Life Cycle Cost Analysis Revisited: The Discount Rate

(This is the first in a series of articles exploring specific aspects of performing life-cycle cost analyses for pavement design and rehabilitation applications.)

Life cycle cost analysis (LCCA) is a process for evaluating the total economic worth of competing project alternatives by analyzing initial costs and discounted future costs and benefits over the expected life of the project.

Mark B.Snyder, Ph.D, PE
Engineering Consultant

LCCA can be described as a five-step process:

1) Identify feasible alternatives. Pavement LCCA are greatly simplified and more easily validated if the selected alternatives have similar traffic load and volume capacities while providing similar levels of expected performance (serviceability) over the pavement design life.

2) Estimate the timing and scope of projected maintenance and rehabilitation activities for each feasible alternative.

3) Estimate the agency and user costs for each activity in each feasible alternative.

4) Compute the life cycle cost of each alternative. The "net present worth or cost" and "equivalent annual worth or cost" techniques are generally easiest to apply correctly.

5) Analyze the results, considering how agency and user costs compare among the various alternatives.

Computing life cycle costs (step 4) requires the selection of important inputs and parameters that can significantly influence the results of the analysis. One of the most important inputs is the discount rate.

The "discount rate" represents the combined effects of inflation and the cost of money (i.e., interest or opportunity cost). It allows us to analyze cash flows over time in terms of the value of today's dollar.

The discount rate can be estimated as the difference between the interest rate (the cost of borrowing money that you don't have or the value of investing money that you do have) and the inflation rate.

The results of LCCA are <u>very</u> sensitive to the discount rate. Higher discount rates reduce the present value of future costs (and benefits), favoring the selection of alternatives with lower initial costs and higher maintenance and rehabilitation costs. Conversely, lower discount rates treat future costs as being more nearly equal in value to initial costs, resulting in more favorable consideration of alternatives with lower and/or fewer maintenance and rehabilitation costs, even if initial costs are somewhat higher.

> *The results of LCCA are <u>very</u> sensitive to the discount rate.*

The traditional public sector view of the discount rate is that the "interest" component should reflect "social opportunity costs" - the potential "return" (additional benefits to the public) that would be realized by spending the funds on public schools, social programs or other items of public benefit. Since these benefits are difficult to quantify, most U.S. public sector economists use a generalized discount rate that is based on the returns provided by government bonds (e.g., Treasury Bill yields) and forecasts of overall inflation. These figures generally result in a discount rate of 3 to 4 percent.

There are at least two major problems with this view and approach:

1) Most highway funds come from taxes and tolls, with some funding from the sale of bonds. Further, government budgets are typically spent during each budget cycle and little (if any) money is invested to accrue interest.

2) Many sources of highway funds are "dedicated." Savings produced by selecting one design or rehabilitation alternative over another often cannot be used for education, social programs, etc. Even non-dedicated funds are rarely diverted to other government sectors once they have been budgeted to the highway or street department. Therefore, there is no "cost of opportunity forgone."

> *The bottom line: for many highway agencies, the "interest" rate approaches zero.*

Another problem with the traditional public sector view of discount rate is that the rate of inflation for the goods and services required to design, construct and maintain pavements is often significantly different from the official rate of inflation for consumers.

> *"The bottom line: for many highway agencies, the 'interest' rate approaches zero."*

LCCA Revisited: The Discount Rate *(Cont'd)*

For example, the U.S. Consumer Price Index (CPI, the most common measure of inflation in the U.S.) rose by 1.6 to 3.4 percent per year between 2001 and 2006, and 4.1 percent for 2007. By contrast, the U.S. Government Industry Producer Price Indexes (PPI) for Highway and Street Construction was relatively flat from 2001 through 2003, but increased by 10.8, 14.1, 6.2 and 9.6 percent in 2004, 2005, 2006 and 2007.   It is up 22.4 percent for the 12 months that ended in August 2008! (Source: Bureau of Labor Statistics: www.bls.gov/cpi for CPI, www.bls.gov/ppi for PPI.)

It is clear that the use of a discount rate that is based on market interest and consumer inflation rates is inappropriate for economic analyses of agency costs in the highway and heavy construction industries. Furthermore, the use of "standard" general discount rates may lead to the selection of a construction or rehabilitation alternative that is not the most cost-effective (and may even be the least cost-effective).

The most accurate economic analysis of agency costs will be obtained by using a discount rate that reflects the actual cost of agency funds (e.g., the average rate of return on portions of the income stream that are invested, or the weighted average cost of money when bonding is used for funding) and an estimate of the projected rate of inflation for highway construction and maintenance activities.

Example: A highway agency has an annual budget of $10 million, of which $8 million comes from dedicated user fees.

> *"It is clear that the use of a discount rate that is based on market interest and consumer inflation rates is inappropriate for economic analyses of agency costs in the highway and heavy construction industries."*

The remaining $2 million in funding is obtained through bonding (5 percent annual yield), which results in annual bond debt service of $100,000. Therefore, the weighted average interest rate for this agency is $100,000/$10,000,000 or 1.0 percent per year.

If the average highway and heavy construction inflation rate over the analysis period matches the consumer price index, it may average about 3.5 percent. *The appropriate discount rate in this case would be approximately 1.0 – 3.5 = -2.5 percent.* Using a higher rate of inflation for the highway and heavy construction industry (one that reflects the rates observed over the last several years) would produce an even more negative value for the discount rate.

A negative discount rate weights the value of future expenditures more heavily than the value of present expenditures. This concept may seem strange, but it is quite valid for analyzing cash flows where inflation rates exceed the cost of money (as often is the case for highway agencies).

It should be noted that discount rates based on the consumer price index and forecast rates of general inflation are well-suited for analyses of user costs, which should be performed (and evaluated) separately from agency costs.

Future articles in this series will address other aspects of life cycle costs analyses for highway and pavement design and rehabilitation applications, including user costs, treatment of salvage value and remaining service life, consideration of non-monetary decision factors, and more.

> *"...the use of 'standard' general discount rates may lead to the selection of a construction or rehabilitation alternative that is not the most cost-effective (and may even be the least cost-effective)."*

Did you know?

Concrete Paving Association of Minnesota was formed in 1959 and is the second oldest concrete paving association in the country. Wisconsin was the first, incorporated in 1955.