NCHRP 08-71: Methodology for Estimating Life Expectancies of Highway Assets

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1. Work plan

2. Sample formats for progress charts

1. WORK PLAN

Figure 1 presents a timeline of the work plan, while subsequent sections provide details of the work plan.

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LEGEND

- Submission of Report
- Meeting with the NCHRP Panel
- Workshop
- Other Activities of the Research Team

NOTES

Final report preparation includes incorporation of post-workshop comments.
Task 1  Information Search, July 5 - Sep 30, 2009
In this task (which has already started), we are reviewing and documenting research reports and papers in the
general subject area of life expectancies, not only for highway assets (pavements, bridges, culverts, signs, pavement
markings, guardrail, roadside facilities, etc.) but also for other asset types. Areas of the search include:
- definitions of life expectancy and associated performance indicators
- values of life expectancy established for the different assets and environmental conditions
- factors that affect life expectancies
- statistical/econometric techniques for analyzing data related to life expectancies
- current practices in financial and management accounting for depreciation of major capital assets (this will
be done so we can compare life expectancies values and concepts used in these practices to those used in
the management and maintenance of highway assets).

Task 2  (Assessment of Data Availability),  Sep 1 - Nov 30, 2009
In this task, we will assess the availability of data for the study. It is expected that there will be marked differences
in the data availability across the different highway asset types and agencies. For example, for bridge and pavement
assets, management systems have been relatively well established at state agencies and thus would likely be able to
furnish most of the necessary data. For other assets such as small culverts, road signs and signals, and other roadway
and roadside appurtenances where there seems to be relatively little data, our data search will be more aggressive.

Task 3  (Methodology for Life Expectancy Estimation),  Nov 1 - Jan 31, 2010
In this task, we intend to implement the overall architecture of our study by developing methodologies for life
expectancy estimation. This will be done with due cognizance given to (i) the cases of application that depend on the
type and frequency of asset rehabilitation and maintenance activities, (ii) the different dimensions of life expectancy
estimation, and (iii) specific procedures for each case of application and for each dimension.

With regard to the Cases of Application, we will consider at least 4 potential application cases (i) rehabilitation and maintenance activities are performed as assumed by the designer in the life-cycle cost analysis, (ii) minimal maintenance is performed over the life of the asset, (iii) more proactive rehabilitation and maintenance activities are performed to extend the asset’s life, and (iv) materials or designs that require no or very little maintenance are used.

With regard to Dimensions and Considerations, we will decompose the methodology into two levels of
dimensions. This is because depending on their cultural or administrative practices, state agencies determine and
express, implicitly or explicitly, the life expectancy of their assets in different ways. For example, some agencies
prefer to express life expectancy in years while others may do so in terms of accumulated usage levels or loading.
Also, agencies have used a variety of means to determine life expectancies: historical practice, expert opinion, or
cost-benefit methods.

The higher level of dimensions will comprise: Asset or facility class or type (road sign, culvert, etc.); Life
cycle status (new facility or existing facility); Monitoring approach (condition-based vs. interval-based). Then for
each combination of the high-level dimensions (for example: new, pavement, condition-based), we will examine the
problem statement from lower level of dimensions: Methods (historical practice, expert opinion, rational methods);
Variables for expressing facility life (age in years, accumulated usage or climate effects); Nature of data for life
expectancy determination (panel, time series, cross-sectional).

The different dimensions discussed above will serve as a basis for decomposing our problem into the
several asset classes and types, performance indicators, and data types. We will then adopt a general analytic
procedure for the various asset classes. For most highway assets, the point at which agencies consider that the asset
life has ended is due to three primary causes: fatigue, extreme events, and irreparable deterioration. We intend to
define what we mean by end-of-life in each case, and then come up with methods to forecast remaining life.
From the results of Task 3, we will first identify factors that potentially influence the life expectancies of the highway assets. These factors, which depend on the asset class under consideration, generally include specific type of the asset, material type, design criteria, inspection frequency, maintenance timing, and other parameters characterizing maintenance and preservation activities, asset age and/or traffic loading, and climatic severity. We will then investigate the sensitivity of asset life expectancy to each factor. The statistical significance of individual factors in influencing the life expectancy of each asset class/type will be tested statistically. Also, we will implement the tested models in an Excel spreadsheet in order to provide a framework for repeatable sensitivity analyses and for generating reports of the results. The spreadsheet will provide a place to enter sample data; to implement the various submodels for performance forecasting; and to combine the separate models into an overall prediction of service life. It is anticipated that the spreadsheet model will be self-contained and will require little or no Visual Basic programming. The intention is to use worksheet formulas and built-in Excel statistical capabilities to demonstrate the models.

Task 5 (Submission of Report and Meeting to Review Tasks 1 to 4) Report Submission-March 31, 2010; Meeting -April 30, 2010
The first Interim Report will provide a thorough documentation of Tasks 1 to 4, for review by the NCHRP. The report will discuss our information search and a candid assessment of data availability at the identified sources. The report will also include our thinking regarding the alternative (and recommended) methodologies for life expectancy estimation given the level of data availability, an identification of the factors affecting life expectancies, and a methodology for carrying out sensitivity analysis. The research team and panel will have a teleconference meeting organized by the NCHRP approximately 1 month after the NCHRP receives the initial draft Interim Report 1.

