Cost benefit analysis applied to reliability policies in France

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Views expressed here do not reflect the Ministry’s position
Policy context:
- Transport policies focus on managing existing capacities
- Fluidity is the primary objective, reliability is implicit
- Need for traffic management appraisal is increasing
  - For diverse traffic management measures

Existing assessment practices:
- CBA is commonly used for capacity policies
  - but barely for traffic management
- Ex post evaluation is used for traffic management
  - in a “benefit transfer” approach for experimental measures
Outline (2)

- Existing CBA framework for transport policy:
  - Is applicable for reliability and traffic management
  - in spite of “critical” knowledge gaps

- Knowledge gaps:
  - Time value
    - Towards a scheduling reflecting opportunity costs of activities?
  - Impact of information on behaviours
  - Links between fluidity, safety, reliability
  - Dynamic modelling: multimodal, macro-scale, pollution
1. Policy context (1)

- Transport policies in France: recent trends
  - “Shift” from capacity to flows management
    - National and local budget constraints
    - “Greening” of transport policies
    - End-user’s orientation (quality of service)
  - Impetus on multimodal approaches
    - e.g. dynamic use of road capacities for public transport
    - e.g. park and ride policies in peri-urban areas
    - e.g. multimodal door to door information
    - e.g. multimodal freight policies
  - Impetus in the road sector: draft ITS directive?
    - Relevant level of harmonization for traffic management and traffic information practices?
1. Policy context (2)

- Reliability is not the main policy objective
  - Congestion, environment, safety, public finance

- ... but the importance of reliability should increase
  - Multimodal approaches will increase the value of reliability / unreliability for users (connections)
  - Information to users may increase demand for reliability
  - Perception of indirect impacts of incidents and road fatalities, i.e. non recurrent congestion, is increasing
  - Climate change and critical infrastructure protection concerns will raise reliability issues for extreme impacts / low probability events
1. Policy context (3)

- Road traffic management: appraisal needs
  - Comparaison of traffic management and capacity
  - Selection of local investments by road operators
  - Relevance of national / european service standards
    - Cf. draft ITS directive
      - (e.g. maximum incident detection delay)
  - Relevance of national traffic management policies
    - (e.g. trucks overtake ban)
- Data management
  - Marginal cost of data vs marginal value for traffic management
  - Expected gains of new technologies (floating vehicles)
1. Policy context (4)

- An increasing mix of objectives and instruments
  - Fluidity, safety, reliability
    - are tightly correlated from a global perspective
    - but must be de-correlated for policy analysis
  - Capacity and traffic management are multi-objectives
    - Fluidity, reliability, safety
    - with shared costs (e.g. information costs)
  - need for a comprehensive assessment approach
    - multi-impacts → CBA is generally appropriate
    - diversity of measures → CBA must be “customized”
- Reliability policies = traffic management?
Probability (travel time > t)

- Congestion
- Un-reliability

Fluid travel time
Buffer time
Unreliable travel time

Anticipated travel time

Travel time objectives
Reliability objectives
Fluidity, environment, safety objectives
<table>
<thead>
<tr>
<th>Policies</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>Traffic management</em></td>
</tr>
<tr>
<td></td>
<td><em>Other policies</em></td>
</tr>
<tr>
<td>Capacity (local)</td>
<td>Road capacity ; Rail traffic / slots management</td>
</tr>
<tr>
<td>Redundancy</td>
<td>Alternative routes / modes availability</td>
</tr>
<tr>
<td>Connectivity</td>
<td>Door to door oriented slots management</td>
</tr>
<tr>
<td>Prevention</td>
<td>Incident prevention through safety policies</td>
</tr>
<tr>
<td>Preparedness and intervention</td>
<td>Incident detection</td>
</tr>
<tr>
<td></td>
<td>Emergency management plans</td>
</tr>
<tr>
<td>Pre-Information</td>
<td>Transparency on modes / operators / routes reliability</td>
</tr>
<tr>
<td>Real time information</td>
<td>Dynamic routing</td>
</tr>
<tr>
<td></td>
<td>Real time information on schedules</td>
</tr>
<tr>
<td>Pricing</td>
<td>Congestion / peak pricing</td>
</tr>
<tr>
<td></td>
<td>Un-reliability pricing</td>
</tr>
</tbody>
</table>
2. Traffic management: existing assessment practices (1)

- Traffic management policies are still in an experimental phase
  - Measures are tightly linked to local situations
  - Equipments are quickly evolving
  - Relevant authorities are diverse: national road authority and its regional directorates; motorway companies; local authorities

- Assessment practices aim at testing and capitalizing experiences

- Existing assessment practices focus on:
  - “classical” transport indicators:
    - travel time, safety, CO2, local pollutants, noise
  - Acceptability / impacts on behaviours (ergonomy)
2. Existing assessment practices (2)

