Oregon Department of Transportation

Research Stage 1 Problem Statement
Number 26-29 – "Explore the Effectiveness of Adaptive Traffic Control Work Zone Strategies"

1. Concisely describe the **transportation issue** (including problems, improvements, or untested solutions) that Oregon needs to research.

The Oregon Department of Transportation (ODOT) relies on temporary traffic control measures to manage safety and vehicle flow through construction and maintenance work zones. While these controls are effective in short-term deployments, long-term stationary work zones, which may use the same traffic measures for months or even years, present unique challenges. Driver exposure to static controls over extended periods can lead to reduced compliance due to habituation or desensitization. Research is needed to assess the impact of prolonged exposure on driver behavior and to explore the effectiveness of real-time, AI-based, adaptive traffic control strategies that adjust dynamically to changing driver behaviors and work zone and traffic conditions. Outputs could guide ODOT in implementing responsive traffic control plans that enhance safety and maintain driver attentiveness throughout long-term projects.

2. What **final product or information** needs to be produced to enable this research to be implemented?

The proposed research aims to enhance safety and efficiency in Oregon's long-term construction and maintenance work zones by providing ODOT with adaptable, real-time traffic control solutions. The research will result in an AI-based system for real-time designing and managing temporary traffic controls in long-term, stationary work zones, focusing on maintaining control effectiveness over extended periods. This final product would provide specific strategies, such as the periodic adjustment of signage and incorporating adaptive traffic control technologies that dynamically respond to real-time conditions, mitigating driver habituation and enhancing compliance.

The research will also produce an "Adaptive Traffic Control Implementation Guide," tailored for ODOT personnel, contractors, and traffic control teams to support immediate implementation. This guide will cover policy recommendations, procedures, and practical tools, such as adaptive response protocols and decision-making frameworks, that can be incorporated into ODOT standards. In addition, the guide would offer targeted training modules to equip field personnel with the knowledge needed to apply these best practices effectively. If successfully implemented, these resources could shape future ODOT policies, reinforcing a data-driven approach to work zone traffic control that promotes safe, responsive work zones across Oregon's transportation network.

3. (Optional) Are there any individuals in Oregon who will be instrumental to the success of implementing any solution that is identified by this research? If so, please list them below.

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4. Decision making lenses

Please complete the following three sections. Your answers to these questions will be applied on a programmatic basis to support agency decisions. Answering yes to the questions below is not required. Resolving a narrowly focused technical research problem may meet agency needs without answering yes to any of the following questions. The ODOT Research Section will seek a balanced portfolio some projects will answer yes to one of the three categories below (e.g., climate, equity, and/or safety) and other projects in a different category.

We are looking for an overall program balance and no one project is expected to balance all categories. Generally, a research problem statement is expected to be able to answer yes with clear and verifiable information in only one of the three categories below, some projects may be able to answer yes in two or even three categories. Some projects (i.e. needs focused on specific elements of infrastructure design), may have no yes answers but may still be high value research need.

Climate

Oregon recognizes the climate crisis and makes systemic changes to reduce emissions caused by travel. Every mile driven in Oregon is powered by a clean source of fuel. We seek research that supports construction and maintenance operations are carbon neutral and investments in mobility that support travel by low and no emission modes. While every research project may not result in a reduction in emissions, transportation investments overall support emission reductions to achieve state goals. Oregon envisions a transportation system that is resilient in the face of seismic and climate events and impacts to the degradation of the natural environment are reduced. Our vision includes a transportation infrastructure is built in a way that avoids impacts on key habitat and results in better environmental conditions for wildlife and native vegetation. For definitions and details please review the equity vision, goals, and objectives of the ODOT Strategic Action Plan and Oregon Transportation Plan.

4f. Will addressing the **transportation issue** identified as a need in Question 1 develop, or validate methods for the estimation, measurement, or monitoring of transportation generated greenhouse gasses (GHG)?

☐Yes ☒No ☐Unsure

4g. If climate or GHG is not the focus of this **transportation issue** identified in this problem statement, will the research apply a GHG analysis to transportation infrastructure, planning, operations, maintenance, or materials?

☐Yes ☒No ☐Unsure

4h. Will the addressing the **transportation issue** include development or testing of construction practices, methods, or materials to establish potential reductions in greenhouse gas emissions?

☐Yes ☒No ☐Unsure

4i. Will the solving the **transportation issue** in question 1 study or support the reduction of vehicle miles traveled and single occupancy vehicle travel or support transition to electric vehicles (or other types of zero emission vehicles) or low-carbon alternative fuels?

