Influence of Treatment Types on Performance-based Planning

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Managing Backlogs

U.S. departments of transportation (DOTs) currently face significant budget shortages: According to the ASCE 2017 Infrastructure Report Card, the backlog of repairs for existing highways is $420 billion. To optimize DOT spending and improve pavement network performance, the Moving Ahead for Progress in the 21st Century (MAP-21) Act requires transportation agencies to use performance-based planning to develop a strategy for meeting performance targets within a budget constraint using pavement treatments, which mainly include preservation, overlay, and reconstruction (POR). For many DOTs, preservation has had a higher priority due to its low price. However, when compared to overlay and reconstruction, preservation is less durable and offers shorter-term performance. In this study, we explore the influence of different treatment types on pavement network performance and provide insights into performance-based planning.

A New Approach to Performance-based Planning

CSHub researchers have developed a probabilistic budget allocation model for performance-based planning called probabilistic treatment path dependence (PTPD), which has been the subject of prior research briefs. The model captures the various optimal future treatment paths depending on future uncertainty in costs and deterioration. Since high expected performance tends to have a higher risk of cost overruns, PTPD can also incorporate performance risk analysis explicitly, allowing decision-makers to balance the trade-offs between risk of cost overruns and performance. Researchers applied the PTPD model to Iowa's 1500-mile-long interstate system and explored the outcome of different treatment types over a 30-year analysis period. Specifically, they compared three treatment strategies, preservation only (P-only, short-term benefit), overlay and reconstruction only (OR-only, long-term benefit), and mixed treatment types (POR). They then measured long-term pavement performance for each strategy us-

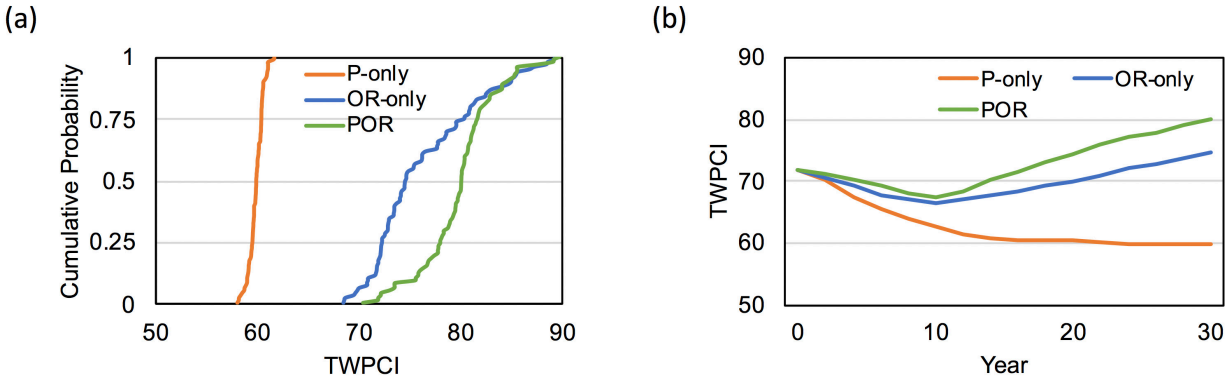

Fig.1: Comparison of different treatment types. (a) shows annual mean traffic-length weighted PCI (TWPCI); (b) shows the cumulative probability for TWPCI at year 30.

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ing the pavement condition index (PCI), which ranges from 0 (bad) to 100 (good), and weighted PCI based on traffic-length (TWPCI).

Findings

Researchers found that the POR strategy led to the best average pavement network performance (See Figure 1a & b). To achieve similar average network performance, the OR-only strategy would need a 12% higher annual budget. When future scenarios are optimal, OR-only and POR strategies have similar performance due to the long-term characteristics of overlay and preservation. While overlays are more expensive than preservation treatments, they offer greater long-term benefits and performance improvements.

Therefore, even though the P-only strategy could fix more roads, each road would see only limited improvement for a short period of time before requiring another action: this explains the strategy's poor long-term performance. However, in other scenarios, the improvement of network performance is driven by the number of maintained segments. For example, if the material price is high, incorporating preservation could lead to more maintained segments due to its lower price and thus a better average network performance.

Key Take-aways

- CSHub analyses show that the preservation-only strategy taken by many transportation agencies does not improve long-term pavement network performance.
- Researchers found that a mix of treatment types could lead to a better average pavement network performance.
- This research provides insights for agencies to improve the cost-effectiveness of their pavement management strategies.

Learn More

To learn more about CSHub pavement network asset management research, visit https://cshub.mit.edu/pavements/asset-management

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