



ATRC
ARIZONA
TRANSPORTATION
RESEARCH
CENTER

**RESEARCH
NOTES:**

Project 418

December 2005

CUSTOMER-ORIENTED LEVEL OF SERVICE MAINTENANCE MANAGEMENT SYSTEM

The Performance Controlled System (PeCoS) system has been used by the Arizona Department of Transportation (ADOT) for over 25 years. It has helped maintenance managers develop and carry out maintenance programs. However, PeCoS does not provide information on level of service (LOS) outcomes, i.e., the effectiveness of the maintenance programs.

The objective of this project is to develop a customer-oriented LOS maintenance management system, a unique approach that focuses on the needs of Arizona's traveling public and identifies the results of maintenance work. To achieve this objective, the functions have been defined and conceptual design conducted for the new system. Industry best practices have been surveyed among eleven states to identify how the new system can benefit from industry innovations. A highly detailed approach has been employed for gathering public perception of Arizona's highway maintenance program through statewide focus groups and attitude surveys to identify customer needs and concerns. The project also employs a rigorous approach to condition assessment and determining budget levels. Opportunities have been evaluated to integrate life cycle cost analysis (LCCA) into ADOT's maintenance activities. Finally the project has developed a software strategy and implementation plan.

FUNCTIONAL REQUIREMENTS AND CONCEPTUAL DESIGN

The new maintenance management system retains the capabilities that are now in the PeCoS (ADOT's current system), but has the following additional capabilities:

- **LOS Objectives.** Pass-fail tests are used, showing a percentage of each feature that either passes or fails the measurement criteria.
- **Customer Involvement Process.** Focus groups and two types of attitude surveys have been conducted on a statewide basis to determine the service levels desired by Arizona citizens.
- **Condition Assessment Tracking and Trend Analysis.** Assessments of existing conditions are conducted at least annually to establish the current LOS for each maintenance feature. Data is then studied to determine trends in road conditions and to compare existing conditions with desired service levels.
- **LOS to Level of Effort (LOE) Conversion Factors.** A conversion factor (workload factor) converts the

difference between planned and actual LOS into an LOE that will produce the annual work quantity needed to raise or lower the LOS to the desired value.

- **Service Request/Work Order System.** Service requests are logged and a work order generated and forwarded to the appropriate foreman for investigation and resolution.
- **Management Reports for LOS Outcomes.** LOS outcome reports are provided, such as actual LOS summaries, actual versus planned LOS, or trends in LOS values over a period of time.

INDUSTRY BEST PRACTICES

Telephone interviews were conducted with maintenance managers in twelve states to assess the state-of-the-practice. Maintenance managers in three states (Colorado, Florida, and Washington) were then contacted to provide additional details on specific focus areas. The findings of these surveys are analyzed, and the industry best practices that can benefit ADOT's new customer-oriented level of service maintenance management system have been identified.

PUBLIC PERCEPTIONS

To help establish a customer-oriented LOS maintenance management system, public perception of Arizona's highway maintenance program was obtained using a statewide telephone survey; focus groups with residents of Phoenix, Tucson, and Flagstaff; and a supplemental survey. Focus groups were also held with 92 ADOT maintenance staff from regions around the state. The findings are outlined below.

Current Maintenance Levels

Arizona residents generally rate current maintenance favorably. Residents rate the current maintenance levels for traffic control and

safety, vegetation, snow/ice removal, and roadside maintenance the highest. Urban residents have the highest level of satisfaction with current service levels, including the efficiency of ADOT maintenance staff. Arizona road maintenance is rated higher than maintenance provided by local jurisdictions and other states. Actual maintenance conditions are worse than public perceptions in all service areas.

Desired Maintenance Levels

Service levels should be improved in all maintenance areas. Safety should be the most important maintenance goal. Enhancement of traffic control and safety, bridge, drainage, and roadside maintenance should be considered as key improvement objectives. Roadway surface maintenance is in need of the most improvement.

Program Funding

Residents are willing to spend more tax money to achieve their desired levels of service, if they are assured that it is necessary. The maintenance areas of traffic control and safety and paved roadway surfaces should have the highest funding priorities. State spending on preventive maintenance is strongly encouraged.

ADOT Maintenance Staff Findings

Maintenance staff members are generally in touch with public perceptions regarding maintenance. Maintenance staff members have significantly lower opinions of current maintenance conditions than the public does.

Supplemental Findings

Residents perceive paved shoulder erosion and ride quality to be well maintained. Paved shoulder drop-offs are also generally seen as well maintained. Residents do not perceive unpaved shoulder erosion and unpaved shoulder drop-offs to be well maintained. Residents seek high maintenance levels in all five areas tested.

