Approach to Level-of-Service Target Setting for Highway Assets

DETAILS

8 pages | 8.5 x 11 | PAPERBACK

ISBN 978-0-309-37482-8 | DOI 10.17226/22090

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October 2015

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

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Research Results Digest 396

APPROACH TO LEVEL-OF-SERVICE TARGET SETTING FOR HIGHWAY ASSETS

This digest summarizes the findings from NCHRP Project 14-25, "Guide for Selecting Level-of-Service Targets for Maintaining and Operating Highway Assets." The digest was prepared by Amir N. Hanna, NCHRP Senior Program Officer, from "Guide to Level of Service (LOS) Target Setting for Highway Assets," an attachment to the contractor's final research report, authored by Teresa M. Adams and Kyle Schroeckenthaler, University of Wisconsin-Madison; Ernie Wittwer, Wittwer Consulting; John O'Doherty, University of Michigan; and Marie Venner, Venner Consulting. Dr. Adams was the principal investigator.

INTRODUCTION

Asset management principles are used by state departments of transportation (DOTs) to operate, maintain, upgrade, and expand physical assets effectively throughout their life cycle. These principles include (1) establishing high-level policy goals and objectives, (2) developing performance measures to accomplish the goals and objectives, (3) analyzing options and trade-offs for investment strategies, (4) making decisions based on quality information and data, and (5) monitoring outcomes to provide accountability and feedback. A key component of such a strategy is the identification of important maintenance features that make up highway infrastructure and the establishment of a level-of-service (LOS) target for each. Such targets have often been established based on the expert opinion of individuals and not necessarily following a systematic process.

In general, LOS is defined in terms related to customer service, such as safety, convenience, aesthetics, comfort, or mobility. However, there are no widely accepted methodologies for determining the appropriate LOSs associated with the condition of different assets. Research was needed to identify methodologies and develop a guide for selecting target LOSs for maintaining and operating highway assets. NCHRP Project 14-25 was conducted to address this need. The research team proposed an approach for LOS target setting and presented it in "Guide to Level of Service (LOS) Target Setting for Highway Assets" (Guide) to help highway agencies better utilize asset management principles and manage highway assets more effectively.

RESEARCH APPROACH

The research team obtained information through a review of literature, responses to a questionnaire provided by state and provincial transportation agencies, and interviews with specialists of selected state DOTs. This information was used to identify the different performance measures, standards, and LOSs used in maintenance management or maintenance quality assurance. The information also identified relevant issues pertaining to the target-setting

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process, such as flexibility, data availability, priority setting, relationship to budgeting process and strategic goals, and risk management. The research team then organized and used these findings to identify a rational approach to LOS target setting. This approach served as the basis for the Guide, which works with the data and procedures developed by transportation agencies as part of their maintenance quality assurance (MQA) systems or their maintenance performance management system. The Guide is accompanied by supporting materials, including appendices that provide detailed information on the different aspects of the Guide and a spreadsheet tool and instructions to assist with its implementation.

ISSUES IN CURRENT PRACTICE

The literature review, survey responses, and state DOT interviews conducted in this research identified several issues in current practice that should be considered in the process for LOS target setting. These issues include the following:

- Most agencies collect at least some maintenance condition data using sampling techniques that are expensive and may expose data collectors to traffic hazards. These agencies may be able to reduce the number of samples they collect and/or greatly improve the precision of the condition estimates by employing stratified sampling techniques.
- Many agencies lack formalized processes for ensuring that maintenance activities fulfill the agency's maintenance goals and for assessing how well the goals are met. Policy and decision makers (legislative and agency upper management) want the maintenance operations to be as transparent as possible, and often they must react to changes in priorities involving available resources over which they have little or no control. They want to know objectively what changes in LOSs might occur as a result of high-level policy actions.
- Many agencies rely on the experiential knowledge of individuals to prioritize maintenance activities. This approach, while based on good engineering judgment, may not be defensible if tradeoffs on expenditures and allocations are challenged. Systematic approaches for assessing the contribution of maintenance activities toward achieving maintenance program goals can improve internal and external conversations regarding funding priorities.
- Maintenance cost accounting systems tend to focus on the cost of inputs rather than on the cost of outputs. Many agencies struggle to associate material, equipment, and labor costs with specific maintenance activities and the output quantities of maintenance activities. Indirect approaches for estimating maintenance activity costs, such as price tags and cost allocation, could significantly improve agencies' ability to predict maintenance costs and outcomes.
- Many agencies rely on historical precedents and inventory levels to allocate maintenance funds as if those legacy approaches are optimal. Simple optimization techniques can provide justifications for allocating funds in a way that is consistent with maintenance goals and maximizes the impact of maintenance expenditures.
- Few agencies formally consider risk as an ongoing concern in managing the maintenance program. Agencies can implement simple processes for considering risk more formally in LOS target setting and maintenance management.
- Only a few agencies have realized the full benefits of target setting and performance management that can be achieved by communicating conditions, targets, and program goals both inside the agency and to interested parties outside of the agency.