- Methodology (main features)
  - After – before or with – without comparison :
    - 2 “comparable” periods
    - For dynamic measures : periods, with and without activation
    - For permanent measures : short period or annual
  - On the same section / network

- Indicators :

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel time</td>
<td>Average speed or time spent in delays</td>
</tr>
<tr>
<td>Safety</td>
<td>Number of accidents / fatalities</td>
</tr>
<tr>
<td>Enforcement</td>
<td>Number of offenses</td>
</tr>
<tr>
<td>Acceptability</td>
<td>Surveys</td>
</tr>
<tr>
<td>Pollutants, noise</td>
<td>Local measurements</td>
</tr>
</tbody>
</table>
2. Existing assessment practices (3)

- Comparable to other guidelines or practices
  - EU Tempo and Easyway guidelines
    - [www.easyway-its.eu](http://www.easyway-its.eu)
  - US ITS evaluation tool-box (RITA)
    - [www.its.gov/evaluation/guide_ressource.htm](http://www.its.gov/evaluation/guide_ressource.htm)
  - Cf. french method and case studies
    - [www.zelt-fr.org](http://www.zelt-fr.org)

- Main limits
  - No “business as usual” scenario
  - No assessment of reliability
  - Safety assessment based on a limited data
  - No CBA
2. Existing assessment practices (4)

- CBA application to ex ante evaluation of traffic management
  - Traffic management measures have to be taken into account to optimize the reference situation for capacity projects
    - Cf. provisional instruction for road project appraisal, 2007
    - Cf. reference efficiency of traffic management measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Reference efficiency (impact on transport demand)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-information : route advice</td>
<td>3% to 8%, 20% in peri-urban</td>
</tr>
<tr>
<td>Real time information : dynamic routing</td>
<td>1% to 5% (year average)</td>
</tr>
<tr>
<td>Peak-pricing + information</td>
<td>10%</td>
</tr>
<tr>
<td>Dynamic speed limits</td>
<td>3%</td>
</tr>
</tbody>
</table>

- CBA has to be applied for traffic management measures (recommendation : Conseil général des ponts et chaussées, 2004)
3. CBA applied to reliability:
a comprehensive tool-box? (1)

- The “tool-box” (in brief)
  - List of costs and impacts
  - Monetary values
  - Cost of public funds
  - Discount rate, life time, residual value
  - Reference / business as usual scenario
  - Alternative scenarios / optimisation
  - Risk analysis

3. CBA applied to reliability: a comprehensive tool-box? (2)

Questions:

- Does the existent CBA tool box for “capacity” assessment correctly reflect reliability objectives?

- Is the existent CBA tool box for “capacity” assessment relevant for traffic management?

NB: this tool-box was applied to assess vulnerability of critical infrastructures (= costs of “durable” disruptions) (2007)
<table>
<thead>
<tr>
<th>Cost or impact</th>
<th>Relevance for traffic management?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment</td>
<td>✓</td>
</tr>
<tr>
<td>Maintainance</td>
<td>✓</td>
</tr>
<tr>
<td>Operation costs</td>
<td>✓</td>
</tr>
<tr>
<td>Travel time</td>
<td>✓</td>
</tr>
<tr>
<td>Safety</td>
<td>✓</td>
</tr>
<tr>
<td>Vehicles operation costs</td>
<td>✓</td>
</tr>
<tr>
<td>Fuel costs</td>
<td>✓</td>
</tr>
<tr>
<td>CO2</td>
<td>✓</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>✓</td>
</tr>
<tr>
<td>Landscape</td>
<td>✓</td>
</tr>
<tr>
<td>Local pollutions</td>
<td>✓</td>
</tr>
<tr>
<td>Noise</td>
<td>✓</td>
</tr>
<tr>
<td>Comfort</td>
<td>✓</td>
</tr>
<tr>
<td>Monetary values of impacts</td>
<td>Availability for « capacity » policies (in France)</td>
</tr>
<tr>
<td>----------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Travel time</td>
<td>√</td>
</tr>
<tr>
<td>Safety</td>
<td>√</td>
</tr>
<tr>
<td>CO2</td>
<td>√</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>No</td>
</tr>
<tr>
<td>Landscape</td>
<td>No</td>
</tr>
<tr>
<td>Local pollutions</td>
<td>√</td>
</tr>
<tr>
<td>Noise</td>
<td>√</td>
</tr>
<tr>
<td>Comfort</td>
<td>√</td>
</tr>
<tr>
<td>Modelisation of impacts</td>
<td>Availability for « capacity » policies</td>
</tr>
<tr>
<td>-------------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>Travel time</td>
<td>√</td>
</tr>
<tr>
<td>Safety</td>
<td>√</td>
</tr>
<tr>
<td>CO2</td>
<td>√</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>±</td>
</tr>
<tr>
<td>Landscape</td>
<td>±</td>
</tr>
<tr>
<td>Local pollutions</td>
<td>√</td>
</tr>
<tr>
<td>Noise</td>
<td>√</td>
</tr>
</tbody>
</table>
3. CBA applied to reliability: a comprehensive tool-box? (3)

- Impacts beyond CBA?

