HDM-4 as a Tool for Asset Management

by
Peter D. Cook
Sophia Yu Consulting, Inc
&
Dr. Simon Lewis
ITIS, Inc

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Presentation Outline

- What’s new about Asset Management (AM)?
- What does HDM-4 do? And not do?
- How has HDM-4 been used in AM?
- Why is HDM-4 important?
- How can DOTs use HDM-4?
Definition and Status of Asset Management

"A systematic process of effectively maintaining, upgrading and operating assets, combining engineering principles with sound business practice and economic rationale, and providing the tools to facilitate a more organized and flexible approach to making decisions necessary to achieve the public’s expectations." (PIARC, 2003)

- It is a new framework for doing business within a transportation agency
- It takes a different focus on analysis than has been traditional (i.e., economic appraisal rather than engineering appraisal)
- It requires new ways of doing business – and new tools to support it.

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Process is good, but field operationalization of it to date has been weak

— Difficult for DOT’s and practitioners to really “see” what AM practically means
Making AM Work

Best practice experiences indicate that successful operationalization of an Asset Management Business Framework (AMBF) implies:

- Viewing Asset Management as a *top-level* decision-making process
- Reorganizing the DOT Business Processes to fit this process
- Purchasing or developing of *top-level decision-making tools* == *actually having tools to do!*
Why HDM-4 Relevant?

- Out there 17 years – 17 years of doing it!
- Legacy of development and history of use
- $10m+ investment
- Operationalized a large part of the AMBF process – highways focused
- Gives practical example to DOT’s ---they need it!
- It works!
- *Not much else out there* (only HERS as a similar tool)
HDM-4 In Wider Context

- A research program on road deterioration and Vehicle Operating Cost (VOC) effects

- A set of technical models

- A software application that manages the technical models and evaluates strategies and improvements for the road network
Key Steps in Asset Management
-- Supported by HDM-4

◆ Asset Valuation (Economic and Financial)
  ▪ Latest version addition

◆ Assessment of Performance
  ▪ Condition Assessment
  ▪ Relationship to user benefits and costs
  ▪ Prediction of future performance and evaluation over time

◆ Alternative Analysis (project or corridor-level)
  ▪ Identification of alternatives (investments or other actions)
  ▪ Comparison with do-nothing case (economic and non-economic evaluations)

◆ Trade-off Analysis (program-level)
  ▪ Within a mode (investment policies and/or strategies)
  ▪ Between modes (multimodal policies or strategies)

◆ System-wide performance (economic and non-economic criteria) (with Budget Constraints)
HDM-4 View of Asset Management
## Functions Addressed by HDM

<table>
<thead>
<tr>
<th>Function</th>
<th>Time Horizon</th>
<th>Responsible</th>
<th>Spatial Coverage</th>
<th>HDM-4 Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic planning</td>
<td>Long term (strategic)</td>
<td>Senior management and policy makers</td>
<td>Network-wide</td>
<td>Strategy Analysis</td>
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<tr>
<td>Roadwork programming</td>
<td>Medium term (tactical)</td>
<td>Middle-level professionals</td>
<td>Sub-network, several road sections</td>
<td>Programme Analysis</td>
</tr>
<tr>
<td>Project preparation</td>
<td>Budget year</td>
<td>Technical staff</td>
<td>Sections, project level</td>
<td>Project Analysis</td>
</tr>
<tr>
<td>Research and policy studies</td>
<td>As appropriate</td>
<td>Policy makers, researchers</td>
<td>As appropriate</td>
<td>As appropriate</td>
</tr>
</tbody>
</table>
Highway Management Analysis Cycle

Highway Management Information:
- Inventory
- Condition
- Resources
- Treatments
- Productivity
- Unit Costs
- Economic parameters

Source: PIARC
HDM-4 Architecture and Potential Links

Source: Kerali, et al.
**Condition and Performance Assessment**

- HDM-4 provides condition and performance assessment in terms of:
  - Physical measures
  - Financial Measures (impact on vehicle user costs)
Basic Functions of HDM-4
Highway Evaluation

Condition Index Rating

Ride m/km
Distress %  90  Poor
Rut mm
Structural #
Safety #

- Current Condition
- Deterioration Prediction

Remaining Service Life

Benefits to Society

- Current Condition
- Deterioration Prediction
- Maintenance Effects
- Vehicle Operating Costs

Source: World Bank
Technical Models - 1

- *Road Deterioration Models* (surface distress with different interventions over time, depending on road characteristics and conditions)

- *Road User Effects Models* (VOCs for different vehicles on different roads, at different speeds with different traffic conditions)
Technical Models - 2

- Safety, Energy and Environmental Effects (number of accidents, fuel consumption, pollutant emissions)
- Optimization models for evaluation (NPV, IRR, B/C, incremental NPV under budget constraints)
- Multi-criteria analysis model for trade-offs
  - Economic (RAC, RUC, NPV)
  - Functional (Comfort, Delay)
  - Energy (Energy Efficiency)
  - Environment (Air Quality)
  - Safety (Accident Analysis)
  - Political
  - Social (Social Benefits)
HDM-4 and Road Asset Data Flow