These issues have been considered in the process for LOS target setting and addressed in the Guide.

OVERVIEW OF THE LOS TARGET-SETTING PROCESS AND THE GUIDE

A process for target setting that draws from the fundamentals of statistics, operations research, and optimization was selected to develop simple analytic techniques and strategies for incorporation into the Guide. As shown in Figure 1, the process for setting and implementing LOS targets consists of three steps: Preparing to Set Targets, Setting Targets, and Managing with Targets. A brief description of these steps is provided in this digest; details are provided in the Guide and its supporting materials.

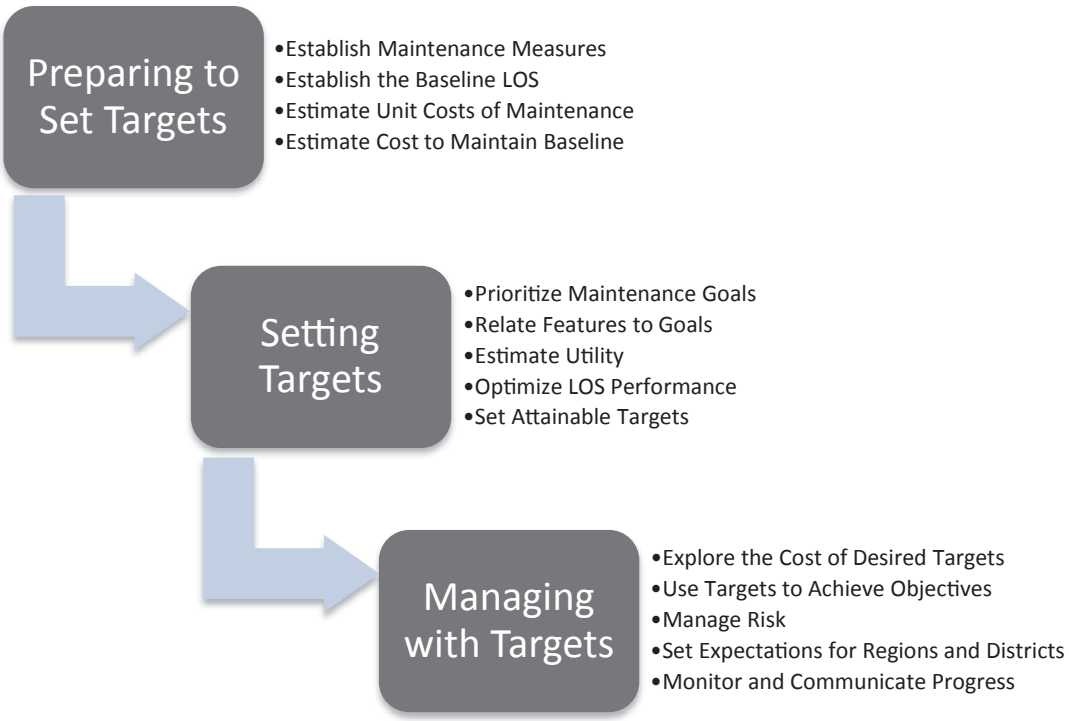

Figure 1 Generalized process for setting maintenance LOS targets.

Preparing to Set Targets

Measurement and target setting are data-intensive activities. They require the agency to collect information to formalize its objectives and understand its baseline of performance on maintenance operations and funding allocations.

Establish Maintenance Performance Measures: The LOS target-setting framework builds upon the agency's MQA program. This step involves deciding what highway features will be measured, how the features are to be measured, and how those measures are scored on an LOS scale. Since MQA programs are widely used and understood, the LOS target-setting process assumes agencies have established highway features and defined performance measures for assessing the LOS of those features.

