Enhancing Mobility: A Roadmap for Improving Highway Conditions

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Center Name: Pacific Northwest Transportation Consortium (PacTrans)

Research Priority: Improving the Mobility of People and Goods

Principal Investigator(s): Kishor Shrestha (WSU)

Project Partners: N/A

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Project Start and End Date: 8/16/2023 – 8/15/2025

Project Description: The roadway system is an essential component of millions of Americans' mobility and economic growth. According to the American Society of Civil Engineers, 43% of public roadways (across the US) in 2021 were in poor condition, which increased from 21% in 2015. In the Pacific Northwest, the Washington State Department of Transportation (DOT) missed 44% of its highway maintenance asset condition targets in 2022, an increase from 32% in 2020 and 33% in 2019. Such misses in targets increased the 'due' and 'past due' maintenance backlog in Washington state. When roadway assets are not maintained on time, reactive maintenance or rehabilitation becomes necessary, which is substantially more expensive due to decreased asset lifespans, lost production time, and poor planning. For instance, the chip seal can cost $50,000 to $60,000 per lane mile (Weston, 2012). Suppose chip sealing is "past due" or not performed promptly. In that case, it can harm the lower pavement layers, potentially leading to the need for costly reconstruction ($400k to $500k per lane mile). This posed critical challenges to state DOTs, which weakened their capacity to upkeep the roadways. Challenges include imbalanced asset conditions and increasing maintenance costs because of reactive maintenance.

State DOTs primarily rely on a traditional fund allocation approach (based on need-based subjective judgments), which could be more effective and efficient. Many states continue using this approach, even though they have historical data and great potential to utilize a practical data-driven approach. Therefore, there is an immediate need to develop an innovative roadmap/ framework to allocate funds effectively based on future asset conditions utilizing a data-driven strategy. The principle objective of this study is to develop an innovative roadmap that maximizes the utilization of funds and streamlines processes for highway asset management, all based on predicted asset conditions. The roadmap will utilize predictive models to forecast the level of service (LOS) condition of the roadway assets and Machine learning (ML) algorithms. The ML algorithms will be trained, validated, and tested using historical data.

Finally, implementing the proposed roadmap aims to revolutionize state DOTs' capacity by utilizing a data-driven approach to allocate funds, prioritize highway assets for funding, make informed decisions, predict asset LOS conditions accurately, and effectively utilize public funds. This project will significantly

impact roadway asset management in 50 state DOTs. The roadmap can also be applied to other infrastructure assets such as bridges, railway lines, and water and sewer networks.

US DOT Priorities: This project serves the USDOT priorities and RD&T in multiple ways. By addressing the deteriorating state of public roads, the project directly advances the USDOT's goal of enhancing the nation's highway network. The project's novel roadmap helps to transform state DOT asset management, a goal that is consistent with the USDOT's goal to advance effective and efficient asset management techniques. Additionally, the project engages in ground-breaking and revolutionary research by offering data-driven solutions for fund allocation and asset condition prediction using predictive models and machine learning algorithms. This strategy helps transform how DOTs prioritize maintenance and rehabilitation projects as it differs significantly from conventional traditional subjective judgment-based techniques. The project's results may help state DOTs' ability to make well-informed decisions, forecast asset conditions, and allocate public funds efficiently. This will address critical issues with roadway asset management and advance the nation's transportation infrastructure as a whole.

Outputs: This project will produce a novel roadmap. The graphic roadmap will form a foundation for developing an algorithm (machine learning) for effective and efficient asset funding allocation in states.

Outcomes/Impacts: The results of this study will have a significant influence on the legislative and policy frameworks as well as the transportation system. State DOTs will be able to optimize fund use and streamline procedures for managing roadway assets by switching from traditional subjective judgment-based fund allocation techniques to a data-driven approach. This change will lead to improved decision-making, precise asset condition projections, and effective use of public funds. As a result, the transportation system will see increases in durability, safety, and dependability as well as a decrease in the cost of maintenance and rehabilitation. The results of this study could revolutionize the way DOTs prioritize and oversee roadway assets, resulting in more efficient and sustainable transportation infrastructure management strategies across the country.

Final Research Report: *will provide upon completion of the project*