EVALUATION OF SAFETY ALTERNATIVES

Economic Evaluation of Alternative Projects

• Objective
  – Compare costs and benefits of projects on equivalent basis
  – Use equivalent basis of total present sum, or of uniform annual costs in same year
Economic Evaluation

• Economic evaluation is required when;
  – Costs are high
  – Countermeasures compete at one site
  – Benefits vary for various countermeasures

• FHWA requires an economic evaluation to justify the use of federal funds

Bases of Comparison for Economic Analysis

• Costs of safety improvements include;
  – Construction or implementation costs
  – Operation (of facility) costs
  – Maintenance costs
  – Salvage value (or costs)
Economic Evaluation of Alternative Projects

• Safety benefits include
  – Reduction in;
    • Fatal accidents + Type A Injury
    • Injury accidents (Type B & C)
    • PDO accidents
  – Also
    • ' Travel time
    • ' Delay
    • ' Operating costs

Economic Evaluation of Alternative Projects

• Equivalent basis of comparison
  – Equivalent uniform annual costs/benefits
  – Present worth of costs/benefits
  – Future worth of costs/benefits
Economic Analysis Basics

Comparison of Projects on Equivalent Uniform Annual Cost/Benefit Basis

- Definitions
  - Initial costs or benefits = P
  - Annual costs or benefits = A
  - Future costs or benefits = F
Comparison of Projects on Equivalent Uniform Annual Cost/Benefit Basis

• Method
  – Convert all benefits and costs to equivalent uniform annual amounts:
    • $P \rightarrow A \ ; \ A = [\text{capital recovery factor}] \times (P)$
    • $F \rightarrow A \ ; \ A = [\text{SFF}] \times (F)$
  – Convention
    • $P \rightarrow A \ (\text{service life}, \text{discount rate}) = \text{capital recovery factor}$

  i.e., Factor to take present sum and convert to equivalent equal periodic payments

Calculations of Equivalent Uniform Annual Costs

GIVEN:
  Initial cost = $1,000
  Service life = 10 years
  Discount rate = 10% per year

FIND:
  Convert to equivalent uniform annual amount
  Find tabled factor $P \rightarrow A \ (10 \text{ yrs, } 10\%) = 0.1627$
  Calculate equivalent uniform annual cost
  $\text{EUAC} = $1,000 (0.1627)$
  $\text{EUAC} = $163$
### 7% Interest Factors for Annual Compounding Interest

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Source: LHSS Users Guide, pp C-10

### 10% Interest Factors for Annual Compounding Interest

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Source: LHSS Users Guide, pp C-13
### Information Needed for Economic Evaluation

- Construction / installation costs
- Operation and maintenance costs
- Anticipated safety benefits

### Economic Evaluation Process

- Estimate accident reduction potential
- Estimate the safety benefits:
  \[
  \text{Safety benefits} = \sum \text{fatal acc.} \times \$\text{fatal} + \sum \text{injury acc.} \times \$\text{injury} + \sum \text{PDO’s} \times \$\text{PDO}
  \]
- Determine construction / installation / operation / maintenance costs
- Put all costs/benefits on a common economic basis
  - Equivalent uniform annual costs/benefits
  - Present worth of costs/benefits
- Compare benefits and costs
Implementation Costs

• Include all costs incidental to;
  – Construct
  – Install
  – Operate
  – Maintain

Other Information Needed for Economic Evaluation

• Service life
• Interest rate (vest charge rate)
• Salvage value
Service Life

- Service life is that time that a countermeasure serves in a fully functional manner as originally intended.

Vest Charge Rate

- Interest rate (time value of money) must be applied consistently for all competing countermeasures.
Salvage Value

- Net value at end of service life
- Often zero
- May be negative, if no value, but costs to remove

Anticipated Benefits

- Accident reduction
- Reduced travel time
- Reduced delays
- Reduced fuel consumption
### Source of Accident Reduction Factors

- Agency studies
- Caltrans
- ODOT
- Missouri DOT
- Washington DOT
- Current literature
- Federal Highway Administration

### Established Dollar Value of Accident Costs

- NSC
- NHTSA / FHWA
- Agency policy
**Traffic Crash Costs:**

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<tr>
<th>AIS Level Severity</th>
<th>Descriptor</th>
<th>Cost Per Injury (Dollars)</th>
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Source: NHI, 2005

**FHWA Costs per Accident**

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<th>Accident Type</th>
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<td>Fatal</td>
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Source: Highway Safety Manual
Economic Evaluation Methods

- Total cost
- Net benefits
- Cost effectiveness
- Benefit cost ratio

Appropriateness of Total Cost Method

- Total cost may be used only when benefits are equal for all alternatives

Total Cost = Safety Costs + Implementation
Appropriateness of Net Benefit Method

• Net benefit method may be used only when implementation costs are equal for all alternatives

Net Benefit = Safety Benefit – Implementation Costs

Comparison of Net Benefits and Benefit/Cost Ratios

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Comparison of Net Benefits and Benefit/Cost Ratios

Net Ben_A = $10,000 - $5,000 = $5,000

Net Ben_B = $105,000 - $100,000 = $5,000

BCR_A = $1000 / $5000 = 2

BCR_B = $105,000 / $100,000 = 1.05

Appropriateness of Cost Effectiveness

- Cost effectiveness may be used when implementation costs are known and magnitude of effects can be quantified for alternatives

Cost Effectiveness = \( \frac{\text{Diff.in Costs}}{\text{Diff.in Effects}} \)
Cost Effectiveness

\[ \text{CE Ratio} = \frac{\text{Cost}_{\text{New}} - \text{Cost}_{\text{Current}}}{\text{Effect}_{\text{New}} - \text{Effect}_{\text{Current}}} \]

For example -
Dollar cost to reduce fatal accidents by one

Benefit Cost Ratio Method

- Benefits and costs must be quantified for each alternative

\[ \frac{\text{B/C}}{\text{C}} = \frac{\text{Safety Benefits}}{\text{Implementation Cost}} \]
Example: Benefit-Cost Analysis

• Given information
  – Initial implementation cost = $100,000
  – Additional O&M cost = $4,000/yr
  – Accident reduction (annual) from improvement
    • 1 injury accident
    • 12 PDO accidents

Example: Benefit-Cost Analysis

– Accident costs
  • Injury accident: $200,000
  • PDO accident: $4,000
– Salvage value = 0
– Service life = 10 yrs
– Discount rate = 10% p.a.
Example: Benefit-Cost Analysis

• Calculations solution
  – Annual safety benefits ($ saved)
    1 x $200,000 = $200,000
    12 x $4,000 = $48,000
    Total = $248,000
  – Equivalent uniform annual cost (EUAC)
    = $200,000 (CRF) + $24,000
    = $200,000 (0.1424) + $24,000
    = $52,480
  – B/C = 248,000 / 52,480 = 4.7

Appropriateness of Countermeasure Selected

• Evaluate benefits versus costs
• Result depends on;
  – Service life identified
  – Values of accidents assumed
  – Vest charge selected
  – Costs of construction, operation, maintenance