Joint Transportation Research Program

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Heavy Fleet and Facilities Optimization

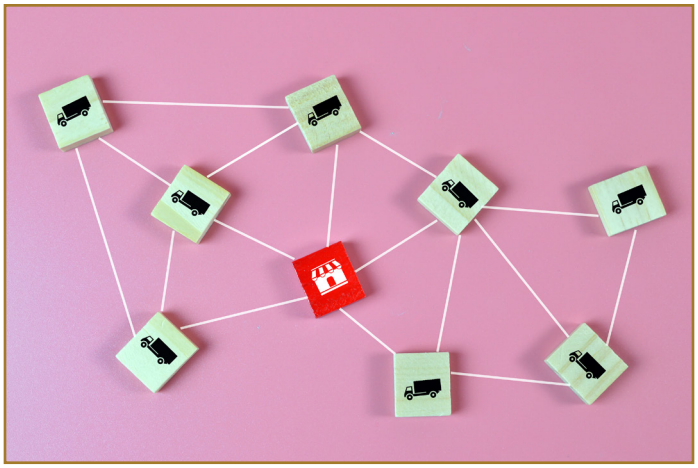
Introduction

Indiana is situated in a wet-freeze zone. The state encounters significant snow events, and INDOT is responsible for clearing the resulting snow from the roads. For winter operations, INDOT has divided the state into six districts, which contain a total of 101 unit locations and a fleet size of about 1,100 snow-removal trucks. Depending on the amount of snow, the number of trucks vary in each unit of each district.

This project aims to understand the current mix of equipment in the fleet. It also aims to understand the current snow route network in the state, to recommend an optimal truck replacement strategy that reduces overall cost, and to recommend an optimal snow route network with optimal facility locations and distribution of trucks that reduce total deadhead (non-productive) miles. Data driven analysis was performed for understanding the INDOT fleet and the snow route network across the state. From these analyses, implementable solutions are recommended to INDOT.

Findings

- Data analysis of INDOT's current fleet shed light on the current mix of equipment and some other important parameters, such as average age, average maintenance cost, operation cost, and total cost of ownership, among many others.
- The analysis of the snow route data for all the units provided the total deadhead miles associated with each unit location. Analysis of Automated Vehicle



Snow route optimization.

Teacher Photo. (n.d.). *Wooden block with trucks and store symbol linked with lines. Logistic industry concept* [Vector illustration]. Shutterstock. https://www.shutterstock.com/image-photo/wooden-block-trucks-store-symbol-linked-2015316380

Location (AVL) system sensor data provided clarity for the route, speed, and salt spread rate of the truck.

- The benchmarking process helped identify the different strategies used by other agencies for truck replacement and snow removal operations. Benchmarking indicated that the deterministic Life Cycle Cost Analysis (LCCA) model should be used as a truck replacement strategy. This model was used to prepare a truck replacement strategy for INDOT's current fleet.
- The Truck Replacement Optimization model was developed based on the LCCA. The model allows the user to add inputs and provides the optimal replacement age for the trucks based on the region they belong to.
- Models based on two separate approaches were developed to examine snow routes, facility locations, and truck distribution. Results from these models indicate optimal snow route, location of the facility, and the number of trucks to be deployed to minimize the number of deadhead miles.

Implementation

Based on the benchmarking study, a LCCA-based optimization model for truck replacement strategy was developed. The analysis of the current fleet data showed the effect of age and miles driven on total operating cost and how the optimal age of truck replacement varies across the northern, central, and southern regions. Having a region-based truck replacement strategy will help reduce the overall cost for INDOT.

Analysis of INDOT's current snow route network led to the development of optimization models with two different methods, which provide an optimal network of snow routes at unit level. Method 1 employs mathematical model optimization, which obtains results for four different approaches that alter current snow routes and facility locations to achieve minimum deadhead miles and improve performance. On average, as much as 45.83% of reduction in deadhead miles is observed using Approach 4. Different districts and units observe reduction with different approaches. This optimal solution reduces the deadhead miles and thus provides more efficiency to INDOT's snow removal operations.

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