



0-6623: Optimizing Resource Allocations for Highway Routine Maintenance

Background

The Texas Department of Transportation (TxDOT) is responsible for maintaining more than 190,000 lane miles of highways. TxDOT is not only obligated to preserve the pavements in good condition, but it must also maintain the roadside and all roadway fixtures in a functional and acceptable condition. To add to this already difficult task, the agency has experienced funding fluctuations that can disrupt the timing of scheduled maintenance work, resulting in unstable highway conditions. The cost of deferring certain maintenance treatments can consume a considerable amount of future revenue that could otherwise be dedicated to system improvements. This situation has forced TxDOT to look for new and innovative maintenance strategies that are aligned with its needs and requirements. To accomplish this, TxDOT requested the researchers develop a methodology to minimize the impact of routine maintenance budget fluctuations on highway conditions.

What the Researchers Did

The researchers focused on quantifying the risk of not performing a maintenance activity and identifying the priority of maintenance activities based on the quantified risk. To accomplish this goal, several tasks were fulfilled:

- A thorough literature review was conducted on current highway maintenance prioritization programs in the United States and other countries, including existing methodologies to quantify risks and prioritize maintenance activities in both civil engineering and other fields. The analytical hierarchy process (AHP) was selected as the methodology after the literature review was finished.
- A workshop with the TxDOT Expert Work Group was held to define the objectives of TxDOT's routine maintenance program and categorize routine maintenance activities into groups. Four maintenance objectives were defined: safety, system preservation, system operation, and aesthetics. Sixteen maintenance groups were identified.
- A conceptual framework of quantifying risks of not performing a maintenance activity and identifying the priority of maintenance activities was developed, based on the literature review and comments from the Expert Work Group.
- Four pilot districts—Austin, Lubbock, Paris, and Pharr—were select to conduct pilot applications of the framework to verify the validity of the proposed methodology.
- Individual judgments for maintenance objectives and maintenance activities from all selected engineers were collected and analyzed to obtain the risks of not performing a maintenance activity, leading to the priorities of maintenance activities.

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- A prototype system was developed after the results were obtained from all four pilot districts. This web-based prototype system provided a user-friendly interface for users to adjust an existing routine maintenance program to fit an available budget while minimizing the impact on the highway network conditions.

What They Found

Developing a highway maintenance plan is a complex and large-scale multiple-criteria decision-making (MCDM) process, which is a challenge to TxDOT. The AHP provides a framework to decompose the complex problem into smaller, more manageable sub-problems and give decision makers a better understanding of the problem and the relationships of the individual criteria or attributes. The AHP can also synthesize the ranking of alternatives or options based on different criteria, which is critical in developing a highway maintenance plan because several criteria have to be considered in the process.

Strong similarities showed in the maintenance objectives and maintenance activities priorities. All four pilot districts selected safety as the most important objective and aesthetics as the least important one when developing maintenance strategies. All four districts selected pavement-related maintenance activities as their top-three activities and roadside-related maintenance activities as their bottom-three activities. Furthermore, three out of four pilot districts selected pothole patching as their most important maintenance activity; only the Paris District selected edge repair as its most important activity.

Average daily traffic (ADT) and truck volume are two exposure factors to affect the priorities of maintenance projects in addition to the priorities of maintenance activities obtained from individual judgments. They present the impact of traffic on the maintenance project priorities. Because truck volume on the highway is not proportional to the ADT, the selection of exposure factors will significantly affect the final results and should be considered very carefully.

What This Means

The proposed methodology could help improve the consistency of the highway condition by replacing a purely subjective method with a formal decision support framework. In addition, the proposed methodology could help reduce road users' exposure to unfavorable highway conditions while simultaneously reducing TxDOT's liability by minimizing the risks induced by budget fluctuations. More specifically, the proposed methodology in this study:

- Enables engineers to assess the maintenance needs of the roadway network and quantitatively evaluate the implications of budget fluctuations;
- Provides engineers with a versatile framework that can be adjusted to reflect local conditions and strategies;
- Facilitates the selection of maintenance programs and strategies that minimize the impact of budget fluctuations on the overall condition of the roadway network; and
- Allows engineers to better conduct "what-if" analyses of various funding levels, which can yield cost savings.

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