CONDITION ASSESSMENT AND BUDGET

A two-year maintenance budget was prepared, based on the newly developed maintenance management procedures. The development of this budget required establishing:

1. The existing condition of the infrastructure.
2. The desired condition of the system (LOS).
3. The cause-and-effect relationship between maintenance activities and system condition.

The various maintenance activities were grouped into nine categories to assess the existing condition and to determine the desired condition of the highway system.

Cause-and-Effect Relationship Between Maintenance Activities and System Condition

In order to determine the cause-and-effect relationship, four ADOT maintenance personnel worked with Jorgenson & Associates at their Maryland office for one week. The group was used as an expert task group to determine the amount of effort necessary to obtain the five conditions for each of the PeCoS items related to the nine maintenance categories. For each PeCoS item the investment required to maintain each LOS was determined, and the budget amount was then aggregated into a total budget for each of the nine categories.

Budget and Data Model Development

The public's subjective evaluation does not correlate directly with the quantitative measurements used by ADOT to rate current conditions. For this reason, data models were developed to represent the relationship between the investment and the resulting LOS obtained for each of the nine maintenance categories.

Budget Assumptions

The budget was calculated using eighteen PeCoS maintenance items. The budget was prepared for each of these items by adding the investment necessary to produce the consumer shift to last year's budget amount and increasing that total by an inflation rate of 3.3 percent

LIFE CYCLE COSTS

ADOT currently tracks cost data using its PeCoS maintenance management system; however, costs are not directly linked to specific treatments applied at specific locations. No formal treatment performance data are collected or retained in PeCoS, making cost analyses highly problematic. For this reason, opportunities were evaluated to integrate LCCA into ADOT's maintenance activities. The results of the evaluation for various maintenance activities are outlined below.

Pavement

Pavement maintenance is especially appropriate for this type of analysis because there are alternative treatments available. There is also a mechanism in place (ADOT's pavement management system) for tracking impacts of treatments on performance; however, the following modifications to the system are needed for performance monitoring and modeling:

- A tracking system to keep track of treatments and the locations where they are applied.
- A means of monitoring performance.
- A system to predict pavement condition and trigger the need for treatment.
- Assessment of treatment recommendations from the pavement management system to assess the accuracy of the analysis and update the models.

Other Maintenance Activities

ADOT is also interested in evaluating the applicability of extending LCCA to other maintenance decision processes beyond pavements. In all maintenance activities, LCCA should be used to select among alternative treatments with non-equal costs and/or lives. However, in considering LCCA in decision making for other maintenance features, appropriate maintenance activities and factors affecting performance should be evaluated (outlined in Chapter VI of this document).

SOFTWARE STRATEGY AND IMPLEMENTATION PLAN

An analysis of the requirements, the state of information technology capability at ADOT, and the availability of viable vendor software products on the market was conducted, and four alternatives were identified, each having the capability of satisfying ADOT's requirements:

- Alternative 1 – Purchase a maintenance management system package that includes both asset inventory and work management, and custom build an LOS planning framework software application.
- Alternative 2 – Keep PeCoS and custom build asset inventory and LOS planning framework software applications.

- Alternative 3 – Keep PeCoS, purchase an asset inventory system, and custom build an LOS planning framework software application.
- Alternative 4 – Custom build a complete LOS-capable maintenance management software application.

The evaluation of these alternatives resulted in Alternative 1 and Alternative 3 being very close, with a slight advantage to Alternative 3 based on cost and risk criteria.

Based on this evaluation, the recommendation is to proceed with Alternative 3, and keep the PeCoS system, purchase a packaged asset inventory system, and proceed with the specification, design, construction, and implementation of an LOS planning framework application. This is predicated on the assumption that the PeCoS system will prove to be a viable tool for planning, organizing, and directing ADOT's maintenance work. Once the complete, detailed requirements for integrated asset management have been documented, a formal evaluation of the PeCoS system should be conducted, and a decision made as to whether PeCoS should be kept or replaced. If it is decided that ADOT should replace PeCoS, then the recommendation would be to proceed with Alternative 1.

The full report: **Customer-Oriented Level of Service Maintenance Management System**, by Dye Management Group, Inc. (Arizona Department of Transportation, report number FHWA-AZ-05-418, published October 2005) is available on the Internet. Educational and governmental agencies may order print copies from the Arizona Transportation Research Center, 206 S. 17 Ave., MD 075R, Phoenix, AZ 85007; FAX 602-712-3400. Businesses may order copies through ADOT's Engineering Records Section.