Establish the Baseline LOS: In this process, current performance is used as the baseline against which targets are set. This is accomplished by collecting and analyzing the data needed to assess the baseline. Many agencies use sampling techniques to gather performance data and produce an estimate of the baseline performance; agencies must recognize the importance of the accuracy of these estimates. The Guide presents statistical strategies and several estimator functions that were derived specifically for the types of data collected for highway MQA programs.

Estimate Unit Costs of Highway Maintenance: Knowing the cost of maintenance is essential for optimizing within budget constraints. Maintenance costs must be expressed in measurement units that are consistent with deficiency rates on the agency's LOS scale (e.g., the cost of a mile of paving, an acre of mowing, or a square yard of patching must be known or estimated). Price tags and cost allocation are two of the approaches commonly used for estimating the requisite maintenance costs (details of these approaches are described in the Guide).

Estimate the Cost to Maintain the Baseline LOS: Knowing the cost to maintain the baseline LOS performance is necessary for allocating budgets as it makes it possible to consider tradeoffs and performance effects of increases or decreases in resource allocations and find areas where increased or decreased spending could have benefits (details of the process for estimating costs to maintain the baseline performance are described and illustrated by an example in the Guide).

Setting Targets

Setting meaningful targets is a multi-step process. The agency may (1) define, understand, and prioritize maintenance goals; (2) relate the maintenance features, or activities, to those maintenance goals;

(3) prioritize feature maintenance based on its expected contribution to achieving a maintenance goal; (4) develop an optimization tool to support decision making; and (5) set LOS targets that are attainable within budget constraints to find attainable LOS targets.

Prioritize Maintenance Goals: Maintenance goals give meaning to LOS targets and help maintenance managers explain budget allocations and the benefit of expenditures to both internal and external audiences. The LOS target-setting process assumes that DOTs have pre-established maintenance goals; this step prioritizes these goals by assessing the contribution of each goal to the overall success of the maintenance program. This prioritization can be achieved using one of two methods: the Simple Multi-Attribute Rating Technique (SMART) and the Analytical Hierarchy Process (AHP) (details of these methods are provided in the Guide).

Relate Maintenance Features to Maintenance Goals: Highway features are the basic building blocks of an MQA program; agencies maintain these features to achieve their maintenance goals. In this step, the maintenance of each highway feature is assigned to one of the agency's maintenance goals (the Guide presents a simple approach to help build this relationship). However, if it is found that a feature cannot be related to any of the goals, then either the need for maintaining this feature or the set of identified goals should be reassessed.

Estimate Maintenance Utility of the Features: Because some maintenance features contribute more toward achieving goals than others, assigning a relative utility for each feature is required. The relative utility of the features can be quantified using SMART or AHP (the Guide provides instructions for assigning utility weights for each feature based on comparison judgments contributed by one or many experts and includes examples using data from several state DOTs).

Optimize LOS Performance: A simple optimization technique is adopted to allocate available funds to maximize performance on maintenance goals. The optimization adjusts targets by allocating funds to features and maintenance activities having low cost and high utility while at least satisfying minimum performance expectations for features and activities having high cost and low utility (the Guide contains the mathematical formulation for the optimization model along with an Excel workbook implementation with user instructions).

Set LOS Targets That Are Attainable within Budget Constraints: Budget constraints are often determined by high-level policy makers, and in some cases, budget constraints cannot be met without some compromise on minimum service expectations (the Guide describes an iterative process for setting attainable targets that maximize program performance by adjusting budget allocations and minimum performance expectations).

Managing with Targets

Target setting is a process for identifying targets that can be used to support maintenance management responsibilities. The target-setting process involves identifying and managing risk, monitoring progress, making adjustments to the plan and program based on feedback, and communicating results.

Explore the Cost of Achieving Desired LOS Targets: Understanding the cost of achieving desired LOS targets is useful for communicating with policy and decision makers regarding the value of certain funding levels. Reasonable estimates must be established for both the incremental cost of attaining those targets and the incremental benefits (the Guide includes an Excel workbook and optimization model that can be used to estimate the cost of desired LOS targets).

Use LOS Targets to Achieve Management Objectives: LOS target setting is an activity that builds upon the agency's performance management program and data and is likely driven by some underlying management objective. Target setting is expected to save money, change priorities, reallocate budgets, or result in some other outcome (the Guide identifies some of the management objectives for setting LOS targets for a maintenance program and describes the three common frameworks for tracking these objectives: benchmarking, trend lines, and tiered approaches).

