Life Cycle Cost Analysis for Pavements
Learning Outcomes

LIFE CYCLE COST ANALYSIS for PAVEMENTS

- Basic LCCA concepts
- Steps, and inputs
- Keys to Success
- Rules
What is an LCCA and how is it used?

Life Cycle Cost Analysis (LCCA) is a structured process for conducting an economic analysis of two or more competing investment alternatives that takes into account all costs over the life of an investment.

• General example:
  • Vehicle purchase: Toyota Prius versus Toyota Camry
What is an LCCA and how is it used?

Pavement related examples

Pavement Type Selection:
- asphalt versus concrete
- paved versus unpaved

Pavement Structural Design:
- Perpetual Pavement versus conventional design
Other LCCA options or use

Bridge related examples:
- Steel
- Concrete
- Combination Designs

Numerous other Construction
- Dams
- Underground
- Mass Transit
LCCA versus LCA
Life Cycle Cost Analyses and Life Cycle Assessments are different things.

Economic Value
FHWA guidance on LCCA
LCCCA programs

RealCost
FHWA LCCA

Excellent Reference!!
New Update coming
PaveXpress Module
LCCA programs

- **LCCA and LCCAExpress** from the Asphalt Pavement Alliance
Idealized Pavement Performance Trend

Serviceability / Pavement Condition Index

Threshold

Time or Traffic

How is this time really determined?
LCCA Basics

\[ NPV = Initial\ Const.\ Cost + \sum_{k=1}^{N} Future\ Cost_k \left[ \frac{1}{(1 + i)^{n_k}} \right] - Salvage\ Value \left[ \frac{1}{(1 + i)^{n_e}} \right] \]
LCCA CALCULATIONS

\[ NPV = \text{Initial Const. Cost} + \sum_{k=1}^{N} \text{Future Cost}_k \left[ \frac{1}{(1 + i)^{n_k}} \right] - \text{Salvage Value} \left[ \frac{1}{(1 + i)^{n_e}} \right] \]

where:

- \( NPV \) = Net Present Value, dollars
- \( N \) = Number of rehab./maintenance costs incurred over the Analysis Period
- \( i \) = Discount rate, percent
- \( n_k \) = Number of years from the initial construction to the \( k^{th} \) expenditure

Cost

Rehab.  Discounting  \( i \)  Time  Salvage Value

Asphalt.  AMERICA RIDES ON US
Most of Agency Cost is in:

- **Initial Construction**
  - 70 to 90%
- **Rehabilitation**
  - 10 to 25%
- **Reactive Maintenance** - Almost no effect
- **Salvage Value** - Very little effect
Elements of an LCCA

A. Analysis Period
B. Performance Periods
C. Cost Data
D. Discount Rate
E. Salvage Value
F. User Costs
Key LCCA inputs

A. Analysis Period

- The Analysis Period is the number of years that the competing options are evaluated in the LCCA.
- FHWA guidance: “Analysis Periods used in LCCA should be long enough to capture long term differences in discounted life cycle costs among competing alternatives.” No minimum is time is given.
- The Analysis Period should include reconstruction if that is a common occurrence for either pavement type.
- Longer Analysis Periods increase the uncertainty of future costs.
Key LCCA inputs

B. Performance Periods

- Performance Periods, also known as Service Lives, are the expected time (in years) between the pavement construction and rehabilitation activities.
Summary of Middle 90% of Pavement Ages at Time of 1st Rehab

<table>
<thead>
<tr>
<th>Pavement Type</th>
<th>No.</th>
<th>Avg</th>
<th>Min</th>
<th>Max</th>
<th>Std Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>206</td>
<td>17.68</td>
<td>7.09</td>
<td>28.93</td>
<td>5.51</td>
</tr>
<tr>
<td>PCC</td>
<td>121</td>
<td>23.84</td>
<td>12.88</td>
<td>35.44</td>
<td>5.79</td>
</tr>
</tbody>
</table>

