

MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 22-487 (project 637) | November 2022

Assessing and Improving Efficiency of Snowplowing Operations via Data and Analytics



the ISSUE

Snow removal is essential to ensuring public mobility and safety, especially in the areas suffering frequent snowstorms. According to the Federal Highway Administration, more than 70% of the nation's roads are located in snowy regions. As a result, road maintenance operations concerned with snow removal and ice control cost more than \$2.3 billion each year. To meet the rising expectations of road users and limit these investments, it is important to maximize the efficiency of snow-removal operations.

the RESEARCH

This project was concerned with improving the efficiency of Utah Department of Transportation's snowplowing operations. Researchers conducted work to optimize snow plowing routes in 12 northern Utah regions by applying vehicle routing heuristics. Researchers met with the supervisor in each region two to five times to validate both sets of routes. Discussions typically involved the following items:

- Road network: In addition to network partition, we had to validate the required number of passes along each road link, which depends on the number of lanes as well as existence of wide shoulders.
- Operational policies: Because different regions have different operational policies, we had to ensure that they are accounted for in the proposed routes.
- Fleet composition: Because snow removal operations may involve trucks of different types and capabilities, we had to validate fleet composition for each region. The UDOT fleet includes regular



A University Transportation Center sponsored by the U.S. Department of Transportation serving the Mountain-Plains Region. Consortium members:

Colorado State University
North Dakota State University
South Dakota State University

University of Colorado Denver
University of Denver
University of Utah

Utah State University
University of Wyoming



Lead Investigator(s)

Nikola Marković, Ph.D
nikola.markovic@utah.edu

Co-Investigator(s)

Cathy Liu, Ph.D
cathy.liu@utah.edu

Research Assistant(s)

Yinhu Wang

Project Title

Assessing and Improving
Efficiency of Snowplowing
Operations via Data and
Analytics

Sponsors | Partners

Utah Department of
Transportation

USDOT, Research and
Innovative Technology
Administration

the **RESEARCH** cont.

(or general purpose) trucks that clean one lane at a time, double-wing trucks that clean one and a half lanes at a time (e.g., right-most lane and a shoulder), and tow-plow trucks that simultaneously clean two lanes.

- Capacity constraints: Salt capacity is a common constraint in snow removal operations. Because salt capacity was more constraining than fuel, the latter was not considered explicitly.
- Performance measures: All the regions were interested in four performance measures: vehicle miles, vehicle minutes, deadhead miles that measure excessive passes, and the turnaround time that denotes duration of the longest route.

the **FINDINGS**

The objective was achieved by proposing more efficient routes. The team developed an array of computational techniques pertaining to data mining, data visualization, and route optimization to reconstruct UDOT's snowplowing operations, propose more efficient routes, and effectively communicate results. Even though the snowplow routes originally operated by UDOT were fairly efficient, the development and implementation of sophisticated optimization algorithms enabled the team to find more efficient routes.

the **IMPACT**

On average, routes were improved 4.87% in terms of vehicle miles, 13.95% in terms of deadhead miles, and 15.38% in terms of turnaround time.

For more information on this project, download the Main report at <https://www.ugpti.org/resources/reports/details.php?id=1132>

For more information or additional copies, visit the Web site at www.mountain-plains.org, call (701) 231-7767 or write to Mountain-Plains Consortium, Upper Great Plains Transportation Institute, North Dakota State University, Dept. 2880, PO Box 6050, Fargo, ND 58108-6050.



This publication was produced by the Mountain-Plains Consortium at North Dakota State University. The contents of this brief reflect the views of the authors, who are responsible for facts and the accuracy of the information presented herein. This document is disseminated under the program management of the USDOT, Office of Research and Innovative Technology Administration in the interest of information exchange. The U.S. Government assumes no liability for the contents or use thereof.



NDSU does not discriminate in its programs and activities on the basis of age, color, gender expression/identity, genetic information, marital status, national origin, participation in lawful off-campus activity, physical or mental disability, pregnancy, public assistance status, race, religion, sex, sexual orientation, spousal relationship to current employee, or veteran status, as applicable. Direct inquiries to Vice Provost, Title IX/ADA Coordinator, Old Main 201, 701-231-7708, ndsuoaa@ndsu.edu.