TRA Transport Research Arena Europe 2008
April 21.-24., 2008
Ljubljana. Slovenia

APPLICATIONS OF MULTI-CRITERIA DECISION ANALYSIS AT THE FINNISH ROAD ADMINISTRATION

Paper ID number: 7.5.6

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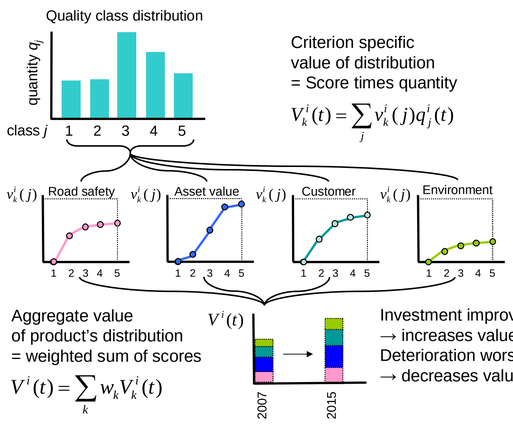
Part A: Network-level budget allocation between road keeping products

Introduction

- Integrated allocation framework
  - Includes all major products
- Multi-criteria analysis and optimization
- Existing data and subjective knowledge
  - Technically simplified product models
  - Overall analysis and guideline results
- Interactive managerial workshops
  - Discussion and systemic understanding

Aggregate value of products

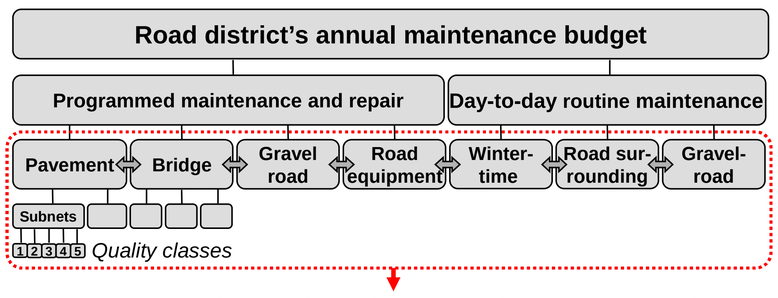
- Transparent linear-additive model



Incomplete weight information
- Weights reflect relative importance of the criteria
- Weights need not be fixed to run computations
- For example, rank-ordering implies a set of feasible weights
- Illustrate the effects of different weights → incorporated sensitivity analysis

Investment improves distribution → increases value
Deterioration worsens distribution → decreases value

Products and model coverage

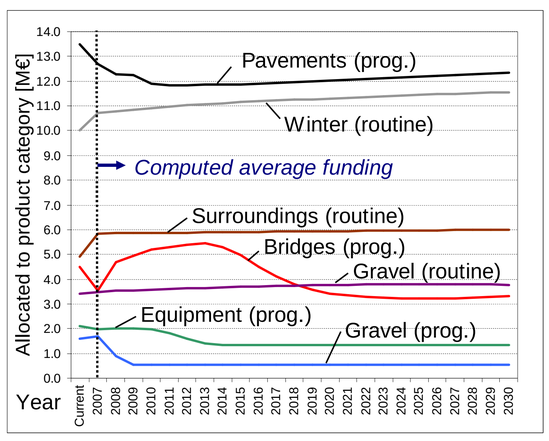


Integrated evaluation and computation

- Quality distributions as units of analysis
  - Standardized and *ad hoc* classifications

Example of main results

- Annual allocation of given total budget



Model details
- Linear programming
- Simplified repair and deterioration dynamics
- Funding allocated at product & quality level
- Objective function: sum of the aggregate values of all products' annual quality discounted over 30 years
- Product specific budget constraints
- Quality targets and other constraints also possible
- Monte-Carlo sampling of the feasible weight set → average results from using different weights

