Transportation Asset Management

The Role of Engineering Economic Analysis

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Introduction

• The mission of the Federal Highway Administration’s Office of Asset Management is to provide leadership and expertise in the systematic application of management and investment strategies for highway infrastructure assets

• Mission includes development of tools, techniques, and information on applications of Transportation Asset Management (TAM)
FHWA’s Approach to TAM

• Office works in cooperation with AASHTO and other national organizations in promoting TAM
  – In 1997, AASHTO requested that FHWA assist it with development of products and programs that could aid States in implementing TAM in their organizations
  – FHWA assisted AASHTO in the development of its strategic plan for Asset Management

• No national policy for TAM
What TAM Is

• Recent Thinking – TAM is a strategic approach to the optimal allocation of resources for the management, operation, and preservation of transportation infrastructure.

• There are other definitions of TAM, but most specify a common goal of making better resource allocation decisions with better information.
“Better Resource Allocation Decisions”

• What constitutes a better resource allocation decision?
  – “Cost-effective” solutions are frequently cited as desired standard
  – “Economically efficient” allocation of resources
  – “Optimal” allocation or “highest rate of return on investment”
Where EEA Fits in TAM

- TAM requires an integrated decision-making process of which EEA is a critical part.
- EEA directly addresses the core reason we undertake transportation projects – the creation of net benefits for the traveling public and society at large.
- EEA will not work without good data and performance modeling.
Asset Management: Where EEA Fits

- Data Collection
- Performance Modeling
- Development of Alternatives/EEA
- Decision-Making
- Implementation
- Monitoring

Feedback

External Factors and Constraints
- Policies
- Budgets
- Goals
EEA Informs Decision Maker

• Note that diagram does not show EEA at Decision Maker level
• EEA informs Decision Maker but does not make the decision
  – Decisions will be based on a host of factors, including policies, budgets, and goals
• If EEA is done correctly, it will reflect agency goals and objectives and answer Decision Maker questions about resource allocations
EEA Tools

- EEA provides a tool kit for better allocation of resources through TAM framework
- Tools range in complexity and scope
  - Discounting
  - Life Cycle Cost Analysis/value engineering
  - Benefit-Cost Analysis
  - Applications in economic development studies
- As in any tool kit, use of the right tool saves time and effort
Discounting

• Discounting is the backbone of EEA
• Use of a discount rate facilitates comparison of the costs and benefits of alternative transportation projects over time
• Dollars can be:
  – Relocated in time
  – Any combination of flows can be summed into a single value at a single point in time
  – Lump sums can be converted to annual flows
• Discount rate is distinct from inflation rate
Life Cycle Cost Analysis (LCCA)

- LCCA is discounting applied to the cost side of an investment decision.
- LCCA should be applied once a decision to undertake an improvement has been reached, but the method of implementing the improvement is undecided.
  - All reasonable design alternatives should be evaluated over identical analysis periods.
  - Benefits of design alternatives must be equivalent.
  - Analysis of differences in life cycle costs only.
LCCA Steps

• Step 1: Establish design alternatives
• Step 2: Determine activity timing
• Step 3: Estimate costs (Agency and user)
• Step 4: Discount life cycle costs
• Step 5: Analyze the results
Potential Applications of LCCA

• Pavement design (choice between pavement types)
• Pavement and Bridge Management Systems may have LCCA capabilities
• Selection of pavement preservation strategies
• Bridge replacement
Benefits of LCCA

• In many cases, there is no question that an improvement must be made—the question concerns only what is most cost-effective means to do it
  – A failing bridge that must be replaced
  – Cost-effective solution will likely be optimal investment of resources in asset preservation

• Practice of LCCA promotes broader use of EEA tools

• LCCA is “disciplining framework” for review and discussion of project design alternatives
Economic Concepts in LCCA

- LCCA introduces following economic concepts
  - Notion of long term, as represented by “life cycle”
  - Risk analysis
  - Best practice LCCA specifically addresses costs to users associated with work zones and maintenance
Limitations of LCCA

- Cannot compare design alternatives that have different benefits (e.g., reconstruct road vs. reconstruct road with widening)
- Cannot, of itself, answer question of whether an improvement is worth pursuing (i.e. the project has a positive net present value)
LCCA Products

• Numerous commercial products are available to do LCCA
  – Range from simple spreadsheets to component management systems to specialized project analysis programs
  – FHWA has issued the Life-Cycle Cost Analysis in Pavement Design Interim Technical Bulletin and will soon be releasing an LCCA model that incorporates risk analysis
Benefit-Cost Analysis (BCA)

- The discounted value of project’s life cycle benefits is compared to the discounted value of its life cycle costs
- Different measures are used to compare benefits to costs
  - Net present value (NPV)
  - Benefit-cost ratio (B/C)
  - Equivalent Uniform Annual Value
  - Internal rate of return (IRR)
Applications of BCA

- BCA is used to address the following resource allocation decisions:
  - Whether or not to pursue an improvement
  - Select among design alternatives with different benefits
  - Select among competing projects in same mode
  - Select among competing projects in different modes
Key Role of Discount Rate in BCA

• Discount rate reflects the productivity of capital, people’s preferences for current over future consumption, and the scarcity of investable resources

• If an investment doesn’t yield discounted benefits that exceed discounted costs, this means resource allocation is not economically efficient
How to Get to “Optimal” with BCA