☐Yes ☒No ☐Unsure

4j. Will the solving the **transportation issue** in question 1 lead to work that will support, measure, monitor, transportation system resilience in response to expected climate events, effects, or natural disasters in general?

☐Yes ☒No ☐Unsure

4k. Will the solving the **transportation issue** in question 1 lead to work that may result in better environmental conditions for wildlife and native vegetation ?

☐Yes ☒No ☐Unsure

4l. If you answered yes to any of the climate questions above or can provide alternative details related to climate, please provide additional information:

Equity

Equity can have many dimensions and impacts relating to communities, and transportation. It is important that problem statement proposals clearly explain in what capacities are equity dimensions or impacts being examined within problem statements. It is a goal of the OTP to "Improve access to safe and affordable transportation for all, recognizing the unmet mobility needs of people who have been systemically excluded and underserved. Create an equitable and transparent engagement and communications decision-making structure that builds public trust". Proposed research may have the intent of studying elements of this goal or apply analysis to specific transportation topics to ensure the resulting research recommendations is consistent with our equity goals. For definitions and details please review the equity vision, goals, and objectives of the ODOT Strategic Action Plan and Oregon Transportation Plan.

4a Is the **transportation issue** identified as a need in Question 1 specifically focused on transportation equity?

☐Yes ☒No ☐Unsure

4b If the **transportation issue** is not focused on transportation equity, will the primary topic be assessed for equity benefits or impacts within the research project?

☐Yes ☒No ☐Unsure

4c Is the implementation of potential findings from this research likely to directly involve participation from an identified group that would benefit from an equitable process or outcome?

☐Yes ☒No ☐Unsure

4d Is the intended final product or information expected to support ODOT's equity efforts (Including but not limited to supporting one of the equity related objectives of the ODOT's Strategic Action Plan or Oregon Transportation Plan) ?

☐Yes ☒No ☐Unsure

4e If you answered yes to any of the equity questions above or can provide alternative details related to equity, please provide additional information:

Equity-Related Components:

While equity is not the primary focus of this research, the proposed study supports ODOT's equity goals by enhancing safety and accessibility across all Oregon communities. By examining the long-term effectiveness of temporary traffic control measures, the research aims to develop adaptive strategies that ensure consistent safety for all drivers, including those in underserved or rural areas who may encounter long-term construction work zones more frequently.

Additionally, by improving temporary traffic control effectiveness, this research indirectly contributes to reducing accident risks and improving the reliability of travel times, which can disproportionately benefit those with limited transportation options or those relying on critical travel routes. This alignment with ODOT's equity goals fosters a safer and more reliable transportation experience that serves the needs of all Oregonians.

Safety
Research outcomes may include interventions and countermeasures to prevent or reduce the frequency of crashes or other causes of transportation-related injury or death; or may include measures to reduce severity of injury (including prevention of death) after a crash or other injurious event. For definitions and details please review the equity vision, goals, and objectives of the ODOT Strategic Action Plan, Oregon Transportation Safety Action Plan and Oregon Transportation Plan.

4m. Will solving the **transportation issue** in question 1 support improving **safety culture** for either transportation workers or the traveling public?

☒Yes ☐No ☐Unsure

4n. Will the solving the **transportation issue** support improving safety through **healthy and livable communities**?

☒Yes ☐No ☐Unsure

4o. Will solving the **transportation issue** support improving safety through using **best available technologies**?

☒Yes ☐No ☐Unsure

4p. Will solving the **transportation issue** support improving safety through **communication and collaboration**?

☒Yes ☐No ☐Unsure

4q. Will the solving the **transportation issue** support improving safety through **investing strategically**?

☒Yes ☐No ☐Unsure

4r. If you answered yes to any of the safety questions above or can provide alternative details related to safety, please provide additional information:

This research focuses on improving safety for transportation workers and the traveling public. The study aims to develop real-time, adaptive traffic management strategies using AI tools that minimize risks associated with driver complacency and desensitization in long-term work zones by studying the long-term effectiveness of temporary traffic control measures. Enhanced and adaptive controls will reduce the likelihood of accidents, promote safer driving behaviors, and create a safer environment for workers exposed to prolonged construction zone hazards. The research outputs will also improve ODOT's overall

safety culture by establishing data-driven recommendations that can be consistently applied across varied work zones, ensuring safer conditions for all stakeholders involved.

