and inactive travel time, respectively. The values next to the dashed road segments correspond to travel times to and from the depot.

The interactive software program assumes a goal of clearing roads by St. Louis County within 24 hours after snowfall ends. Data on weather conditions and an agency’s staff, equipment, work rules and levels of service are used to generate recommendations for:

- The number of operators needed at each depot three to four hours in advance of actual deployment. Plow route assignments can be reorganized to balance workload at each depot.
- Start and end times for plowing. The software program balances the cost of overtime and delaying plow start times to recommend how much plowing should be done in overtime mode and how much should be delayed to the start of the next day’s regular shift.
- Fixed routes that should be plowed first.
-

An optimal number of employees and the range of possible extra plowing costs over 10 years of storms.

The tool also compares three strategies for deploying the available workforce: contract employees, split shifts and staggered shifts. The program calculates the optimal number of employees for each strategy and identifies the most flexible and cost-effective solution.

What’s Next?

St. Louis County will begin using the Workforce Deployment Tool during the 2011-2012 winter season and expects to recoup the cost of this study within that season by making more efficient use of operators, equipment and materials. The decision support tool is also expected to result in a more uniform response to storms by the county’s four maintenance districts that manage road networks with significant variations in traffic volume. Over time, the county may provide training and make the Workforce Deployment Tool available to all 17 maintenance reporting sites in the county.

This Technical Summary pertains to LRRB-produced Report 2011-03, “Optimal Workforce Planning and Shift Scheduling for Snow and Ice Removal,” published December 2010. The full report can be accessed at <http://www.lrrb.org/PDF/201103.pdf>.