Acces and egress of public transport

Bicycle and transit

dr. ir. Danique Ton

dr. ir. N. van Oort

5825 Advanced Public Transport Operations and Modelling
Access and egress / first and last mile
Modelling

• Mode choice (PT main part)

• Mode choice (access and egress)

• Station choice (origin and destination)
  • Time depending
  • Bicycle depending
Challenge the future
Stated preference first/last mile station Delft Campus

Torabi et al. 2019
• Demand responsive transport
• Autonomous shuttles
Usage and familiarity

Arendsen (2019)
The bicycle and transit mode
Minister Van Veldhoven: “We hebben meer fiets, meer OV en meer brains nodig”

Fietsparkeercongres 2019
Combining best of both worlds

[Kager et al. (2016), Shelat et al. (2017)]
Potential Bicycle and Transit

- Improving access and egress
- Improving door to door mobility
- Enhanced Public transport design
Network design dilemma

Many stops
Short access, long in-vehicle time

Few stops
Long access, short in-vehicle time
Benefits of station access by bicycle

- substantially less expensive (than car based access)
- smaller parking footprint

- $40,000 (25,000 Euro) per car space
- $4,000 (2,400 Euro) per bicycle stored
- $1,000 (600 Euro) per bicycle stored

26 bicycles
Challenges
Research objectives

Increasing modal share of sustainable transport (door-door)

1 To understand the bike and transit combination
   - Benefits
   - Users
   - Behaviour
   - Potential

2 To design optimal bike and transit transport
   - Routes, parking
   - Transit networks
   - Sharing facilities
   - Integrated design
Research and design cycle

Observing and analyzing
- Data
- Surveys
- Trends
- Pilots

(Re)design
- System
- Networks
- Control

Understanding
- Theory and models

What if?
- Models and tools

Challenge the future
Modal share

- Netherlands
- Copenhagen
- Munich
- UK

Share of bicycle as access mode to transit (%)

<table>
<thead>
<tr>
<th>Location</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Netherlands</td>
<td>30%</td>
</tr>
<tr>
<td>Copenhagen</td>
<td>25%</td>
</tr>
<tr>
<td>Munich</td>
<td>15%</td>
</tr>
<tr>
<td>UK</td>
<td>5%</td>
</tr>
</tbody>
</table>
Melbourne

By bicycle
By bus
By car as a passenger
By car as the driver
Walk

Geoff Rose (2019)
Potential market for cycling as an access mode (Melbourne)

- 71% can ride a bicycle
- 57% have access to a private bicycle
- 43% interested if better cycling infrastructure was connected to the station
- 35% willing to use a public share bike to access station

Geoff Rose (2019)
Trips NL

- Car (driver): 32%
- Car (passenger): 21%
- Bike: 3%
- Train: 2%
- Bus, tram, metro: 15%
- Other: 27%

KM's NL

- Car (driver): 50%
- Car (passenger): 22%
- Bike: 9%
- Train: 9%
- Bus, tram, metro: 7%
- Other: 3%
Factors

- Think of 1 positive and 1 negative factor affecting the bicycle+transit combination
- Example from birth country
- Teams of 2 or 3
39 FACTORS IN 8 GROUPS

1. Culture & attitudes towards cycling and rail
2. Characteristics cycle-rail users
3. Rail system
4. Train journey
5. Station typology
6. Region’s bikeability
7. Bicycle journey
8. Competition other modes

Van Mil, J.F. et al. (2018), Insights into factors affecting the combined bicycle transit Mode, CASPT conference, Brisbane
### Factors (1/3)