- Existing debate in France: does CBA correctly reflect:
  - Equity, social exclusion / inclusion?
  - Effects on geographical distribution of activities and competition?
  - Keynesian effects?

- Is this debate relevant for reliability / traffic management?
3. CBA applied to reliability: a comprehensive tool-box? (4)

- **Equity, social exclusion:**
  - Are low income/fragile households more impacted by unreliability?
    - ~ yes
    - cf. scheduling approach: costs of schedule disruptions or disturbance may be higher

- **Location of activities and competition**
  - Are “just in time” activities more critical for competition?
    - ~ yes
    - competition for other activities is generally at a larger geographical scale (EU) than the project’s scale
3. CBA applied to reliability: a comprehensive tool-box? (5)

- **Keynesian effects**
  - Assuming that keynesian effects have to be taken into account
  - Which is not the recommendation for project assessment
- Are keynesian effects higher for traffic management?
  - ~ yes and no
  - Projects can start quicker than new capacities but slower than surfacing
  - Domestic value added is higher for construction than for ITS technologies
4. Main knowledge gaps (1)

- **Time value**: relevance of the scheduling approach
  - Just in time is increasing (social activities, business)
    - Value of un-reliable time is increasing faster than value of time
  - Reliability is a significant modal choice criteria:
    - Need for differentiated time values among users
      - (e.g. type of freight)
  - Costs of un-reliable time depend on available alternatives for re-scheduling activities
    - Need for differentiated time values
      - among social groups
      - between geographical locations
4. Main knowledge gaps (2)

- Time value: relevance of the scheduling approach
  - Traffic management measures are diverse:
    - Traffic management can address:
      - high delays - low probability events
      - or short delays – high probability events
        → need for different time values for different delays
    - Traffic information can address:
      - real travel time: information favours dynamic routing
      - value of time: information enables scheduling reorganisation
      - buffer time: information enables choices based on existing reliability
        → need to separate buffer time / un-reliable time
        → need to differentiate values of un-reliable time depending on delays
4. Main knowledge gaps (3)

- Reliability assessment and the scheduling approach
  (simplified presentation)

N users : $i = 1, \ldots, N$

P events : $p = 1, \ldots, P$

Total unreliability =

$$\sum_{i,p} (\text{value of unreliable time})_{i,p}$$

* $\left[ \text{(real travel time)}_{i,p} - \text{(buffer time)}_i - \text{nominal travel time} \right]$
<table>
<thead>
<tr>
<th>Component</th>
<th>Real time information</th>
<th>Pre-information</th>
<th>Incident management</th>
<th>Dynamic capacity allocation or routing</th>
<th>Fluidity (if anticipated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>value of unreliable time per user</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>value of unreliable time per event</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>real travel time per user</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>real travel time per event</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>buffer time per user</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>References in France</td>
<td>Value of unreliable time / value of time</td>
<td>Comments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>----------------------------------------</td>
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<td></td>
</tr>
<tr>
<td>STIF (2000)</td>
<td>6</td>
<td>Public transport in the Paris region: un-reliable time is defined as « delays »</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delache (2008)</td>
<td>2 to 20</td>
<td>Scheduling model (utility losses of « disrupted » activities due to non expected delays – beyond buffer time) with different assumptions on schedules rigidity</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Expected travel time | Activity 1 | Activity 2
---|---|---
Real travel time
Value of un-reliable time
/value of reliable time

Nominal travel time
Anticipated travel time = nominal + buffer time
4. Main knowledge gaps (4)

- Impacts of time values for existing CBA
  - Case of automatic incident detection: inter-urban motorway (2*3)

<table>
<thead>
<tr>
<th>Impact</th>
<th>Normal time value</th>
<th>5 * normal time value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel time</td>
<td>0,8 %</td>
<td>4,0 %</td>
</tr>
<tr>
<td>Safety</td>
<td>99,1 %</td>
<td>96,0 %</td>
</tr>
<tr>
<td>Environment and energy</td>
<td>0,1 %</td>
<td>0,0 %</td>
</tr>
<tr>
<td>Total impacts</td>
<td>1</td>
<td>1,03</td>
</tr>
</tbody>
</table>
4. Main knowledge gaps (5)