ROAD INVESTMENT DECISION SUPPORT TOOLS

ROAD ASSET DATABASE
(Not HDM-4)

INPUTS

OUTPUTS

Long Term Strategic Road Plan
Multi-Year Work Program
Detailed Project Level Appraisal
Policies Standards Research

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Performance Goals and Measures

- HDM-4 measures performance in terms of surface condition and financial/economic results.
- HDM-4 sets performance goals in terms of optimizing economic value, considering:
  - Benefits to road users (VOC cost savings and time savings)
  - Life Cycle Costs to the road owner/manager
- The achievement of the goal is measured in terms of NPV for the maintenance and improvement strategy.
- The best combination strategy for the road network has the highest NPV.
Financial Performance Assessment

Financial Measures provided by HDM-4 are:
- Total Annual Cost of maintenance
- Total Annual Vehicle Operating Costs
- Total Annual Accident Costs
- NPV for given maintenance strategy
- NPV for given improvements
- Optimum budget by year, with or without constraints

Measures are available for the road network as a whole, for categories of roads and for individual road sections
Alternative Analysis

- HDM-4 good in this area for road pavement assets
- Allows alternatives for surface treatment with different criteria, based on performance measures (e.g. IRI threshold, % cracking threshold, etc.)
- Takes alternative improvements of all types
- Determines optimum mix of interventions
- Uses incremental NPV to evaluate alternatives
- Net changes are calculated for alternatives:
  - Accidents
  - Emissions
  - Energy
Trade-Off Analysis

- It is strong in trade-off analysis for road pavement assets
- Uses incremental NPV to evaluate trade-offs, along with emissions
- Includes:
  - Economic benefits (VOC savings and travel time for passengers)
  - Life Cycle Costs for roads
- Net changes are available for trade-off analysis in:
  - Accidents
  - Emissions
- HDM-4 Version 2 includes multi-criteria analysis (adding political assessment and social benefits)
Two (brief) Reference Case Studies

Tonga – HDM-4 as System Component

New Zealand – NZdTIMS
Integrating HDM-4 with Other Systems
Tonga Case
HDM Role in New Zealand Road Asset Management

Conclusion: What HDM Does Well and Does not Do Well

✿ Well:
  - Facilitates Asset Valuation
  - Organizes the key road asset information for decision-support
  - Provides a method to enter maintenance and improvement strategies
  - Optimizes maintenance strategy under budget constraints (this can still be improved in some ways - as in NZdTIMS)
  - Evaluates road improvement projects
  - Carries out budget constraint analysis and does trade-off analysis for road assets with multi-criteria analysis

✿ Not Well:
  - Does not evaluate bridges, off road structures (except in Asset Valuation) or other modes (e.g., transit)
### HDM-4 and HERS-ST

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>HDM-4</th>
<th>HERS-ST</th>
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<tbody>
<tr>
<td>Development Sponsors</td>
<td>World Bank, World Road Association (PIARC)</td>
<td>FHWA</td>
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<tr>
<td>Development Time</td>
<td>20 years</td>
<td>5 years</td>
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<td>Number of North American DOT users</td>
<td>1 (Quebec)</td>
<td>20 (9 more interested)</td>
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<td>World-wide Users</td>
<td>700-800</td>
<td>20</td>
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<td>Key Features</td>
<td>Highway System Data Entry <em>(more detailed cal.)</em></td>
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<td></td>
<td>Maintenance Analysis</td>
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<td>Improvement Analysis</td>
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<td>Vehicle Operating Cost</td>
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<td>Delay Times and Costs</td>
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<td>Accidents</td>
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<td>Emissions</td>
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<td>Cost-Benefit Analysis</td>
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<td>Scenario Analysis</td>
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<td>Multi-Criteria Analysis</td>
<td>Road Network Map</td>
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<td>Asset Valuation</td>
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<td>Weaknesses</td>
<td>Highway only</td>
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Overall HDM-4 Conclusions

- HDM-4 is only part of an Asset Management System – for road/pavement management
- However, it may be useful as a start-up system
- It is worth a closer look by DOTs
- It works best when it is supported by a separate database management system (as in Tonga and New Zealand)
- However, the optimization logic it uses, based on incremental NPV over a “do-nothing case”, can be applied to all assets
- The new multi-criteria analysis has extended its value to many users
HDM-4 Information and Availability

A series of publicly available manuals is available including:

- Overview of HDM-4
- Applications Guide
- Software User Guide
- Analytical Framework and Model Descriptions
- Guide to Calibration and Adaptation

HDM-4 licenses are available from HDMGlobal at a relatively low cost

- [http://civ-hrg.bham.ac.uk/isoohdm/](http://civ-hrg.bham.ac.uk/isoohdm/)

HERS Information:

Overall AMBF Considerations

💎 Needed an AM Business Framework to practically do AM – could be a first step

💎 Useful as:
  - as a tool also for teaching and training in AM concepts
  - gives senior management a sense of what AM can provide (i.e., principally, a top-level decision support tool, not engineering inventory management!

💎 HDM may be the best example there is today