Task 6 (Application of the Developed Methodology), May 1 - Jul 31, 2009
In this task, we will draw upon the results of Tasks 1-5, with due revisions made in response to the Panel comments. We will apply the methodologies developed in Task 3 for estimating life expectancies of new and in-service assets for the identified asset classes. Using data gathered in Task 4, we will then demonstrate the capability of the alternative methodologies to show the influence of the factors that influence life expectancy. We will modify the recommended methodologies, wherever necessary, to enhance its usefulness to the transportation agencies. Our proposed approach to this task is to implement the approach developed in Task 3 as a simple Excel spreadsheet model, building on the model used for sensitivity analysis in Task 4. The model would provide a place to enter sample data as gathered for Task 4; a framework for implementing empirical and mechanistic models, as recommended in Task 3, for various asset types; and the functions for computing, graphing, and reporting on the combined probability density functions for overall life expectancy.

The spreadsheet model is not intended to be implemented in routine business processes, but will instead provide a working example that can be used as a teaching tool and employed by designers of enterprise information systems such as asset management systems. It will assist in relevant parts of Task 4 to automate the sensitivity analysis, and will be useful for generating examples and figures for the final report. The spreadsheet will be critical for helping agencies understand the life expectancy model and how it might be put into practice.

Task 7 (Submission of Report and Meeting to Review Tasks 5 to 6), Report Submission-July 31; Meeting - Aug 31, 2010
The Research Team will submit a second interim report documenting the findings of Tasks 5 and 6 after completion of those tasks. The Interim Report 2 will document the methodology and examples of its application for estimating life expectancies of the identified highway assets. The report will illustrate how these life expectancies may be used in life-cycle cost analysis of new and in-service assets to develop programs or schedules for asset replacement, rehabilitation, or maintenance. Furthermore, the report will describe the effects of uncertainties (regarding the execution of these schedules/programs as planned) on the actual performance of these assets. Approximately 1
month after the NCHRP receives the initial draft Interim Report 2, the Research Team will meet with the NCHRP project panel via teleconference and modify Interim Report 2 in response to panel comments.

**Task 8 (Development of Guidebook and Workshop Organization), Sep 1, 2010 - Dec 31, 2010**

In this task, we will develop a guidebook and other resources that will assist highway agencies to implement the methodologies we developed in previous tasks. The design of our Guidebook will be guided by the specific uses to which it is intended to be put. Thus, it would be organized according to various types of applications of the methodology. These would include project-level planning and design studies, and integration into management systems for bridges, pavements, and highway maintenance. Example applications and graphical depictions would be especially important for communicating the usefulness of the product.

The Excel spreadsheet model we will develop in Tasks 4 and 6 will be an essential resource to accompany the Guide. It will provide a means of entering sample data, applying the various submodels, and presenting the results. It will present a working example for developers of management systems. The Excel model will be distributed on a CD with the Guidebook, and/or made available online and linked from an online version of the Guidebook. With the concurrence of the NCHRP and the Panel, we will develop a webpage summarizing the research, providing examples, and linking to the full Guidebook and Excel model. This would be helpful as a way of introducing transportation agency managers to the products. In addition to demonstrating the technical concepts, the Excel spreadsheet model will also demonstrate a more general goal of combining technical input from a variety of asset types to compute a generic, cross-asset performance indicator. It is our objective to use these resources as a persuasive tool to help break down institutional obstacles to asset management implementation. We will organize a workshop with the NCHRP project panel and no fewer than twenty other carefully chosen participants to solicit comments on these resources. The participants will be a balanced mix of practitioners who would be users of the methodology developed in this project and thus will be those that we expect to provide a suitably comprehensive and balanced perspective on the utility of the guidebook for local and state DOTs and other highway agencies. The workshop would include exercises making use of the Guidebook and Excel model to solve practical problems. Subsequently to the workshop, we will make any modifications to the guidebook in response to workshop participants’ comments.

**Task 9 (Final Report Preparation and Submission), Jan 1 - Apr 4, 2011**

In this task, the Research Team will submit a final report documenting the entire project. The final report will also include an outline or framework of dissemination activities and future research needed to ensure that transportation agencies can use estimated asset-life expectancies and appropriate analytical methods to design and carry out replacement, rehabilitation, and maintenance programs that maximize asset value and level of service, yield enhanced performance and minimize life-cycle costs. We will also submit a revised version of the guidebook based on comments from the workshop. Also, we will prepare a PowerPoint presentation reviewing the project and its results. The final research product will also include the comprehensive database that we would have assembled for purposes of the demonstrations of the study methodology. We will duly submit the resources (guidebook, PowerPoint presentation, and training materials, and database) in a form suitable for publication, web-access or other dissemination in a manner that is separate from the final report.
2. Sample Formats for Progress Charts

Figures 1 and 2 present samples of the sample charts we intend to use in our reporting of monthly or quarterly progress. These are sample sonly and do not reflect the work levels, expenditure, or dates, of the exiting project.

Figure 1: Sample Chart for Planned and Actual Disbursement of Project Funds

Figure 2: Sample Chart for Planned Progress and Actual Progress