ADDRESSING
UNCERTAINTIES OF
PERFORMANCE
MODELLING

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Acknowledgements

Co-authors

- Michelle Baran - QTMR project leader
- Dr Tim Martin – rutting models
- Lith Choummanivong – LTPP data analysis
- Ranita Sen & Huimin Liu – coding the model

- Prof. Sam Savage
- Marc Thebault
Dealing with uncertainty

• Uncertain information
• Storing uncertain data
• Working with uncertain data
Uncertain information

- External
- Self-afflicted

Average - a convenient untruth
Lost information
Modelling with distributions

- Current models are based on ‘representative’ input – i.e. single values
- ‘Representative input’ – deterministic output
- Array input – array (distribution) output -> probability
No data aggregation

- **Solution:**
- Stochastic Information Packet (SIP)
- Operations with SIPs
**Pilot study**

- Austroads rutting and roughness models
- A combination of ‘certain’ (i.e. single number) and ‘uncertain’ i.e. distributed variables

<table>
<thead>
<tr>
<th>Parameter</th>
<th>min</th>
<th>max</th>
<th>average</th>
<th>distribution</th>
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</thead>
<tbody>
<tr>
<td>cracking (% area)</td>
<td>0.5</td>
<td>8.5</td>
<td>3.2</td>
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<tr>
<td>rutting (mm)</td>
<td>2.0</td>
<td>16.1</td>
<td>6.0</td>
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<tr>
<td>roughness (IRI)</td>
<td>1.26</td>
<td>4.91</td>
<td>2.8</td>
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<tbody>
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<td>SNCo</td>
<td>1.77</td>
<td>5.32</td>
<td>3.3</td>
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<td>Thorthwaite index</td>
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<td>30</td>
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<td>Maintenance expenditure pa. ($/km)</td>
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<td>1139.5</td>
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<tr>
<td>MESA</td>
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<td>0.5</td>
<td>0.5</td>
<td>n/a</td>
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</table>
Rutting model

Rutting cumulative probability - observed distribution

Cum Probability

Slope: 80/20 ptile

Rut Bin

Year 1
Year 3
Year 5
Year 7
Year 9
Slope
Log. (Slope)
Rutting model

Rutting envelope - observed distribution

- 80th percentile
- 50th percentile
- 20th percentile
- Deterministic Rut depth

Year

Rut depth (mm)
Reliability level of average input

Probability vs. annualised cost

- Annualised cost
- Average input
- Poly. (annualised cost)
Conclusions

• Storage of distributions solved

• The full data can be used instead of a ‘representative’ (average) value

• Benefits: more realistic treatment quantities and cost estimates

• Risk / probability is known
Final message

- Average - a convenient untruth
- ‘Yes we can’ use the full data to model performance
Risk to contractors
The shape of the data

- Assumed shape implied by the average
- Actual shape