Important Issues in Pavement LCCA

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Core elements of CSHub approach

- Integrate LCCA & LCA into design process
- Incorporate uncertainty into all analyses
- Statistical data analysis for model inputs
- Engineering and science modeling of important phenomenon
- Analyses of performance, cost, and environmental impacts for various contexts

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Integrate LCA & LCCA into design process

- CSHub created linkage between design tools and evaluation

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Incorporate uncertainty into all analyses

- Statistically Characterize Uncertainty
- Propagate uncertainty to understand risk
Characterize uncertainty for agency and user parameters

Agency:
- Unit-price of inputs
- Quantity of inputs

User:
- Traffic delays & fuel loss

Statistical data analysis for model inputs

Degradation

Future costs

Engineering and science modeling of important phenomenon

Pavement-vehicle interaction (PVI)

Deflection & Roughness
Excess Fuel Consumption (EFC)
Economic & Environmental Impacts

Analyses of performance, cost, and environmental impacts for various contexts

3 Traffic Levels
- Rural local street/highway
- Rural state highway
- Urban interstate

Several framing conditions
- Pavement designs
- Maintenance schedules
- Design life
- Analysis period
Functional equivalence is critical for pavement comparisons

Design life equivalency: Time until first major rehabilitation
Combination of design and maintenance/rehabilitation schedule

These are not functionally equivalent
To create equivalence:
1. Increase asphalt design life, or
2. Decrease concrete design life

Key insights from research

Life cycle perspective is important
Context is important
Excess fuel consumption drives user costs
Uncertainty is important for inputs and outputs

Life cycle perspective is important

Total life-cycle costs for a state highway in Florida

Future costs can be significant

Flexible pavement design developed by Applied Research Associates (ARA), Inc.; AADTT 11k/day, 4 lanes; Wet-no-freeze-FL; FDOT-based rehabilitation schedule; Analysis period = 50 years.

Life cycle perspective alters relative competitiveness

Initial cost only: 17% difference
Life Cycle Cost: ~0% difference
Context is important

Costs vary with location, traffic level, & pavement design

- Interstate, rigid design
  - Initial costs: 79%
  - Rehab costs: 21%

- Local highway, rigid design
  - Initial costs: 89%
  - Rehab costs: 2%

- Interstate, flexible design
  - Initial costs: 53%
  - Rehab costs: 47%

- State highway, flexible design
  - Initial costs: 47%
  - Rehab costs: 53%

Excess fuel consumption drives user costs

- Traffic Delay: 4%
- M & R: 16%
- User Cost: 22%
- Initial: 62%
- Excess Fuel Consumption: 56%

Uncertainty is important for inputs

Distribution of Unit Price of Concrete for Pavement Projects

- What is driving variation in initial costs?

Capture drivers of initial cost and variation through statistical models

Concrete material prices highly dependent on quantity used on job

- Initial cost is usually major driver of variation in probabilistic comparative pavement LCCAs
There is uncertainty in future price projections
But probabilistic projections are plausible

![Real Price Index Graph]

CSHub forecasts have been shown to be more effective than current assumptions

![Average Error of Forecast Graph]

Testing the effectiveness of the model for the state of Colorado

Real price projections outperform conventional assumptions of no real price change

Uncertainty is important for outputs

Probabilistic LCCA provides insight on relative risks

![Frequency vs. Net Present Value Graph]

Robust comparisons: confidence in a result despite uncertainty

How frequently does design A cost less than design B?
Design A costs less than design B in 90% of simulations → statistically significant result
Probabilistic analysis illuminates key parameters driving variation in final cost

**Initial cost is usually major driver of variation in probabilistic comparative pavement LCCAs**

Key insights from research

- Life cycle perspective is important
- Context is important
- Excess fuel consumption drives user costs
- Uncertainty is important for inputs and outputs

More information available at:
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We have worked with many agencies to review their LCCA practices. We'd be glad to work with you.