Big Data opportunities in public transport:
Enhancing public transport by ITCS

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Introduction

- Intermodal Transport Control Systems
  - Valuable data
  - Evaluating and controlling
  - Predicting and optimizing

- Research agenda
  - Optimizing public transport
  - Network, timetables and operations
  - Three key aspects:
    - Vehicle -> Passengers
    - Trip -> journey
    - Costs -> benefits
  - Data driven research
Big Data

- Different types and sources
- Bluetooth, Wifi, GSM
- Social media
- Signalling, vehicles
- Focus research: passengers and vehicles
Big Data

**GSM data; tracking travellers**
- Potential public transport services

**Vehicle data (AVL); tracking vehicles**
- Evaluating and optimizing performance

**Passenger data (APC); tracking passengers**
- Evaluating and optimizing ridership and passengers flows

**Combining data sources (APC and AVL)**
- Service reliability from a passenger perspective

ICTS provide these data
The potential benefits

Optimizing network and timetable design:

**The Netherlands:**
Potential cost savings: > €50 million

- **Utrecht:** € 400,000 less yearly operational costs
- **The Hague:** 5-15% increased ridership
- **Amsterdam:** ~10% increased cost coverage
- **Tram Maastricht:** > €4 Million /year social benefits
- **Tram Utrecht:** : €200 Million social benefits
The challenge

Data → Information → Knowledge → Improvements
Applied examples

- Monitoring and predicting passenger numbers: What if
- Benefits of enhanced service reliability

- Optimizing planning and real time control
  Van Oort, N. and R. van Nes (2009), Control of public transport operations to improve reliability: theory and practice, Transportation research record, No. 2112, pp. 70-76.

- Optimizing synchronization multimodal transfers
  Lee, A. N. van Oort, R. van Nes (2014), Service reliability in a network context: impacts of synchronizing schedules in long headway services, TRB

- Improved scheduling
Passenger data

Connecting to transport model:
• Evaluating history
• Predicting the future
• Elasticity approach (quick and low cost)

• Whatif scenario’s
  • Stops: removing or adding
  • Faster and higher frequencies
  • Route changes

• Quick insights into
  • Expected cost coverage
  • Expected occupancy
Challenge the future

fictitious data
Whatif results: Flows rerouting
Whatif results: Flows increased frequencies
Cost Benefit Analysis
Transformation crowded bus line into tram line
Cost Benefit analysis required

CBA > 1,0

YES  NO

+  

[Images of a train and a bus]
Approach

- Forecasting operations (historical vehicle data)
- Forecasting future ridership (historical passenger data and transport model)
- Using algorithms PhD to calculate service reliability effects in Euros (based on AVL and APC data)
- Expressing expected impacts in Euros

- Service reliability effects are about 60% of all benefits!
- Ministry supported project!
Three step approach

- AVL data
- APC data
- Reliability ratio

- Vehicle performance
  - Schedule adherence
- Passenger impacts
  - Additional travel time and variance
- Travel time impacts
  - Additional travel time and variance in travel time units

Transport model
Step 1: vehicle performance

Van Oort et. al (2013) Optimizing public transport planning and operations using AVL data: The Dutch Example
Step 2: passenger impacts

Van Oort (2011) Service reliability and urban public transport design
Step 3: translation into travel time units

Values of time and reliability

<table>
<thead>
<tr>
<th>Reismotief</th>
<th>VoT</th>
<th>VoR</th>
<th>Reliability Ratio</th>
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<tr>
<td>Woon-werk</td>
<td>7,75</td>
<td>3,25</td>
<td>0,4</td>
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<tr>
<td>Zakelijk</td>
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<td>1,1</td>
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<td>Overig</td>
<td>6,00</td>
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<tr>
<td>Gemiddeld (*)</td>
<td>6,75</td>
<td>3,75</td>
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</tr>
</tbody>
</table>

Bus/ Tram/ Metro (in euro’s per persoon per uur, marktprijzen, prijspeil 2010)

KiM (2013) De maatschappelijke waarde van kortere en betrouwbaardere reistijden (in Dutch)
Summary

• Big data enables optimization of public transport
• ITCS provide valuable data
• Evaluating and controlling -> predicting and optimizing
• Data-> Information -> Knowledge -> Improvements

• Three paradigm shifts:
  • Vehicle -> Passengers
  • Trip -> journey
  • Costs -> benefits

• Two applied examples
  • Passenger data and whatif analysis
  • Cost benefit analysis

• ITCS can make the difference!
Questions / Contact

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Research papers:
https://nielsvanoort.weblog.tudelft.nl/