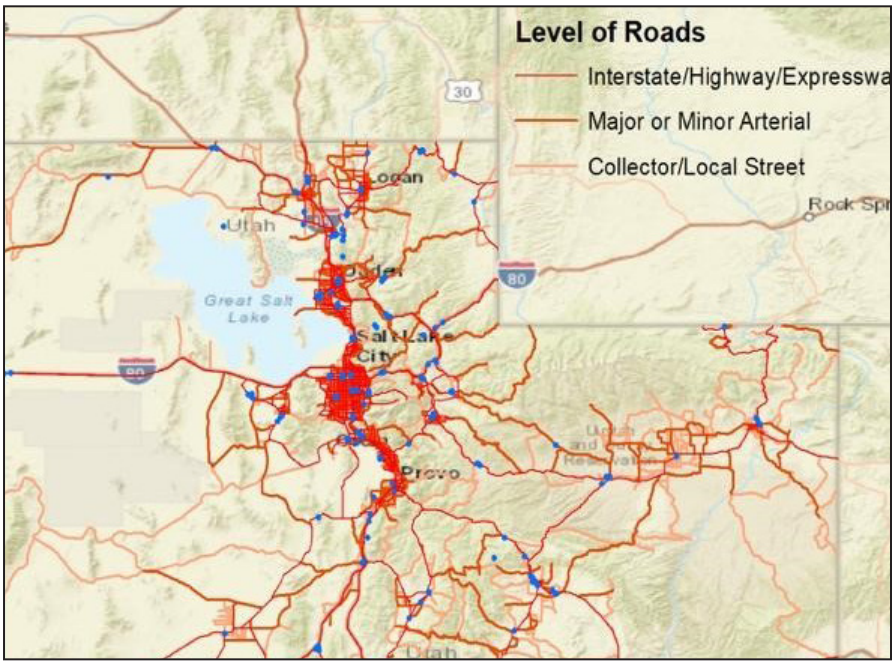
MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 21-429 (project 544) | March 2021

Lifecycle Assessment Using Snowplow Trucks' Automatic Vehicle Location Data



the ISSUE

Snowplow trucks serve a crucial role in winter highway maintenance activities of deicing and removing, loading, and disposing of snow. These activities are essential to public mobility and safety. An effective performance monitoring and analysis process can help transportation agencies manage snowplow trucks and maintain normal functioning of roadways. A key is balancing repair and maintenance costs, which tend to increase over the life of a truck with the price of purchasing a new truck exceeding $150,000. Traditional cost-benefit analysis helps transportation agencies identify the optimal replacement cycle for snowplow trucks. However, such macro-level analysis fails to evaluate the operational efficiency for a single truck, and cannot capture key factors contributing to performance deterioration.

the RESEARCH

In this study, we are presenting a methodological framework using a data-driven approach to estimate the optimal utilization age of snowplow trucks, considering both total costs and operational efficiency. Specifically, a cost-benefit analysis is conducted to determine the optimal life cycle for Class 8 snowplow trucks by leveraging purchase and resale data and maintenance costs throughout their service spans.

To further analyze operational efficiency at the micro-level and to identify the crucial factors that lead to performance deterioration, machine learning approaches (random forest and support vector machine models) are implemented to predict truck performance using factors such as weather, working environments, fuel consumption, mileage, and service year and rank the importance of those factors. This micro-analysis can help transportation agencies improve truck replacement strategies by identifying key factors affecting truck performance. Lastly, a sample application of the developed prediction model suggests a threshold of work intensity for preventing rapid deterioration of trucks' performance under various working environments.

MOUNTAIN-PLAINS CONSORTIUM REGION 8

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University of Denver
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Utah State University
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Project Title

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the **FINDINGS**

The suggested optimal life cycle for Class 8 snowplow trucks managed by UDOT is five years on the statewide level. However, most Class 8 snowplow trucks were disposed of after 13 or more years of use. This longer service span can result in more frequent major repairs and higher maintenance costs. As a result, UDOT should shorten the average life cycle for Class 8 snowplow trucks to reduce overall expenses.

In fact, a small percentage of snowplow trucks can still function with satisfactory operational efficiency beyond the calculated optimal life cycle. It appears there is a trade-off between work intensity and performance, where more working mileage leads to more frequent major repairs. In other words, the average working mileage could be controlled or allocated across trucks to prevent rapid performance deterioration. The proposed random forest model can help UDOT accurately identify the performance of snowplow trucks with a variety of conditions, which can complement the replacement strategy.

the **IMPACT**

Predicting truck performance and identifying factors that lead to performance depreciation are paramount. First of all, a number of trucks may still perform well at the "optimal" replacement year determined by the model. As a result, replacing all trucks at that age could be a significant waste of resources. Additionally, a better understanding of truck performance can help agencies refine their replacement strategies to systematically determine the service continuity/termination at the micro-level. As a result, if truck performance can be monitored and predicted with high resolution and high accuracy, trucks can be replaced in a timely manner to optimize useful life while minimizing maintenance expenses.

For more information on this project, download the entire report at https://www.ugpti.org/resources/reports/details.php?id=1027

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.