Multiple objectives / criteria

- Road safety
  - Accident risk from poor asset condition
- Asset value preservation
  - Maintenance backlog
- Customer satisfaction
  - Comfort, speed, confidence, feedback
- Environmental concerns
  - Noise, chemicals, dusting, nature, tidiness

Key modes of interactive analysis

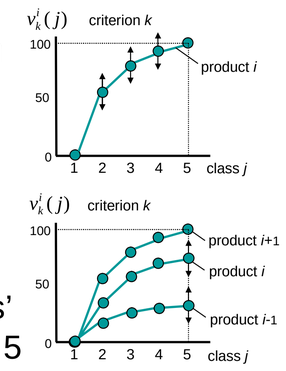
- Computed vs. current allocation
  - Which products gain or lose and why?
  - Facilitate structured discussion
- Impacts of alternative preferences
  - Which products are most sensitive/robust?
  - Contributions to customer satisfaction
- Prioritization of products
  - Which products gain or lose, first or later, if total budget is increased/decreased?

Relative benefit evaluation

- Based on Multi-Attribute Value Theory
  - Qualitative → alternative to user cost approach

❶ *Shape* of the value function for each product
  - Difference between classes

❷ *Level* of the value function, i.e. maximum scores
  - Difference between products' swings from class 1 to class 5



Conclusions

- Workable pilot of integrated analysis
  - Reflects key needs and preferences
  - Exhaustive life-cycle models not necessary
- Interactive process
  - Evaluations and computations provide a structured and transparent framework for facilitated communication and analysis
  - Strategic impact evaluation and results analysis workshops, not routine operations management system

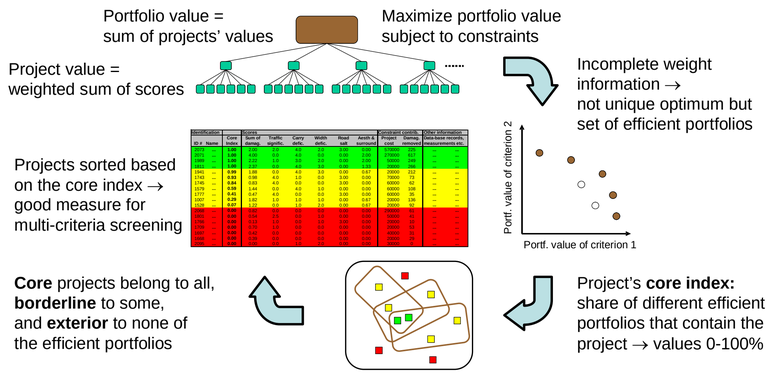
Part B: Bridge repair programming

Introduction

- Project screening for repair programs
- Large multi-criteria portfolio problem
  - Hundreds of bridges per district
  - Budget and other constraints
  - Several prioritization indexes and data
  - Different criteria suggest different programs → how to aggregate?
- Robust Portfolio Modeling methodology
  - Incomplete weight information

Robust Portfolio Modeling (RPM)

- Multi-criteria project portfolio selection methodology developed at TKK



Core index as aggregate measure

- *Relative* measure of project's *fit* into the portfolio → accounts for:
  - Project performance on multiple criteria
  - Incomplete information on criterion weights
  - Estimated cost and competing projects
  - Budget and portfolio feasibility constraints
- Tentative prioritization → helps focus
  - Transparent → detailed project data shown
  - Does not suggest optimal portfolios

Conclusions

- Run repeatedly with several districts
  - Matches programming managers' plans better than single criterion systems → works well for screening purposes
- Portfolio support for programming
  - Extended tool with core index values and functionalities for project selection
  - Portfolio-level information, e.g., total and average performance or cost of projects, balance among functional classes

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Acknowledgements

Finnish Road Administration,
Asset management research program (VOH, 2003-2007),
South-East Finland road district

Academy of Finland

Awards for part A research

Finnra asset management research program (VOH, 2003-2007)
Award as one of the program's best projects

Institute for Operations Research and the Management Sciences
(INFORMS) Decision Analysis Society (DAS)
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