Elemental Decomposition and Multi-Criteria Method for Valuing Transportation Infrastructure

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Study Motivation

- Government Accounting Standards Board agency requirement
- Numerous valuation methods exist
- Traditional methods have a number of shortcomings:
  - Assumption (implicit) that assets are monolithic
  - Assume one perspective (service life or condition)
  - Do not consider user perspective
  - Do not consider real estate value
  - Do not probabilistic analysis
- Elemental decomposition and multi-criteria (EDMC) method accounts for:
  - Multiple perspectives (agency, user)
  - Asset components (different deterioration rates)

Realistic Nature of Asset Deterioration

A single asset is comprised of multiple components which deteriorate at different rates and in different patterns. Simply basing the value of an asset on one component’s deterioration detracts from the actual asset value.

Assets Considered in this Valuation

- Pavements
- Bridges
- Culverts
- Guardrails
- Road Signs
- Underdrains
- ROW

Value using EDMC: $18.6M
Value using RC: $36.1M

Components

(Illustration: JFK Bridge, Jeffersonville, IN)

Stakeholder Perspectives & Attribute Ratios

Remaining Service Life Attribute
Condition Attribute
Any Attribute

\[ RSL_{ij} = \frac{P_{ij} - P_{worst,j}}{P_{base,j} - P_{worst,j}} \]

\[ AR_k = \frac{AR_k}{AR_{max} or AR_{range}} \]

Thus, for a given asset component \( i \) and criteria (attributes) \( k=1,2,\ldots,K \), the value, \( V_r \), is given by the following equation where \( w_k \) is the relative importance of each perspective

\[ V_r = \sum_{k=1}^{K} \left( w_k \cdot \text{cost}_{\text{comp}} \cdot \frac{AR_k}{AR_{max} or AR_{range}} \right) \]

Where,

- \( V_r \) is the value of the asset at time \( t \)
- \( w_{SL} \) is the relative importance of the SL perspective (agency)
- \( w_{CP} \) is the relative importance of the condition perspective (user)
- \( AR_k \) is the attribute ratio performance criteria or attributes
- \( \text{Cost}_{\text{comp}} \) is the cost for an asset component \( i \)

Benefits of using (EDMC) Method

- Asset Decomposition into Multiple Components
- Dichotomy between Condition (agency) & Service Life (user)
- Inclusion of Real Estate Value
- Probabilistic Considerations (Monte Carlo)

Results: Values of Indiana’s Highway Assets

Indiana Network Valuation Results using different Valuation Methods

EDMC Total Indiana Value: $70 Billion (determined in this study)