The use of performance indices and the advancement in their development for improved accountability

D. Johns & P. Bridge
Vaisala
Winter Service – Cost Benefit


- 1 to 9 Cost to benefit ratio
- Underpinned early investment into RWIS and proactive treatment regimes
- Times have changed – difficult to assess what this benefit is
- MDSS – 1.33 to 8.67
- Cost allocations are well understood
  - Vaisala Value Calculator (Bridge, Attalah)
  - FHWA cost of accidents...
- But how to apply to the real world where treatment already takes place and in fact avoids many issues that do cost?
- Costs of weather have been reduced as the system has been interfered with intentionally!
Winter Service – Cost Benefit

- This paper combines two existing studies to create a first pass on how the benefit of an operational winter service can be assessed.

- Measurement of conditions to assess performance levels

- Cost allocations by route in Scotland
Measuring the weather

- DSC111 provides a reading of ‘GRIP’ by assessing the three layer thicknesses present at the sampling site:
  - Water layer thickness
  - Ice layer
  - Snow layer
- 0.82 = dry road
- 0.1 = hard packed ice
- One simple measurement of the loss of GRIP due to the weather.
A potential Ice/snow event?

Potential event
How well was the road actually treated?

A perfect result

Potential event

Grip > 0.6
Surface state: Moist
How well was the road actually treated?

Total event = 17 hours, Grip < 0.6 for 4 hours. Mobility maintained for 76% of time
How well was the road actually treated?

Mobility nearly zero, untreated event
**Idaho Index**

\[ MobilityIndex \approx \frac{Grip \geq 0.60 \text{Duration(hours)} \times 100}{\text{CombinedEventsDuration(hours)}} \%
\]

\[ SeverityIndex = \text{MaxWindSpeed(mph)} + \text{MaxLayerThickness(mm)} + \left( \frac{300}{\text{MinSurfaceTemp(°F)}} \right) \]

where \( \text{MaxLayerThickness(mm)} = \max(\text{IceLayer, SnowLayer, WaterLayer}) \)

\[ PerformanceIndex = \frac{Grip < 0.6 \text{Duration(hours)}}{SeverityIndex} \]

**Winter Performance Index Legend**

- **0**  - Successfully treated
- **0.00 - 0.30**  - Significantly accelerated grip recovery
- **0.31 - 0.49**  - Some success at grip recovery
- **0.50 - 0.69**  - Very little success at deicing
- **0.70 -**  - Limited maintenance or no deicer success
What does the Mobility Index tell us?

### Total Event hours
- Summarizes the weather in terms of the potential for ice formation on the road/pavement surface without intervention

### Grip < 0.6
- The total number of hours where some form of ice did in fact appear and was measured

### Grip > 0.6
- The total number of hours where active winter service ‘saved’ the road/pavement surface from becoming slippery due to ice

#### Département Conseil Général des Vosges (CG88)

<table>
<thead>
<tr>
<th></th>
<th>Hours</th>
<th>Percentage of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Event Hours</td>
<td>1832</td>
<td></td>
</tr>
<tr>
<td>Total with Grip &lt; 0.6</td>
<td>807</td>
<td>44%</td>
</tr>
<tr>
<td>Total saved hours</td>
<td>1025</td>
<td>56%</td>
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</table>

No overnight operations – low traffic reasoning

#### Transport Scotland primary network

<table>
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<tr>
<th>A702 Boghall winter 2012-13</th>
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<td>Total Event Hours</td>
<td>301.7</td>
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<tr>
<td>Total with Grip &lt; 0.6</td>
<td>25.2</td>
<td>8%</td>
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<tr>
<td>Total saved hours</td>
<td>276.5</td>
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24 Hour operations – no ice policy as critical route
Using Mobility Index parameters to study outcomes

Risk of Ice by hour with maintenance activity
Le Collet 2012-13

Some ice
No Ice
Step 1 complete

- Have a clear observation of how many hours of ice/snow were saved by winter maintenance activities.
- Able to assess different policies against each other
- Can be used to measure changes to practices such as chemical amounts or type
- Transport Scotland currently reviewing the use of Brine by measuring the success against traditional pre-wet

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Cost Allocations
Cost allocations – Transport Scotland

- Value of time per route in terms of hourly delay being saved
  - Point 1 (high) – highly trafficked strategic routes
  - Assumes other routes are open so this is for this route alone being affected
  - Benefit does not include the cost of accidents
- Immediately evident why primary route policies are so important

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<tr>
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<th>Point 1 (high)</th>
<th>Point 2 (middling)</th>
<th>Point 3 (low)</th>
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</thead>
<tbody>
<tr>
<td>Hours Saved by Avoiding 1 Hour Delay</td>
<td>18,000</td>
<td>6,000</td>
<td>3,000</td>
</tr>
<tr>
<td>Value of Time Benefit (£) (2010 Market Prices)</td>
<td>140,000</td>
<td>50,000</td>
<td>20,000</td>
</tr>
</tbody>
</table>
Assessing different methodologies - Scotland

- Basic assumption 1 hour Grip < 0.6 is equal to 1 hour delay
  - Frost likely to be less but snow easily could be more
- Note total cost of operation used not a percentage for an individual route
- Could be termed worse case with very mild winter with only one route being affected at any one time

<table>
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<tr>
<th>Assumption 1 hour Grip below 0.6 = 1 hour delay</th>
<th>Estimated economic loss</th>
<th>Estimated saving over do nothing</th>
<th>Cost to benefit ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>No treatment</td>
<td>42,238,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assuming national daytime only treatment (44%)</td>
<td>18,584,720</td>
<td>23,653,280</td>
<td>1.7</td>
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<tr>
<td>24 hour treatment (8%)</td>
<td>3,379,040</td>
<td>38,858,960</td>
<td>2.8</td>
</tr>
</tbody>
</table>

| Total hours of weather likely to lead to reduced mobility (winter 2012-13) | 302 |
| Economic cost of 1 hour delay (£)                     | 140,000 |
| Cost of winter service operations to Scotland (£)   | 14,000,000 |
Assessing different methodologies  
Widespread event as in 2010 – multiple routes being affected

<table>
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<th>Methodology</th>
<th>Estimated economic loss (£)</th>
<th>Estimated saving over do nothing (£)</th>
<th>Cost to benefit ratio</th>
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<tr>
<td>Assume 302 hours for 8 strategic routes per annum</td>
<td>2416</td>
<td></td>
<td></td>
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<tr>
<td>Economic cost of 1 hour delay (£)</td>
<td>140,000</td>
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- Cost to benefit for partial treatment not accurate due to £14M figure being used however Highland region do operate this way
- However for 24hr operations a 22:1 ratio is suggested
- Note as a sense check Transport Scotland estimated the 2010 winter cost £330M
Summary

- Clear evidence of a real and substantial benefit from conducting a full winter service program
- Figures suggest this has increased since the early days
  - Just in time deliveries, larger economies, road transportation increased rapidly
- Now have a way to measure differing methodologies effectiveness
- Focus on hourly benefit will allow more accurate assessments to be conducted
- Fully transferable methodology
- All available through Vaisala RoadDSS
Thank you