Ride Quality (IRI) Prior to Rehabilitation

<table>
<thead>
<tr>
<th>Pavement Type</th>
<th>Percent of Total Pavement Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very Good**</td>
</tr>
<tr>
<td>AC Pavements</td>
<td>9.6%</td>
</tr>
<tr>
<td>PCC Pavements*</td>
<td>1.1%</td>
</tr>
</tbody>
</table>
Key LCCA inputs

B. Performance Periods

- Most highway agencies set different thresholds for different highway classifications.
Key LCCA inputs

B. Performance Periods

– A shortcoming of using historical PMS data is that the performance trends are for pavements built many years ago that don’t include current technologies and practices.
Key LCCA inputs

C. Cost Data

- Pavement designs (thicknesses) for the competing options will factor heavily in the initial construction costs.
- Design both pavement options with the same approach, i.e. both designed by an empirical method or both designed by a mechanistic-empirical design method.
LCCA Calculations

C. Cost Data: Future Costs

\[ NPV = Initial\ Const.\ Cost + \sum_{k=1}^{N} Future\ Cost_k \left( \frac{1}{(1 + i)^{n_k}} \right) - Salvage\ Value \left( \frac{1}{(1 + i)^{n_e}} \right) \]

These costs are estimated at today’s costs.

Using “Constant” dollars ignores inflations since it would be washed out by bringing the future costs back to a present value.
Key LCCA inputs

D. Discount Rate: OMB Circular A-94

![Graph showing Real 30-Yr. Interest Rate and 10-Yr. Rolling Average from 1979 to 2015]
Key LCCA inputs

E. Salvage Value

- In LCCA, Salvage Value is the worth of an alternative at the end of the Analysis Period.

\[ NPV = \text{Initial Const. Cost} + \sum_{k=1}^{N} \frac{\text{Future Cost}_k}{(1 + i)^{n_k}} - \text{Salvage Value} \left[ \frac{1}{(1 + i)^{n_e}} \right] \]
Key LCCA inputs

E. Salvage Value

- In LCCA, Salvage Value is the worth of an alternative at the end of the Analysis Period. For pavements, there are two components for estimating the Salvage Value:
  1. Remaining Service Life – the value of the pavement structure for the time it is expected to remain in serviceable condition after the Analysis Period.
  2. Residual Value – the net value from recycling the pavement at the end of the service life.
Optional - LCCA inputs

F. User Costs
LCCA - Rules to Live By

According to Dan
Just The Facts

• In LCCA, the first criteria is gathering the facts, not myths.
• Assumptions, hearsay, and guesses will cloud, and many times lead to wasted critical financial resources.
• State vs. Local Condition
Don’t let Answer = Formula

• In LCCA you can’t go into the calculations with the answer and make the numbers work.
• If you have the decision before doing the effort, 9 times out of ten you will dial in your formula to = your answer.
Go with what you know

- In LCCA take the steps in what you know, Costing, and first time to rehab these are LCCA inputs that will make up 75% - 90% of the answer.
- Other long term guesses will cause fluff and can get costly as they can lead to poor decisions.
- If you have a low cost alternative or bid that meets the necessary design and it comes in at a lower cost, go with what you know....
50/50 is not an LCCA input

• In doing LCCA making it fair or because of other misguided reasons is not a strategy that public tax dollars should be used for.

• Calculations and going to the effort in gaining necessary knowledge of critical inputs is a strategy that works and creates a fiscally responsible and long-term infrastructure system.
WWYD ("What would You Do") if your Money?

- When making LCCA, pavement determinations or rehabilitation decisions put yourself in the financial condition of your money.
- When having a public position of trust and responsibility it is important to spend your constituent’s money as if it is your own.
Conclusions

• Don’t forget about all the other reasons to use asphalt pavements
  – Smoothness
    • Maintain Smoothness
  – Noise Reduction
    • Hands Free Cell Phones
  – Recycling – Reuse of Binder
    • And Aggregates
  – Low Carbon Footprint
    • Future Environmental Initiatives
Build Performance
Thank You!

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