• Optimization is possible with BCA
  – Apply BCA to all reasonable project design alternatives
  – Use appropriate discount rate
  – Identify all significant benefits and costs
  – Quantify all benefits and costs to degree possible, consider all else qualitatively
  – Use appropriate means to compare costs and benefits for identical analysis periods
BCA and Unconstrained Budget

- Unconstrained budget
  - Apply BCA to all reasonable project design alternatives
  - Pursue project design alternative with highest positive NPV
  - Pursue all projects where at least one design alternative has positive NPV
- Useful in identifying project inventories
BCA and Constrained Budget

- Constrained budget
  - Similar to unconstrained budget application of BCA except that analyst must select among design alternatives of multiple projects to obtain highest overall rate of return (NPV) for fixed investment levels
  - Design alternatives and projects are selected according to highest B/C ratio
  - Not all projects with positive NPVs will be pursued
  - Calculation can become complicated for large programs
Challenges of BCA

- Calculation of benefits and costs over life cycle is often difficult
  - Agency costs associated with projects can be hard to ascertain
  - User costs and benefits are critical
    - User benefits are purpose for building the road but may be hard to measure and value
    - Uncertain forecasts of traffic, delays, and crash rates
    - Valuation of time and safety is often controversial
  - Externalities and social impacts resist quantification
  - Network effects and induced demand
Benefits of BCA

• Given challenges, why pursue BCA?
  – Desire to get best return from scarce resources
  – With respect to the imprecision of estimates, not doing benefit-cost analysis does not lessen uncertainties; it only masks them
  – By quantifying those costs and benefits that can be monetized, BCA provides stronger basis for making qualitative judgments about the importance of non-monetized benefits
Tips for Good Quality BCA

• Do not start with predetermined conclusion
• Clearly define problem, realistic baseline (no build), all reasonable alternatives, and benefits and costs measures
• Monetize benefits and costs as much as possible, without regard to source of funds
• Use credible data
• Deal appropriately with uncertainty
• Communicate results understandably
BCA Products

• Numerous BCA programs are available for project level analysis
  – AASHTO Redbook and other guides
  – MicroBENCOSt implements AASHTO Redbook
  – State Agency-developed models such as Caltrans’ CalBC, WSDOT Benefit/Cost software, etc.

• Corridor or system level models such as STEAM, StratBENCOSt, and Net BC

• FHWA has issued the Highway Economic Requirements System/State Version HERS/ST) model for program level BCA
HERS/ST

• HERS/ST is a direct extension of the national-level HERS model
  – Applies BCA to the selection and implementation of highway capital improvements
  – Provides a common, objective platform for State DOTs to communicate with State legislatures and other officials regarding the impacts of alternative highway investment levels
  – Analysis is rigorous and considers travel time, safety, vehicle operating, emissions, and highway agency costs
HERS/ST Logic

OVERVIEW

Current Conditions → Traffic Forecast → Simulate Future Conditions and Performance → Identify Deficiencies → Identify Potential Section Improvements → Select System Improvements

Federal Highway Administration
Use of HERS/ST

• The HERS/ST software has been tested by 17 States and is now being revised in response to their comments

• A national conference will be held in the Fall of 2002 to deliver the model to all 50 states
Note on Risk Analysis

• Risk analysis is not a separate EEA tool, but is a means of addressing uncertainty associated with economic outcomes in LCCA or BCA
  – Probabilistic LCCA and BCA allow the value of individual data inputs to be defined by a frequency (probability) distribution
  – An entire probability distribution of NPVs is generated for the project alternative along with the mean or average NPV for that alternative
• Helps to resolve issues associated with uncertainty about user costs and future demand
Economic Development Analysis

• BCA typically does not incorporate or reveal data on economic development impacts.

• Consensus among economists is that accounting for user costs and benefits also captures other value-adding effects of transportation improvements (which are transfers from users).

• However, Decision Makers often want information on how transferred benefits will affect jobs, personal income levels, tourism, property development, etc., at the local level.

• Development analysis complements BCA.
Reasons for Development Analysis

• Benefits and costs experienced at local level are important investment decision criteria
  – How benefits affect locality and State
  – Specific groups may be affected adversely

• Legally-mandated planning and regulatory review

• Public education

• Post-project evaluation
Economic Development Impact

- Transportation investment is often viewed as a means to promote economic development
  - There is a healthy debate as to the impact of new transportation investment on economic development at the national level
    - Strong effects in 1950’s and 1960’s
    - Since 1980, stimulus effects remain but have declined
  - Effects are very pronounced at local level, where most studies reveal highway investment stimulates private investment and can shape and channel growth
Economic Development Methods

- Survey and interview methods
- Market and comparable case studies
- Regional economic models
  - Dynamic simulation models (e.g., REMI)
  - Static Input-Output models (e.g., RIMS II)
- Hybrid modeling systems
FHWA Support to EEA/BCA

- Office of Asset Management will be building a “community of practice” website where it will list information on valuation of user costs and benefits and good practice methods for BCA and other methods of EEA
- Site will identify available software and resources to conduct BCA
Conclusions

- EEA has an important role in Transportation Asset Management
- EEA informs Decision Makers, but does not make decisions
- EEA tools are versatile and can accommodate a large number of variables as well as uncertainty
- FHWA will work with AASHTO to promote EEA and other elements of Transportation Asset Management