Assessing disruption management strategies in rail-bound urban public transport systems from a passenger perspective

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CASPT
July, 2018
Introduction

- Much interest in minimizing impacts of disturbances
- Current protocols driven from resource perspective
- Seems to be a preference for detouring
- Passenger impact different alternatives unknown
Introduction

• Research question

How can **disrupted operations in rail-bound urban public transport systems be managed**, in order to **minimize total generalized passenger travel time**, **taking into account operational consequences**?

• Scope

  – Infrastructure blockage
  – Detours and short-turning

  → Guidelines detour vs. short-turning

• Case

  – HTM The Hague, the Netherlands
  – Tram network

  – Introduction of bi-directional vehicles
Methodology

Disruption

Alternative generation

Alternatives

Alternative assessment

Assessed alternatives

· Detour alternatives
· Short-turn alternatives
· Total generalized passenger travel time
· Delay destination terminal
Alternative generation

- Graph representation network

- Generation of detours
  - $k$-shortest path algorithm (Yen, 1971)
  - Filtering process

- Generation of short-turn possibilities
  - Model input
Assessment of alternatives

1. **Passenger perspective**
   - Total generalized passenger travel time (TGTT)
     - Historical smartcard data (OV-chipkaart)
     - Different trip elements
   - Assumption passenger behaviour:
     - Stop skipped → Walk or wait

2. **Resource perspective**
   - Delay destination terminal
   - Subsequent activity
Methodology

Disruption

Alternative generation
- Detour alternatives
- Short-turn alternatives

Alternatives

Alternative assessment
- Total generalized passenger travel time
- Delay destination terminal

Assessed alternatives
Case study The Hague

- Discrete event-based simulation (Simio)

- Four hypothetical disruption locations (A-D)
  - Two passenger demand patterns

- One actual disruption (July 15\textsuperscript{th}, 2016)
## Scenario matrix

<table>
<thead>
<tr>
<th>Disruption location A</th>
<th>Generated detouring alternatives</th>
<th>Generated short-turning alternatives</th>
<th>Disruption management protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disruption location B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disruption location C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disruption location D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actual disruption July 15(^{th}), 2016</td>
<td></td>
<td></td>
<td>(+ actual implemented measure)</td>
</tr>
</tbody>
</table>
Case studies [3/8]
Location A – TGTT vs. delay

Morning-peak

Resource delay [minutes / vehicle]

Extra TGTT [hours]

Rest-of-day

Resource delay [minutes / vehicle]

Extra TGTT [hours]
Case studies – results passenger perspective

- Detouring versus short-turning
  - ‘Best’ detour alternative vs. ‘best’ short-turn alternative

<table>
<thead>
<tr>
<th>Location</th>
<th>Morning-peak</th>
<th>Rest-of-day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location A</td>
<td>- 6%</td>
<td>+ 28%</td>
</tr>
<tr>
<td>Location B</td>
<td>+ 15%</td>
<td>- 2%</td>
</tr>
<tr>
<td>Location C</td>
<td>- 29%</td>
<td>- 40%</td>
</tr>
<tr>
<td>Location D</td>
<td>- 80%</td>
<td>- 64%</td>
</tr>
</tbody>
</table>

Detouring yields 6% less TGTT for location A (peak), as compared to short-turning.

Detouring yields 28% more TGTT for location A (rest-of-day), as compared to short-turning.
Difference detour 5 & ST
Passenger demand

Morning-peak

Rest-of-day

Detouring

Short turning
Case studies – results passenger perspective

- Potential savings extra TGTT
  - ‘Best’ alternative vs. current disruption management protocol

<table>
<thead>
<tr>
<th>Location</th>
<th>Morning-peak</th>
<th>Rest-of-day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location A</td>
<td>49%</td>
<td>39%</td>
</tr>
<tr>
<td>Location B</td>
<td>13%</td>
<td>0%</td>
</tr>
<tr>
<td>Location C</td>
<td>41%</td>
<td>41%</td>
</tr>
<tr>
<td>Location D</td>
<td>85%</td>
<td>73%</td>
</tr>
</tbody>
</table>

49% and 39% of the extra TGTT incurred by the protocol can be saved for location A (peak/rest-of-day), by implementing the alternative yielding the lowest TGTT.
Protocol
Findings and conclusions

• Current protocols mainly driven from resource perspective
  → Importance passenger perspective
• Our approach provides insights into passenger impact of measures
• Passenger demand pattern affects impacts detouring and short turning on TGTT

• Detouring vs. short-turning?
Detouring vs. short-turning

- Three variables of main importance:
  - Passengers favoured by detouring vs. passengers favoured by short-turning
  - Detour length
  - Distance short-turning stops
Detouring vs. short-turning

Findings and conclusions

- Ratio through passengers
  - ~ equal
  - high
  - low

- ST length
  - high
  - low

- Detour length
  - high
  - low

- ST
  - high
  - low

- Detour
  - high
  - low

- Detour length
  - high
  - low

- ST depends on
  - high
  - low

- Passage through
  - equal
  - low

Diagram: Node with branches for high and low, indicating relationships between detouring and short-turning.
Recommendations

1. **Applicability framework at HTM**
   - Management of operations process
     - Tactical: Disruption management protocols
     - Real-time: Decision support system
   - Planning process
     - Strategic: Planning additional infrastructure
     - Tactical: Planning of buffer-time in schedules

2. **Extending methodology**
   - Incorporate passenger route choice model: network impacts
Questions / contact

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