Framework and Case Studies for Calculating the Return on Investment for Transportation Asset Management Systems and Process Improvements

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Overview

• Description of NCHRP Project 20-100
• Case study summary
• Framework for calculating Return on Investment (ROI)
• Conclusions and next steps for the research
NCHRP Project 20-100: Return on Investment in Transportation Asset Management Systems and Practices

• Objectives
  – Assess the investments made and returns realized by selected agencies that have adopted TAM systems
  – Develop guidance for estimating the return on investment (ROI) for adopting or expanding TAM systems in an agency

• Project Team
  – Spy Pond Partners, LLC
  – HDR, Inc.
  – Harry Cohen
Example Questions

- What is the ROI of implementing a new Pavement Management System (PMS) that will foster a preservation approach in the agency?

- What is the payback period for a new asset management system that will require an initial investment of time and money, but save staff time in the future?

- What types of agency and user benefits can we expect from a set of investments in new systems and improved processes?
Project Case Studies

- Conducted three case studies to illustrate the framework and provide examples of the benefits of asset management system/process investments

- Selected case studies to obtain range of investment types, geography and other factors

- Case studies:
  1. Western State: pavement management system (PMS) implementation
  2. Eastern State: bridge management system (BMS) implementation
  3. Southern State: maintenance management system (MMS) implementation
Case Study Analysis Process

Process for Case Study Analysis

Plan
- Questionnaire development
- Preliminary ROI framework

Collect
- Meet with stakeholders
- Validate and organize

Analyze
- Application of quantitative methods
- Analysis and documentation
Case Study 1: Western State

- Analyzed effects from 1999-2012 of implementing a PMS
- Changes in business process following PMS implementation
  - Increased emphasis on preservation: agency specified a minimum for districts to budget for preservation treatments
  - Requirement for a specified percent of projects to match PMS recommendations
- Modeling the effects
  - Performed a simulation outside the PMS to determine effect of shift to increased preservation: equivalent to approximately $19M/year
  - Used historic simulation results from the agency’s PMS to estimate effect of a $19M/year cut on conditions
Case Study 1 Analysis Results (2012 $M)

<table>
<thead>
<tr>
<th>Description</th>
<th>Total</th>
<th>NPV</th>
<th>Annualized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agency costs</td>
<td>17.3</td>
<td>23.2</td>
<td>0.93</td>
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<td>User benefits</td>
<td>47.7</td>
<td>56.1</td>
<td>2.24</td>
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<td>Increased residual value</td>
<td>182.4</td>
<td>182.4</td>
<td>7.30</td>
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<td>Total benefit</td>
<td>230.1</td>
<td>238.5</td>
<td>9.64</td>
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<tr>
<td>Net benefit</td>
<td>212.8</td>
<td>215.3</td>
<td>8.61</td>
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- Benefit cost ratio of PMS implementation: ~10 ($238.5 million NPV of total benefit / $23.2 million NPV of total cost)
- ROI of investing in the BMS: 41% ($9.54 million annual benefit / $23.2 million NPV of costs)
- Largest component of the benefit: increased residual value of the pavement network
Case Study 2: Eastern State

- Analyzed effects from 2009 to 2013 of investing in a new BMS
- Changes in business process following BMS implementation
  - Staff reported that use of the BMS enabled a shift in bridge spending to focus on preservation rather than bridge replacement
  - $10M/year + one-time investment of $100M
- Modeling the effects
  - Performed a simulation in the National Bridge Investment Analysis System reproducing observed spending and conditions
  - Simulated an alternative scenario in which preservation spending was limited
## Case Study 2 Analysis Results (2012 $M)

<table>
<thead>
<tr>
<th>Description</th>
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<td>User benefits</td>
<td>-202.4</td>
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<td>-8.05</td>
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<td>Increased residual value</td>
<td>283.9</td>
<td>273.0</td>
<td>10.92</td>
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<tr>
<td>Total benefit</td>
<td>81.5</td>
<td>71.7</td>
<td>2.87</td>
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<tr>
<td>Net benefit</td>
<td>78.6</td>
<td>68.7</td>
<td>2.75</td>
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</tbody>
</table>

- Benefit cost ratio of BMS implementation: ~24 ($71.7 million NPV of total benefit / $3.0 million NPV of total cost)
- ROI of investing in the BMS: 96% ($2.87 million annual benefit / $3.0 million NPV of costs)
- Largest component of the benefit: increased residual value of bridges
Case Study 3: Southern State

- State implemented a maintenance levels of service approach in 2007 followed by a new management system
- Used a time series approach to estimate benefits of MMS implementation
  - Linear regression model predicting LOS scores over time given budgets, presence of the MMS and other variables
  - Requires sufficient historic data on costs and investment effects
- Input data
  - Maintenance spending per mile by maintenance activity and district
  - LOS scores by maintenance category, district, and year
Case Study 3 Conclusions

• Models provided evidence that implementation of the new TAM system resulted in more cost-effective management of LOS maintenance conditions
  – Showed a statistically significant relationship between increased spending and score improvements relative to objectives

• Case study did not yield conclusive financial results
  – Study would have benefited from additional data
  – System implementation occurred at same time as a major change in budget, confounding the analysis

• Basic approach nonetheless shows promise for historic analysis
Analytical Methods Needed
Elements of ROI Framework

- Definition of Investment and Base Cases
- Identification of Benefit and Cost Categories
- Methods for Estimating Benefits
- Performance Measurement and Quantification of Input Values
- Return on Investment Assessment and Reporting
- Consideration of Uncertainty
Potential Benefits of TAM Investments

Direct and Indirect Agency Cost Savings

- Staff time savings from improved data collection and accessibility
- Cost savings from the optimization of investment strategies
- Lower costs from reductions in failure risks for critical assets (e.g., bridges)
- Avoided outlays for legacy systems, including hardware maintenance and software updates
- Enhanced reputation and level of public trust gained through information sharing
- Delayed capital expenditures due to increased asset life (residual value of assets)
- Worker safety (due to bundling of projects)
- Residual value
Potential Benefits of TAM Investments (cont’d)

**User Cost Savings**

- Vehicle operating cost savings (e.g., reduced wear-and-tear, and reduced fuel consumption) from smoother pavements or more direct routing (e.g., with bridge availability)
- Travel time savings
- Accelerated improvements from timely asset management decisions or increased capacity to program maintenance and rehabilitation projects due to cost efficiency
- Reduced work zone delays
- Safety benefits

**Benefits to the General Public (Social Benefits)**

- Emission cost savings
- Reduced noise generation
## Costs of TAM Investments

### Non-Recurring Costs
- Hardware and software acquisition
- Installation
- Training
- Decommissioning

### Recurring Costs
- Maintenance and repair
- Operating expenses
- Software maintenance costs
- Software updates
- Data collection and data analysis costs
ROI Calculation Steps

**Plan**
1. Define Purpose of Study
2. Identify Likely Impacts
3. Assess Available Data

**Collect**
4. Establish Modeling Framework
5. Collect Necessary Data

**Analyze**
6. Conduct Analysis
7. Estimate ROI & Summarize Results
Conclusions/Next Steps

- The ROI framework and calculation process will help agencies:
  - Make the case for needed asset management investments
  - Demonstrate the positive impacts of past investments
- The case studies illustrated the benefits of asset management investments
  - Increased focus on asset preservation
  - Improved system conditions
  - Reduced user costs
- Work is underway to finalize the calculation guidance and spreadsheet tool