Title: Impact of integrated winter road maintenance on transport system resilience

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Citation: 15th International Winter Road Congress, 20 - 23 February 2018, Gdańsk, Poland

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INTEGRATED WINTER ROAD MAINTENANCE AND THE TRANSPORT SYSTEM RESILIENCE

Winter maintenance management and planning
Extreme weather condition risks

- **In the U.S.**:
  - 7,400 fatalities and 670,000 injuries due to weather
  - **500 million hours of delay** caused by limited visibility or slipperiness

- **In the UK**:
  - Average daily cost **£280 million** due to severe weather
  - Normal daily costs due to congestion are £60 million
## In the EU

<table>
<thead>
<tr>
<th>Mode</th>
<th>Accidents</th>
<th>Time costs</th>
<th>Infrastructure</th>
<th>Freight &amp; logistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Physical infra</td>
<td>Maintenance</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road</td>
<td>&gt;10 bill.</td>
<td>0.5-1.0 bill.</td>
<td>ca. 1 bill.</td>
<td>ca. 0.2 bill.</td>
</tr>
<tr>
<td>Rail</td>
<td>&gt;0.1 bill.</td>
<td>&gt;10 mill.</td>
<td>&gt;0.1 bill.</td>
<td>5 – 24 mill.</td>
</tr>
<tr>
<td>IWT</td>
<td>ca. 2 mill.</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>Short sea</td>
<td>&gt;10 mill.</td>
<td>na</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>Aviation</td>
<td>na</td>
<td>&gt;0.6 bill.</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>Light traffic</td>
<td>&gt;2 bill.</td>
<td>-</td>
<td>na</td>
<td>na</td>
</tr>
<tr>
<td>TOTAL</td>
<td>&gt;12 bill.</td>
<td>&gt;1 bill.</td>
<td>ca. 1 bill.</td>
<td>&gt;0.3 bill.</td>
</tr>
</tbody>
</table>

The EU-27 grand total more than 15 bill. € p.a.
We need to identify and innovate in a systemic way the potential of different combinations of measures as adaptation and mitigation strategies.

We need to estimate what kind of measures offer the best cost effectiveness.

Potential for significant benefits for road operators, maintenance decision makers, road authorities and road users.

Better awareness and more proactive measures.

Reduced operational maintenance costs and lighter environmental footprint improvements in traffic safety and traffic management.
Coping capacity (“endurance / toughness”)
- the ability of people, organizations and systems, to use available skills and resources in order to face and manage adverse conditions, emergencies or disasters

Exposure (“weakness”)
- people, property, systems, or other elements present in hazard zones that are thereby subject to potential losses

Susceptibility (“sensitivity”)
- the characteristics and circumstances of community, system or asset that make it susceptible to the damaging effects of a hazard

\[ \text{Resilience} = \frac{\text{Coping capacity}}{\text{Exposure} \times \text{Susceptibility}} \]
Exposure

- Risk
- Feature/w
- Sensitivity
- Covariance

Susceptibility

- Resources
- Skills
- Feature / s
- Hedging

Resilience

- Probability of adverse event, e.g. probability of a storm
- Outdated infrastructure component at the end of its technical service life or obvious poor quality
- non-robust or unprotected components of the system
- dependency on other system components or other systems (e.g. electricity power supply)
- Availability and quality of repair equipment, budget adequacy
- Trained maintenance and repair crews, sophistication of asset management strategies
- Robust designs, engineering and design philosophy (e.g. use of safety multipliers or factors)
- Hedging => protective structures, insurance.
Value stream

System integrator (i.e., core company)

Service/technology provider

Service/technology provider

Service/technology provider

Service/technology provider

Value of co-creation = 1+1=3

Synergy

Supply ↔ Demand ↔ End-customer

Value added

Road authorities

“Winter mobility market”

End-customer requirements and involvement

Innovative procurement models

Get involved!
Value added

Example of Technology System components

Examples:
- Sensors
- Optics
- ICT
- Algorithms

Examples of Systems:
- Met-stations
- Radars
- Cameras
- Visibility meters
- FCD...

Examples of Services:
- Road user info
- Warnings
- Asset manag.
- C-ITS

"Cash value" ⇔ Resilience (=societal benefits)
### Context and issue

**Clarifying the roles and responsibilities of different actors**
- **Opportunity**: Real-time information guidelines
  - If road users have notice or requirements concerning maintenance activities, it is possible to concentrate all the contacts and share the information between them.

**Proper and efficient use of maintenance vehicles and C-ITS**
- **Opportunity**: Possibility of centralizing decision-making related to, e.g., the selection of appropriate de-icing chemicals based on collected data.
- **Opportunity**: Easier to reassess weather conditions during activities and, e.g., change the compound of used de-icing chemicals.
- **Opportunity**: Easier to take a hand with unprofessional ways for conducting maintenance work (e.g., too fast driving).

**Real-time location and awareness of maintenance vehicles**
- **Opportunity**: It is possible to direct entire maintenance vehicle fleet to focus on areas where the driving conditions are the most difficult.
- **Opportunity**: Possible to redefine priority roads for activities based on changing weather and road conditions → situational awareness.
- **Opportunity**: Possibility to inform the movements and activities of maintenance vehicles and recently operated roads → accessibility.

**Correct timing of maintenance activities**
- **Opportunity**: Different contractors can get same weather forecasts and made aligned decisions regarding starting of maintenance activities.
- **Opportunity**: Better possibilities to align and complete activities of various contractors.

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**Integrated winter road maintenance = Increased Resilience**

#### SAFETY AND RELIABILITY

- **PROACTIVENESS AND ENVIRONMENT FOOTPRINT**
- **ACCESSIBILITY**
- **ENHANCED TRAFFIC MANAGEMENT**
SUMMARY:
Benefits – road info and maintenance services

- Providing weather and road weather information to road users in Finland reduced the number and severity of accidents:
  - €16 - €32 million benefits with current services
  - Additional €16 - €32 million with more advanced services

- Benefits in maintenance:
  - €2.7 million total consisting of reduced need for materials, less unnecessary operations, and fewer belated operations

- Weather information to pedestrians and bicyclists would provide significant benefits:
  - Savings of €49 - €73 from reducing slipping accidents by services targeted to end-users
  - Savings of €120 million from reduced slipping accidents by services targeted to maintenance operators

- Benefits for maintenance operators
  - Proactivity: reduced need of personnel and materials
  - Anti-icing has lowered snow and ice control costs by 10-50%
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