Scenario Analysis, Decision Trees and Simulation for Cargo Screening

Galina Sherman and David Menachof: University of Hull – Business School (Logistics Institute)
Peier-Olaf Siebers and Uwe Aickelin: Nottingham University – Computer Science (IMA Research Group)

**Background**

**Introduction**
- Cargo screening at seaports
- Looking for stowaways
- Efficiency is not known

**Tools for evaluating different policies**
- Trade-Off Analysis
- Cost-Benefit Analysis
- Pareto Analysis

**Evaluation methods used in tools**
- Scenario analysis
- Decision trees
- Simulation (Monte Carlo and DES)

**Aim and Focus**

**Aim:** To examine different probabilistic methods that are frequently used for conducting Cost-Benefit Analysis of different cargo screening policies

**Focus:**
- Comparison between techniques
- Data requirements
- Use in security research

**Case Study - Calais**
- Stowaways (clandestines)
- 90,000 lorries/year
- 0.4% are positive detected lorries

**Conceptual Model**

**Scenario Analysis**

- % of vehicles searched
- # of positive lorries stopped
- Comparison with base scenario CG=0%
- % of positive lorries missed
- Cost of extra searches
- Relative # of positive lorries missed vs. CG=0%

**Decision Trees**

**Simulation (using AnyLogic)**

**Results and Conclusions**

<table>
<thead>
<tr>
<th>Risk type</th>
<th>Discrete / Continuous</th>
<th>Correlated / Independent</th>
<th>Decision process</th>
<th>Model Characteristics: Low, Medium, High</th>
<th>Future Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategy</td>
<td>D</td>
<td>D</td>
<td>C</td>
<td>S</td>
<td>H</td>
</tr>
<tr>
<td>Operational</td>
<td>D</td>
<td>C</td>
<td>C</td>
<td>S</td>
<td>M</td>
</tr>
<tr>
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<td>C</td>
<td>C</td>
<td>S</td>
<td>M</td>
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<tr>
<td>Concurrent</td>
<td>D</td>
<td>C</td>
<td>C</td>
<td>S</td>
<td>M</td>
</tr>
</tbody>
</table>

**Table 1:** Two factors with three scenarios and one decision variable with three options

- Traffic Growth (TG)
  - 0%: 0.25
  - 10%: 0.5
  - 20%: 0.25

- Clandestine Growth (CG)
  - 0%: 0.33
  - 10%: 0.33
  - 20%: 0.33

- Search Growth (SG)
  - 0%: 0%
  - 10%: 10%
  - 20%: 25%

**Table 2:** Combined probabilities assuming independence of probabilities

- 50% CG: 0.083
- 0% CG: 0.083
- 7.5% CG: 0.083

- 0% TG: 0.167
- 10% TG: 0.167
- 20% TG: 0.167

- Monte Carlo Simulation
- DES 0: basic (incl. times and resources)
- DES 1: DES 0 & seasonal arrival rates
- DES 2: DES 0 & queue size restrictions (UK controls)
- DES 3: DES 1 & queue size restrictions (UK controls)

**Table 4:** Overall cost comparisons of all methodologies

<table>
<thead>
<tr>
<th>Method</th>
<th>TG 0%</th>
<th>TG 10%</th>
<th>TG 20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA</td>
<td>£52,000</td>
<td>£66,000</td>
<td>£60,000</td>
</tr>
<tr>
<td>DT</td>
<td>£52,000</td>
<td>£66,000</td>
<td>£60,000</td>
</tr>
<tr>
<td>DES 0</td>
<td>£52,000</td>
<td>£66,000</td>
<td>£60,000</td>
</tr>
<tr>
<td>DES 1</td>
<td>£52,000</td>
<td>£66,000</td>
<td>£60,000</td>
</tr>
<tr>
<td>DES 2</td>
<td>£52,000</td>
<td>£66,000</td>
<td>£60,000</td>
</tr>
<tr>
<td>DES 3</td>
<td>£52,000</td>
<td>£66,000</td>
<td>£60,000</td>
</tr>
</tbody>
</table>

**Table 3:** Expected costs excluding SG costs for CG = 0%

<table>
<thead>
<tr>
<th>TG vs. SG</th>
<th>SG 0%</th>
<th>SG +10%</th>
<th>SG +20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>TG 0%</td>
<td>£59,545</td>
<td>£60,000</td>
<td>£60,000</td>
</tr>
<tr>
<td>TG 10%</td>
<td>£59,545</td>
<td>£60,000</td>
<td>£60,000</td>
</tr>
<tr>
<td>TG 20%</td>
<td>£59,545</td>
<td>£60,000</td>
<td>£60,000</td>
</tr>
</tbody>
</table>

**Table 5:** Factors to take into consideration before making decisions

- Traffic Growth
  - 0%
  - 10%
  - 20%

- Clandestine Growth
  - 0%
  - 10%
  - 20%

- Search Growth
  - 0%
  - 10%
  - 20%

- Monte Carlo Simulation
- DES 0: basic (incl. times and resources)
- DES 1: DES 0 & seasonal arrival rates
- DES 2: DES 0 & queue size restrictions (UK controls)
- DES 3: DES 1 & queue size restrictions (UK controls)

**The Research Team**

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