Research Problem Statement

ODOT Research Section
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I. TITLE

17-052 Enhancing Preventive Maintenance (PM) of the ODOT Equipment Fleet

II. PROBLEM

In today's funding environment, ODOT needs innovative solutions to maximize the cost-efficiency of its equipment fleet. Recent years have seen a large shift from corrective maintenance toward preventive and even predictive/risk-based maintenance of equipment. Currently, the ODOT Fleet Services section usually has a canned preventive maintenance (PM) schedule that assumes that all applications of use are same. Such schedule presently only uses time/mileage as decision base and does not take into account real-world operating data and performance measures. Some questions that are of interest and need to be answered are presented as follows. *Could extending PM intervals based on real-world performance measures result in substantial cost savings to the ODOT and maximize the service life and salvage value of ODOT vehicles and equipment?* If the answer is yes, then what is the correct interval, costs and benefits for an effective PM program related to ODOT equipment function/make/model? There is an urgent need to optimize the PM program based on the relevant influential factors so as to achieve effective and efficient asset management.

ODOT currently owns and manages a significantly large amount of equipment and vehicles that could utilize such PM criteria. Kim and Porter (2009) conducted an ODOT-sponsored study which developed a fleet condition model that uses [*(Age/Age standard)+(Usage/Use standard) + (LTD Cost/ Acquisition Cost)*] as a measure to prioritize replacements, which is now adopted by ODOT. Shortly thereafter, the ODOT implemented a new software (Fleet Information Management System, or FIMS) to "capture the right information about its equipment in order to make decisions that reduce costs to the agency". The FIMS sends automatic PM notifications to Transportation Maintenance Managers, which are typically triggered by mileage/meter readings or time period since last service. Note that the newer on-road and off-road engines have valuable information available on the On-Board Diagnostics (OBD) busses through the state-of-the-art technology for the fuel system that ODOT utilizes. ***This data, if intelligently coupled with intuitive and predictive algorithms (e.g., Fan et al., 2011, 2012, 2014), could greatly extend PM schedules based on individual equipment use.*** The primary function of equipment fleet managers is to maintain the right equipment at the right time and at the lowest life cycle cost. To this end, a theoretically sound and practically feasible PM program must be developed to accommodate the specific ODOT needs.

III. PROPOSED RESEARCH, DEVELOPMENT, OR TECHNICAL TRANSFER ACTIVITY

This research project will mainly consist of practitioner surveys and numerical investigation. The goal of this project is to develop a PM program that can intelligently ***recommend*** equipment fleet PM schedules based on ODOT in-practice parameters instead of set-time or set-usage. To accomplish this goal, the research team will:

1. Comprehensively review the state of the practice of fleet equipment performance measurement and PM programs, with a focus on those applicable to ODOT equipment and vehicles;
2. Identify appropriate equipment/vehicles and develop an appropriate data collection plan for the selected equipment/vehicles;
3. Identify performance outliers via inter-quartile-range or IQR method;
4. Develop robust mathematical models and predictive algorithms to predict the need for an oil change based on the data collected, the oil sampling results, and the general information and oil event log sheet;
5. Conduct a life cycle cost analysis and effectiveness evaluation; and

6. Provide a set of recommendations on the feasibility and guidelines of further implementation by the ODOT.

IV. POTENTIAL BENEFITS

By establishing key PM criteria for equipment fleet, ODOT will maximize its return on investment in the fleet services program. The research findings will help optimize the intervals associated with maintenance practices for the ODOT equipment fleet and possibly other motor pools. The implementation of best practices in the asset management will maximize the fleet's performance, reliability, and readiness and minimize its overall life cycle cost and environmental footprint. This research is urgently needed in light of increasingly tight budget available for fleet management and the need for fleet services to meet ODOT's mission and goals.

V. IMPLEMENTATION

This research will develop recommendations and guidelines on the PM schedule (criteria) of various functional types of ODOT equipment and vehicles. These will enable ODOT Fleet Services section to set up maintenance calls and adequate plans based on multiple influential factors instead of overly simplified yet non-optimal time/mileage criteria. This project will leverage ODOT's previous efforts in fleet condition modeling and FIMS and significantly modify the ODOT approach to fleet maintenance.

VI. LIST OF REFERENCES *(optional)*

Kim, D.S., and J.D. Porter (2009). Fleet Management Modeling. Final report for the ODOT, Salem, OR.

Fan, W., Machemehl, R., Gemar, M. and Brown, L. (2014). A Stochastic Dynamic Programming Approach for the Equipment Replacement Optimization with Probabilistic Vehicle Utilization, *Journal of Transportation Systems Engineering and Information Technology*, Volume 14, Issue 3, pp. 76-84.

Fan, W., Machemehl, R., Gemar, M. and Brown, L. (2012). "A Stochastic Dynamic Programming Approach for the Equipment Replacement Optimization with Probabilistic Vehicle Utilization," Presented at the 91st Annual Meeting of the Transportation Research Board, January 22-26, 2012, Washington, D.C.

Fan, W. and Machemehl, R. (2011). Equipment Replacement Optimization: Part I. Solution Methodology, Statistical Data Analysis, and Cost Forecasting. *Transportation Research Record* – Journal of Transportation Research Board, Issue 2220, pp. 88-98.

VII. CONTACT INFORMATION

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