- Impacts of time values for existing CBA
  - Case of automatic incident detection: peri-urban motorway (2*3)

<table>
<thead>
<tr>
<th>Impact</th>
<th>Normal time value</th>
<th>5 * normal time value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel time</td>
<td>12,0 %</td>
<td>40,6 %</td>
</tr>
<tr>
<td>Safety</td>
<td>86,2 %</td>
<td>58,2 %</td>
</tr>
<tr>
<td>Environment and energy</td>
<td>1,8 %</td>
<td>1,2 %</td>
</tr>
<tr>
<td><strong>Total impacts</strong></td>
<td><strong>1</strong></td>
<td><strong>1,5</strong></td>
</tr>
</tbody>
</table>
4. Main knowledge gaps (6)

- Impacts of time values for existing CBA
  - Case of automatic incident detection: urban motorway (2*3) (e.g. Paris area)

<table>
<thead>
<tr>
<th>Impact</th>
<th>Normal time value</th>
<th>5 * normal time value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% benefits</td>
<td>% benefits</td>
</tr>
<tr>
<td>Travel time</td>
<td>25,4 %</td>
<td>63,0 %</td>
</tr>
<tr>
<td>Safety</td>
<td>71,2 %</td>
<td>35,3 %</td>
</tr>
<tr>
<td>Environment and energy</td>
<td>3,4 %</td>
<td>1,7 %</td>
</tr>
<tr>
<td>Total impacts</td>
<td>1</td>
<td>2,0</td>
</tr>
</tbody>
</table>
4. Main knowledge gaps (7)

- Impacts of time values for existing CBA
  - Case of automatic incident detection : urban motorway (2*3) (Paris region)

<table>
<thead>
<tr>
<th>Impact</th>
<th>Normal time value</th>
<th>5 * normal time value + recovery &lt; buffer time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel time</td>
<td>25,4 %</td>
<td>79,9 %</td>
</tr>
<tr>
<td>Safety</td>
<td>71,2 %</td>
<td>19,2 %</td>
</tr>
<tr>
<td>Environment and energy</td>
<td>3,4 %</td>
<td>0,9 %</td>
</tr>
<tr>
<td>Total impacts</td>
<td>1</td>
<td>2,7</td>
</tr>
</tbody>
</table>
4. Main knowledge gaps (8)

- Impacts of time values for existing CBA
  - Case of traffic management in the Strasbourg area (Gutenberg)

<table>
<thead>
<tr>
<th>Impact</th>
<th>Normal time value</th>
<th>5 * normal time value</th>
<th>5 * normal time value + recovery &lt; buffer time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Impact</strong></td>
<td>% benefits</td>
<td>% benefits</td>
<td>% benefits</td>
</tr>
<tr>
<td>Travel time</td>
<td>41.5%</td>
<td>31.7%</td>
<td>22.8%</td>
</tr>
<tr>
<td>Safety</td>
<td>57.2%</td>
<td>67.3%</td>
<td>76.5%</td>
</tr>
<tr>
<td>Environment + energy</td>
<td>1.4%</td>
<td>1.1%</td>
<td>0.8%</td>
</tr>
<tr>
<td>Total impacts</td>
<td>1</td>
<td>1.3</td>
<td>1.8</td>
</tr>
</tbody>
</table>
4. Main knowledge gaps (9)

- Challenges for time value studies along the scheduling approach
  - Possible explanatory factors
    - Value of instant activities affected (personnal vs business)
    - Occupation
    - Revenue (are unpredictable agendas « marketable » ?)
    - Time of the day (transition activities may have higher costs)
    - Availability of information (on alternative route, modes)
    - Disruption duration
    - Predictability of disruption duration
    - Reproductibility of events (« experience curve »)
4. Main knowledge gaps (10)

- Stated or revealed preferences studies?
  - Stated preferences may be more appropriate to differentiate reliability values among users
  - CBA and modelling are presently based on a revealed preferences approach
    - Explore revealed preferences studies including reliability factors in route / modal choices?
    - Explore on route vehicles tracking in un-reliable events?
4. Main knowledge gaps (11)

- Other knowledge gaps
  - Impact of information on behaviours
    - Existing ex-post evaluation needs to be capitalized
    - Develop simulators-based studies on representative users ?
    - Develop stated preference surveys ?
    - Develop on route vehicles tracking ?
  - Links between fluidity, safety, reliability
    - Existing ex-post evaluation needs to be capitalized
  - Dynamic modelling :
    - Multimodal and macro-scale models
      - (beyond road traffic micro-simulation)
      - Integration of information dependant behaviours
    - Links between dynamic modelling and pollutant emissions
      - e.g. “stop and go” impacts on emissions
Thank you

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