This research contributes to healthier, more livable communities by helping to reduce traffic incidents and promoting safer driving environments in long-term work zones. Ensuring the effectiveness of traffic control in areas where construction may disrupt normal traffic flow, especially in rural or underserved regions, enhances the overall livability and travel experience for residents and road users, creating a safer and more accessible transportation network. The proposed research will assess and recommend adaptive, real-time traffic control technologies tailored to long-term work zones. These best-available technologies, such as dynamic signage and automated real-time alerts, will ensure that ODOT implements the most effective measures to maintain driver attentiveness and responsiveness in complex or prolonged work environments. Utilizing these advanced technologies supports proactive safety management that evolves alongside current capabilities and work zone conditions.

This study inherently requires collaboration between ODOT, traffic control personnel, and safety experts to develop a comprehensive implementation guide for adaptive traffic control strategies. By fostering communication among key stakeholders, this research aligns with ODOT's commitment to collaborative safety improvement, facilitating shared understanding and consistency in safety practices across construction sites. Investing in research to develop effective, long-term traffic control strategies is a strategic decision that will prevent accidents and enhance public safety on Oregon's transportation network. The outputs will provide actionable insights and practical tools that ODOT can incorporate into future construction projects, maximizing the impact of safety investments over the lifecycle of long-term infrastructure projects. ODOT is positioned to proactively address safety risks by strategically focusing on adaptive traffic control measures, ultimately reducing statewide injury and accident rates in work zones.

5. Other comments:

Previous ODOT and other research has highlighted the role of temporary traffic control measures—such as radar speed signs, portable changeable message signs (PCMSs), and flashing lights—in influencing driver behavior and speed in work zones. Studies by Garber and Srinivasan (1998), Pesti and McCoy (2001), and Sandberg et al. (2009) have explored the effectiveness of such measures, often indicating variability in their impact duration. However, these studies primarily evaluate short-term effects, leaving a critical gap regarding how these controls perform in long-term stationary work zones, where driver habituation may lessen their positive influence over time. Additionally, these studies do not offer clear, quantitative guidance on the relationship between effectiveness and exposure time that ODOT could apply in designing more enduring traffic control strategies.

Further research on adaptive and time-based traffic control strategies is essential for addressing this gap, particularly as ODOT seeks to develop dynamic, real-time approaches that can respond to prolonged deployment and evolving work zone conditions. For instance, research into adaptive feedback systems and dynamic speed monitoring, such as those examined in more recent studies (e.g., Cruzado and Donnell 2009; Finley et al. 2004), has shown promise for improving compliance and attentiveness over extended periods. By building on these findings, ODOT can establish data-driven guidelines and policies that ensure sustained effectiveness of traffic control in long-term roadway work zones, aligning with ODOT's mission to deliver safe, reliable transportation infrastructure that effectively supports Oregon's unique and evolving needs.

The proposed research will investigate the long-term effectiveness of temporary traffic control devices in stationary work zones, focusing on mitigating reduced driver responsiveness over prolonged exposure. Essential tasks include a literature review and survey of state DOT practices to establish current knowledge on time-based control effectiveness and interviews with traffic control designers to pinpoint opportunities for adaptive modifications in work zone design. Field testing will assess selected traffic control measures over time and, based on these results, adaptive strategies such as periodic signage changes will be developed and tested to counteract habituation effects. A final research report will provide actionable guidance for ODOT's traffic control designs. Additionally, an AI-driven component will leverage machine learning to analyze field data and develop predictive models, enabling real-time, data-informed adjustments to traffic control measures and enhancing adaptability and sustained effectiveness in long-term work zones.

Cruzado, I., Donnell, E. T. (2009). " Evaluating Effectiveness of Dynamic Speed Display Signs in Transition Zones of Two-Lane, Rural Highways in Pennsylvania." Sage Journal, No. 2122, pp. 1–9.

Finley, M. D., Ullman, B. R., and Trout, N. D. (2004). "Traffic Control Devices and Practices to Improve the Safety of Mobile and Short Duration Maintenance Operations." Texas A&M Transportation Institute, FHWA/TX-05/0-4174-2.

Garber, N. and Srinivasan, S. (1998). "Effectiveness of Changeable Message Signs in Controlling Vehicle Speeds in Work Zones, Phase II." VA Transp. Research Council and FHWA, VTRC 98-R10, Dec. 1998.

Pesti, G. and McCoy, P. T. (2001). "Long-Term Effectiveness of Speed Monitoring Displays in Work Zones on Rural Interstate Highways." *Transportation Research Record*, No. 1754, pp. 21-30.

Sandberg, W., Shoenecker, T., Sebastian, K., and Soler, D. (2009). "Long-Term Effectiveness of Dynamic Speed Monitoring Displays (DSMD) for Speed Management at Speed Limit Transitions." Washington, Dakota, and Ramsey Counties.

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