Use of Digital Data and ICT Systems to Improve Resilience of the Transport System to Future Climate Extremes

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Outline

- Motivation
- Project objectives
- Current project stage
- Definition of resilience
- ITS role
- Project challenges
- Conclusions
Heat waves damaged 80km rural roads, estimated cost £2M (2006)

Additional £0.5M 2008/10 for highway drainage work (2007)

Additional salting cost of £0.5Mpa, carriageway damage £1M to £5M (2009-2010)

Source: Institute of Highway Engineer
Project objectives

• To develop a definition for network resilience and identify its characteristics.
• Quantify and develop a reliable indicator framework for measuring resilience of transport network.
• To investigate the role of available and future ITS technologies in enhancing resilience of transport network under unexpected climate change related event.
• To apply the developed indicator framework to one or more regional case studies to examine the role ITS can play in enhancing the resilience of transport network under unexpected climate change related event.
Current Stage

- Define network resilience
- Stability Index
- ITS Role
- Transport, Land-use, ITS
- Resilience Framework
- Selected Model

Modelling

ITS

ITS role

Measures
What do we mean by resilience?
The amount of interruption that can be mitigated before the need to restructure the system or the ability of the system to deal with unexpected events without losing its characteristics.\textsuperscript{1-4}

The property of the system which gives the ability to recoup with system complication and sustain its functionality under expected or unexpected event.\textsuperscript{5}
Avoidance

- Design.
- Demand decreasing.

Mitigation

- Set of policies.
- Implementation of new technologies.

Recovery

- Functionality,
- Recovery time,
- External sources.

Responding stage

- Severity of the event,
- Collaboration.
The dynamic ability of the system to avoid, mitigate, respond and recover from disruption and maintain its functionality as in normal conditions.
<table>
<thead>
<tr>
<th>Resilience Characteristics(^{(6)})</th>
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</thead>
<tbody>
<tr>
<td><strong>Redundancy</strong></td>
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<tr>
<td>The ability of the system to offer several ways (path).</td>
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<tr>
<td><strong>Diversity</strong></td>
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<td>The availability of different modes that cover certain area.</td>
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<td><strong>Resourcefulness</strong></td>
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<td>The capability to detect the problem, set precedence resources and activate sources</td>
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<tr>
<td><strong>Autonomy</strong></td>
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<tr>
<td>The independence of each system to operate</td>
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<tr>
<td><strong>Adaptability</strong></td>
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<td>The ability of the system to readjust its elements, processes or management arrangement to suit changes in serviceable requirement.</td>
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<tr>
<td>Resilience Characteristics</td>
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<tr>
<td>--------------------------</td>
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<tr>
<td><strong>Vulnerability</strong></td>
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<tr>
<td>The degree to which the system is “susceptible” or “sensitive” to threats or hazards that can lead to significant effect on road network performance.</td>
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<tr>
<td><strong>Mobility</strong></td>
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<td>The ability of people and goods to move from origin to destination with acceptable level of transport service</td>
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<td><strong>Strength</strong></td>
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<tr>
<td>the capability of the system to resist the disruption. It also refers to robustness which evaluates the ability of all elements of the system to bear up to a certain level of disruption without losing its effective performance</td>
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</table>
Resilience of Transport system

Mansouri et al. 2009
Nair et al. 2010
Chialastri and Pozzi 2008
Berche et al. 2009
<table>
<thead>
<tr>
<th>Strategies</th>
<th>Tactics</th>
<th>Tools and Technology</th>
<th>Study Cases</th>
<th>Impact</th>
</tr>
</thead>
</table>
| ATM        | Four Lane Variable Mandatory | AMI; AMS; PTZ cameras; CCTV; MIDAS; SACS; HADECS cameras; VDL | ATM on M42 between J3a and J7 | • Reduced congestion  
• Improved journey time reliability  
• Increased capacity  
• Reduced emissions  
• Reduced incidents |
| RWM        | Road weather controlled variable speed limits | RWIS; TIC, DMS | Four years field trial in Sweden | Decrease of fatalities and severity accidents |
|            | Information Dissemination | DMS, HAR, Internet. | HA website HAR | • Informed traveller  
• Network efficiency |
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<tr>
<td>Motorways access control</td>
<td>TM</td>
<td>RM</td>
<td>TM at 30 sites</td>
<td>• Reliable Journey time;</td>
</tr>
<tr>
<td></td>
<td>ITM</td>
<td>RM, MJTSCR</td>
<td>ITM at J-33 of the M1</td>
<td>• Traffic speed;</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>• Traffic flow.</td>
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<tr>
<td>Road Pricing</td>
<td></td>
<td>Electronic toll collection</td>
<td>M6 Toll</td>
<td>Relieve congestion</td>
</tr>
<tr>
<td>Crash prevention</td>
<td>Accident detection</td>
<td>MIDAS</td>
<td>M25 (j6-j8)</td>
<td>• Safe road</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>• Reliable Journey time</td>
</tr>
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Modelling

Activity based Model

Trip generation

Travel demand models

Trip distribution

Model choice

Trip assignment

Macroscopic models

Mesoscopic models

Land use Model

Microscopic models

Modelling
Project Challenges

- Multidisciplinary: combines three different topics: designing indicator framework, ITS and resilience.
- Reliable indicator framework and resilience are newly introduced terminologies in the UK transport system.
- There is a lack of evaluation of ITS effects on environment, low carbon future and network resilience.
CONCLUSIONS

- There is no common resilience definition in transport context.
- Main characteristics of resilience were identified.
- The revolution in ITS technologies results in progress in RTI monitoring and dissemination.
- In addition to proposed clean fuel technologies, low carbon future could be achieved through active traffic management and traffic smoothing techniques.
CONCLUSIONS (CONT.)

- Although, many ITS have been already implemented for many years, there is a lack of evaluation of their effect on environment, low carbon future and network resilience. Therefore, more independent investigations of each ITS technology are welcomed to give a fair assessment of the technology effectiveness and drawbacks.
REFERENCES


REFERENCES (CONT.)


Thanks

Feedback

Questions

Suggestions