<table>
<thead>
<tr>
<th>FACTOR</th>
<th>INFLUENCE ON CYCLE-RAIL USE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culture &amp; Attitude</td>
<td></td>
</tr>
<tr>
<td>local and national transport policy</td>
<td>depends</td>
</tr>
<tr>
<td>high level of cycling</td>
<td>++</td>
</tr>
<tr>
<td>high level of rail use</td>
<td>++</td>
</tr>
<tr>
<td>positive attitude towards cycling</td>
<td>+</td>
</tr>
<tr>
<td>positive attitude towards rail</td>
<td>+</td>
</tr>
<tr>
<td>low perception of barriers</td>
<td>+</td>
</tr>
<tr>
<td>car as status symbol</td>
<td>-</td>
</tr>
<tr>
<td><strong>User Characteristics</strong></td>
<td></td>
</tr>
<tr>
<td>higher level of education</td>
<td>depends</td>
</tr>
<tr>
<td>many 20-39 year olds</td>
<td>depends</td>
</tr>
<tr>
<td>high number of students</td>
<td>++</td>
</tr>
<tr>
<td>high levels of employment</td>
<td>+</td>
</tr>
<tr>
<td>high share of males</td>
<td>+</td>
</tr>
<tr>
<td>share of mid/high income</td>
<td>+</td>
</tr>
<tr>
<td>high number of frequent rail travellers</td>
<td>+</td>
</tr>
<tr>
<td>many people able to cycle</td>
<td>+</td>
</tr>
<tr>
<td>large households</td>
<td>-</td>
</tr>
<tr>
<td>many travellers with heavy luggage</td>
<td>-</td>
</tr>
<tr>
<td>wearing smart clothes</td>
<td>-</td>
</tr>
<tr>
<td><strong>Competition other modes</strong></td>
<td></td>
</tr>
<tr>
<td>trip distance first/last mile 1 - 3.5 km</td>
<td>++</td>
</tr>
<tr>
<td>much congestion for cars</td>
<td>+</td>
</tr>
<tr>
<td>good BTM network</td>
<td>-</td>
</tr>
<tr>
<td>high car ownership</td>
<td>--</td>
</tr>
<tr>
<td>inexpensive BTM travel</td>
<td>--</td>
</tr>
</tbody>
</table>
Factors (2/3)

<table>
<thead>
<tr>
<th>FACTOR</th>
<th>INFLUENCE ON CYCLE-RAIL USE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rail System</td>
<td></td>
</tr>
<tr>
<td>high (service) level of train</td>
<td>+</td>
</tr>
<tr>
<td>large distance between stations</td>
<td>+</td>
</tr>
<tr>
<td>high train frequency</td>
<td>+</td>
</tr>
<tr>
<td>Rail Journey</td>
<td></td>
</tr>
<tr>
<td>trips of 20min+</td>
<td>+</td>
</tr>
<tr>
<td>no other transfers required</td>
<td>+</td>
</tr>
<tr>
<td>Station Typology</td>
<td></td>
</tr>
<tr>
<td>close to production-zones (e.g. dwellings)</td>
<td>++</td>
</tr>
<tr>
<td>terminal station</td>
<td>+</td>
</tr>
<tr>
<td>station category urban medium / rural small-sized</td>
<td>+</td>
</tr>
<tr>
<td>close to attraction-zones (e.g. university)</td>
<td>+</td>
</tr>
</tbody>
</table>
Factors (3/3)

<table>
<thead>
<tr>
<th>FACTOR</th>
<th>INFLUENCE ON CYCLE-RAIL USE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regions bike ability</td>
<td></td>
</tr>
<tr>
<td>early sunset</td>
<td>0 / -</td>
</tr>
<tr>
<td>long winters</td>
<td>-</td>
</tr>
<tr>
<td>hilly</td>
<td>-</td>
</tr>
<tr>
<td>low temperatures</td>
<td>-</td>
</tr>
<tr>
<td>rainy weather</td>
<td>--</td>
</tr>
<tr>
<td><strong>Bicycle Journey</strong></td>
<td></td>
</tr>
<tr>
<td>small distance between station and cycle highway</td>
<td>++</td>
</tr>
<tr>
<td>good quality of cycling lanes</td>
<td>+</td>
</tr>
<tr>
<td>high quantity of cycling lanes</td>
<td>+</td>
</tr>
<tr>
<td>often right of way</td>
<td>+</td>
</tr>
<tr>
<td>large number of other cyclists / bicycle lane volume</td>
<td>+</td>
</tr>
<tr>
<td>direct cycle routes to station (directness)</td>
<td>+</td>
</tr>
<tr>
<td>high levels of safety</td>
<td>+</td>
</tr>
<tr>
<td>good route knowledge</td>
<td>+</td>
</tr>
<tr>
<td>high bicycle ownership</td>
<td>+</td>
</tr>
<tr>
<td>good storage facilities at/near home</td>
<td>+</td>
</tr>
</tbody>
</table>
Users

Catchment areas

Impact of PT quality on catchment areas

Brand, J., et al. (2017), Modelling Multimodal Transit Networks; Integration of bus networks with walking and cycling, MT-ITS Conference Napoli.
Reasons not to cycle?

