Quantifying the Benefits of Pavement Asset Management

By

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Outline

1. McNeil Concepts of Benefit Evaluation
2. Kercher Examples for Cities
3. ADOT Actual Benefits
4. 2015 Benefits Example
5. Pinellas County Florida Benefits
6. Complex Design Calculation vs PMS Solutions
# PMS (Transportation AMS) Maturity Scale

<table>
<thead>
<tr>
<th>PMS Maturity Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Initial 1970’s</td>
<td>No use of tools, processes, or strategy</td>
</tr>
<tr>
<td>2. Awakening</td>
<td>Recognize need, basic data collection. There is often a champion.</td>
</tr>
<tr>
<td>4. Proficient</td>
<td>Expectations and accountability drawn from PMS tools, processes, &amp; strategy.</td>
</tr>
<tr>
<td>5. Best Practice 2000 - DATE</td>
<td>PMS strategies, tools, and processes are evaluated improved and merged into AMS.</td>
</tr>
</tbody>
</table>
McNeil and Mizusawa Concept of *ex ante* evaluation (2)
Overall Condition Index (PCI)
Optimized vs. Ranking – Same 10 Yr. Budget (12)

- PCI = 77
- PCI = 58

Condition Index

Best

Optimized

Ranking

(Worst First)

Optimized PCI

Ranking PCI

0 10 20 30 40 50 60 70 80 90 100


6/4/2015
McNeil and Mizusawa Concept of *Ex post facto* Benefits Evaluation (2)
Regression for Roughness Data Before PMS in ADOT

Average Annual Increase
Slope = 3in/yr

Each point 1 section, 1 year
60,000 points
Arizona Result

Roughness

Age Years

Acceptable Limit

Before PMS

After PMS

Arizona Result

6/4/2015
Roughness vs. Age, Square Root Model

Tolerable Roughness Level: 93 in/mi

1981-1983
14.8 years

1993-1995
16.8 years (95% Confidence)

13.5% Increase

Average
95% Confidence Levels

6/4/2015
ADOT BCR (1990’s Costs) (3)

Documented Costs of operating ADOT PMS over 16 years:

TOTALED: $8.3 million

Benefits over 16 years based on improved roughness and longer life:

TOTALED $423 million

Overall for ADOT BCR over 50:1 Average – 13.5% longer life
ADOT BCR (3)

Even if half the benefits are due to better materials and construction

Minimum PMS BCR is 25:1

Using World Bank estimates, User Cost Savings of 4 for 1, up to 10 for 1.

The BCR to Traveling Public and Tax Payers = Minimum 100:1
MODERN PMS
2015 - Example DOT

40 – 80,000  Centerline Mile Highways
20 – 100      Licensed Users
$700M        Annual Pavement Budget
2015 - Example DOT

Software Acquisition and Training
$700k – $1.3 million, average = $1.0M
Amortized 5 years $1.0M/5 yrs = $200K/yr

Annual Software Maintenance and User Licenses $200 – $700K average = $450K/yr
Agency Operation/Data Collection = $600K/yr

Average Annual Costs of PMS  TOTAL = $1.250M
Annual Benefits

If only 1% Savings (of $700M) = $7.0M
B/CR 7.0/1.25 = 5.5:1

with 5% Savings = $35M
B/CR 35/1.25 = 28:1

with 10% Savings = $70M
B/CR = 70/1.25 = 56:1

User Cost Savings at least 4 X Agency Cost
True Total BCR = 22:1 to 220:1
Findings Pinellas County, Florida

In 2011 PCPW reported major cost savings, much greater organizational efficiency and higher productivity including the following qualified benefits (I):

- The new MMS eliminated the need for 2 other systems, saving $500,000.
- The Mowing department alone saved $1.7 million by a better match between quantity and quality, inventory and methods of mowing.
- The labor pool was reduced to 70 pieces of equipment (about 30%)
- The productivity in work units per hour increased by 45%
- In 2004 annual savings of $2.5 +/- million were predicted. Actual documented budget reduction was actually $6 million.
Other reported general benefits were:

- Joint participation of Senior Management, Supervisors, and all staff members improved the common goal and team spirit in the organization.

- Improvements in efficiency, decision making, organizational development, accountability, planning, reporting, speed of information gathering, and transparency.

- Public Works now accounts for all maintenance work and resources. Cost, Location, and Accomplishment are fully tracked.
Can complex MEPDG equations replace PMS?

Some people seem to think so.
Predicted

Best Space Orbit Calculations

Earth

Moon
Predicted

Actual

Best Space Orbit Calculations

Actually Hundreds of Corrections

Earth

Moon
Very Poor 0

Very Good 5

Failure

Age

Design Life

Predicted with Best Pavement Design Calculations

Actual
In last 10 - 15 years, the US has spent $50-100 million to produce MEPDG with 350 variables, many more if you consider traffic spectrums by load, season, day, and hour.
Almost every US state and FHWA are conducting training courses and calibration studies for MEPDG

WHAT ABOUT INPUT ERRORS?
Simple example –

What is probability of predicting any pavement variable correctly and constructing properly?

For this example say 90% of the time correct input
If 90% probability (chance) of predicting each variable correctly

<table>
<thead>
<tr>
<th>Number of Variables</th>
<th>% of Time</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Answer</td>
<td>Right</td>
<td>Wrong</td>
</tr>
<tr>
<td>1</td>
<td>Joint Probability</td>
<td>90</td>
<td>10%</td>
</tr>
<tr>
<td>2</td>
<td>Joint Probability</td>
<td>81</td>
<td>19%</td>
</tr>
<tr>
<td>4</td>
<td>Joint Probability</td>
<td>66</td>
<td>34%</td>
</tr>
<tr>
<td>8</td>
<td>Joint Probability</td>
<td>43</td>
<td>57%</td>
</tr>
<tr>
<td>16</td>
<td>Joint Probability</td>
<td>19</td>
<td>81%</td>
</tr>
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</table>
Answer with 350 variables? You can calculate; approximately \( 0\% \)

With only 7 variables, the predicted performance will be wrong over \( 50\% \) of the time.

PMS provides the corrective decisions and actions needed to correct the errors to meet your goals.
If 95% probability (chance) of predicting each variable correctly

<table>
<thead>
<tr>
<th>Variables</th>
<th>Right</th>
<th>Wrong</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>95</td>
<td>5%</td>
</tr>
<tr>
<td>4</td>
<td>81</td>
<td>19%</td>
</tr>
<tr>
<td>8</td>
<td>66</td>
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350 Variables? You can calculate near 0%

PMS still is needed to get good performance.
IN SUMMARY

1. Many proven $$$ Benefits from PMS. 
   BCR = 5 – 200
2. The ability of DOTS to manage, organize, and do many things better.
3. The ability to correct Design input and Construction errors.
4. Helps you allocate Budgets to the right action, right place, right time.