Identify and Manage Risk: Risk is a factor that can influence the level at which an agency sets some targets and the ability to achieve them. An active approach to managing risk can reduce disruptions to the program (a process for identifying and managing risks that may impact the agency's ability to set or achieve LOS targets is described in the Guide).

Use LOS Targets to Set Expectations for Regions and Districts: A process that allows managers to set specific targets for regions and districts and to follow up on these objectives is necessary

for allocating funds and managing the maintenance program (an optimization strategy that is easily scalable to different subsets of the maintenance program is provided in the Guide).

Monitor and Communicate Progress: It is important that steps be taken to ensure that the program is implemented as planned. Otherwise, analysis must be done to determine the cause of the variance (the Guide presents a logical approach to monitoring a program and communicating progress).

Organization of the Guide

The Guide is organized into three chapters following an introduction. These chapters represent the major actions needed to successfully set and use targets: Preparing to Set Targets, Setting Targets, and Managing with Targets. Each chapter is broken into several sections, each of which addresses the different elements of each step in the process and is supported by more detailed information in the appendices. Table 1 presents the contents of the Guide.

FINAL REPORT

The contract agency's final research report for NCHRP Project 14-25, "Guide for Selecting Level-of-Service Targets for Maintaining and Operating Highway Assets," gives a detailed account of the project, findings, and conclusions. This final research report is accompanied by the Guide. The Guide includes several appendices that provide further clarifications and instructions to facilitate implementation.

Table 1 Contents of the Guide.

Chapter	Section	Supporting Appendices
2 Preparing to Set Targets	2.1 Introduction	A. Glossary B. Acronyms and Abbreviations C. Agency Self-assessment in Preparing to Set Targets
	2.2 Establish Maintenance Performance Measures and LOS Scales	D. Summary of Commonly Used Measures
	2.3 Establish the Baseline LOS	E. Stratified Sampling and Statistical Analysis
	2.4 Unit Costs of Highway Maintenance	
	2.5 Cost to Maintain the Baseline LOS	
3 Setting Targets	3.1 Prioritize Maintenance Goals	F. AHP for Weighting Maintenance Goals and Features
	3.2 Relate Maintenance Features to Maintenance Goals	
	3.3 Estimate Maintenance Utility	G. Priority and Utility Weights—State Examples
	3.4 Optimize LOS Performance	H. Goal and Program-wide Maintenance Performance I. Workbook Implementation of the Optimization Model
	3.5 Budget Constraints and Attainable LOS Targets	

(*continued on next page*)

Table 1 (Continued)

Chapter	Section	Supporting Appendices
4 Managing with Targets	4.1 Exploring Cost and Desired LOS Targets	
	4.2 Using LOS Targets to Achieve Management Objectives	
	4.3 Manage Risk in Setting and Achieving LOS Targets	J. Risk Severity Level Classification References
	4.4 Using LOS Targets to Set Expectations for Regions and Districts	
	4.5 Monitoring and Communicating Progress	K. Communicating Targets

The final research report, the Guide, and a spreadsheet tool are available on the Transportation Research Board website by searching on *NCHRP Research Results Digest 396.*

ACKNOWLEDGMENTS

The research summarized herein was requested by the American Association of State Highway and Transportation Officials (AASHTO), and conducted as part of the National Cooperative Highway Research Program (NCHRP). The NCHRP is supported by annual voluntary contributions from state DOTs. The research was conducted under a contract with the University of Wisconsin-Madison; Dr. Teresa M. Adams was the principal investigator. The work was guided by the NCHRP Project 14-25 Panel, which included Russell Yurek, Maryland State Highway Administration; Rafael M. Aldrete, Texas A&M Transportation Institute; Enrico Victor "Rico" Baroga, Washington DOT; James Carney, formerly with Missouri DOT; Christopher C. Harris, Tennessee DOT; Lacy D. Love, Volkert, Inc. (formerly with North Carolina DOT); Kathryn A. Zimmerman, Applied Pavement Technology, Inc.; Nastaran Saadatmand, FHWA liaison representative; and Thomas Palmerlee, TRB liaison representative. The project manager was Amir N. Hanna, NCHRP Senior Program Officer.

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500 Fifth Street, NW
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ISBN 978-0-309-37482-8

Subscriber Categories: Maintenance and Preservation