Rijsman et al. (2019)
Station choice
Reasons to choose a further stop

- Avoid transfer
- Closest stop doesn't offer this mode
- Avoid waiting by walking
- Stop better accessible
- Avoid detour
- Like to walk
- Visit another location
- Travel together
- Save money
- Reduce total travel time
- Other

Rijssman (2018)
Factors that have the most influence

The five strongest factors are used for the choice experiment:

- *Bicycle travel time*
- *Train travel time*
- *Transfer time (time needed to park a bike and walk to the platform)*
- *Directness (number of transfers in train trip)*
- *Costs of bicycle parking*
Impact of factors – *Choice experiment*

269 respondents

Van Mil, J.F. et al. (2018), *Insights into factors affecting the combined bicycle transit Mode*, CASPT conference, Brisbane
Transfer
Shared bikes
Challenge the future

[Boor et al. (2019)]
> 1600 schemes operating
391 others are under construction in more than 50 countries

Van Waes et al. 2018
4 generations of bike sharing

1st generation
- 1965, in Amsterdam: White Bikes
- Regular bikes
- Free
- The program collapsed within days.

2nd generation
- 1991-1993 Denmark
- Specially designed for intense utilitarian use with solid rubber tires and wheels with advertising plates,
- Coin deposit.
4 generations of bike sharing

3rd generation

- Bikeabout 1996, Portsmouth University, England
- Magnetic stripe card
- Variety of technological improvements:
  - Electronically-locking racks or bike locks
  - Telecommunication systems
  - Smartcards
  - Mobile phone access
  - On-board computers.

- 2003: Velo’v: 1,500 bikes in Lyon
- 2007: Paris Vélib: 7,000 bikes -> 23,600 bikes

- New programs in Brazil, Chile, China, New Zealand, South Korea, Taiwan, and the U.S
4 generations of bike sharing

4th generation

- Dockless bikes
- 2008-2013: China, Germany, US,

- 2015: Ofo and Mobike, China.
  Integration of mobile payment and GPS tracking technology
- 2017: Obike, Singapore
  LimeBike, United States
  Gobee Bike, Hong Kong
OV Fiets (PT-Bike)

- Started in 2003
- Docked system
- 2003: 800 Bikes ; 100,000 trips
- 2017: 14,500 bikes ; 3,200,000 trips
- 3.2 million trips in 2017
- 300 locations in NL
Challenge the future


En dus... (2016)
En dus... (2017)

En dus... (2018)

Waar zouden we zijn zonder de fiets en de trein?

De populariteit van de OV-Fiets blijft enorm toenemen. Dit jaar zijn er tot 1 oktober al ruim 3 miljoen ritten gemaakt. Dat is een stijging van zo’n 33% ten opzichte van dezelfde periode vorig jaar. Om de groei te kunnen blijven faciliteren wordt het aantal fietsen de komende maanden fors uitgebreid. Er komen in totaal 6.000 fietsen bij.

Stormachtige groei

Bike sharing China

- 2005: Started in Beijing

- 2008: first dockless bike sharing system in Hangzhou with 2800 bikes

- 2016: > 400 cities operating docked bike-sharing  
  > 890,000 bikes in 32,000 stations 
  > 20,000,000 users.

- 2017: 23 million dockless shared bikes  
  50 million orders per day 
  >106 million registered users
Pros and cons
Modal shift?

(a) Modal Shift as a result of Mobike
Future: 5th generation?

Peer-peer bike sharing

$S \quad D \quad D \quad S$

$t_{s1} \quad t_{min} \quad t_{d1} \quad t_{d2} \quad t_{max} \quad t_{s2}$

5-20% reduction

Correia et al. (2018)
Conclusions

- Bike and PT combines benefits of both
- Potential to improve door to door services
- Potential for enhanced quality and efficiency of PT

- Relatively new research area
- Many knowledge gaps

- Challenging: data acquisition and analysis

- To do: Part 2: (Improving) integrated design -> models to support design
Reading material

**Basic: Brightspace**


**Additional: Brightspace**

Brand, J., N. van Oort, B. Schalkwijk, S. Hoogendoorn (2017), Modelling Multimodal Transit Networks; Integration of bus networks with walking and cycling, MT-ITS Conference Napoli.

Correia et al. (2018), Potential of peer-to-peer bike sharing for relieving bike parking capacity problems at railway stations


Ma, X, Y. Yuan, N. van Oort, S. Hoogendoorn (2020), Investigating Impact of Bike-sharing Systems on Modal Shift: A Case Study in Delft, the Netherlands, *Journal of cleaner production*

Rijsman et al. (2019). Walking and bicycle catchment areas of tram stops: factors and insights. *MT-ITS conference*
Questions / Contact

More publications:
http://nielsvanoort.weblog.tudelft.nl/

www.smartPTlab.tudelft.nl

N.vanOort@TUDelft.nl

D.Ton@TUDelft.nl