Preferred citation style

Social networks and their travel impacts

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Research support by

- ETH Zürich
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- NRF, Singapore
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Why social networks in transport/spatial planning?
A shrinking world

Steam ship and locomotive, 1840 - 1930

Propeller aircraft, 1930-1950

Jets, from 1950

Coach and sailing boat until 1840

Dicken, 1998
In-commuter sheds of the ten largest Swiss towns

Nach Botte, 2003
Example: Number of accompanying travellers

- Short vacation
- Excursion: nature
- Other
- Excursion: culture
- Meeting friends
- Further education (leisure)
- Garden/ cottage
- Voluntary work
- Disco, pub, restaurant, cinema
- Meeting relatives/family
- Window shopping
- Pick up/drop off/attendance
- Group/club meeting
- Family duty
- Cemetery
- Active sports
- Education
- Long-term shopping
- Walk or stroll
- Daily shopping
- Private business
- Private business (doctor,...)
- Work

Mean

- Household members travelling along
- Other persons travelling along
- Dog travelling along

Axhausen et al., 2007
Example: Required travel for meetings of ego-alter

Distance between home locations [km]

Percent [%]

Important contact

No
Yes

Schlich et al., 2002
Example: Residential location choice in Kt. Zürich

<table>
<thead>
<tr>
<th>Variable</th>
<th>Beta</th>
<th>t-Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rent/Income</td>
<td>-5.51</td>
<td>***</td>
</tr>
<tr>
<td>log(m2/head)</td>
<td>0.98</td>
<td>***</td>
</tr>
<tr>
<td><strong>Frequency weighted mean distance to friends</strong></td>
<td>-8.16</td>
<td>*</td>
</tr>
<tr>
<td><strong>Exponent (friends)</strong></td>
<td>0.22</td>
<td>**</td>
</tr>
<tr>
<td>Mean distance to work/school</td>
<td>-1.59</td>
<td>**</td>
</tr>
<tr>
<td><strong>Exponent (distance to work)</strong></td>
<td>0.37</td>
<td>**</td>
</tr>
<tr>
<td>Travel time to Bürkliplatz</td>
<td>0.02</td>
<td>**</td>
</tr>
<tr>
<td>log(transit accessibility) * &quot;No car&quot;</td>
<td>0.41</td>
<td>**</td>
</tr>
<tr>
<td>log(car accessibility) * “Car”</td>
<td>-0.30</td>
<td>**</td>
</tr>
<tr>
<td>Share of equally sized HH within 1 km</td>
<td>0.02</td>
<td>*</td>
</tr>
<tr>
<td>Population density within 1 km</td>
<td>0.01</td>
<td>**</td>
</tr>
<tr>
<td>Share of empty flats in municipality</td>
<td>-0.11</td>
<td></td>
</tr>
</tbody>
</table>

N = 683, $\rho^2 = 0.2128; * > 0.1; ** > 0.05; *** > 0.01
Travel and social networks
Definition of a social network

The topology of a social network describes

• Which person/firm (node) is linked to which other persons/firms
• By contacts (links) of a certain quality (impedance or cost)

Closeness $\sim \frac{1}{\text{Impedance}}$
Position: Person as a network member

Individual

„contacts“

Household members
Position: Person as a member of multiple networks
Social capital?
“In economics, capital goods, real capital, or capital assets are already-produced durable goods or any non-financial asset that is used in production of goods or services”

As a durable good it requires:

- On-going maintenance
- Security against theft, vandalism and natural threats
- Savings or creditworthiness for its replacement when not productive enough anymore
Other forms of capital stipulated

Human capital:

**Individual skills** acquired and maintained to live a good life; and especially to work with a particular set of skills productively

(Non-social) Social capital:

- Access to resources beyond market exchange
  - What about patronage?
  - What about duties to family?
- Granovetter/Burt: Control over information flows/access to the people with that control
- Putnam: Non-personal level of trust jointly produced in a society
Individual in its biographical context

Personal world

Biography

Learning

Projects
Social capital as a joint skill

Personal worlds of others

Social capital: Stock of joint abilities
Reciprocal trust

Personal world

Projects

Activity space
Social network geography
Mobility tools

Learning

Biography
Example of a mobility biography (UK architect)

Larsen, Urry and Axhausen, 2006
Example of a local activity space

Female, 24
Full time
Single
216 trips / 6 weeks
Example of a social network geography
Again, why worry about social capital, networks in transport?
Maintenance of the social capital and the networks, in which it is embedded, requires:

- Face to face interaction
- Balanced by other forms of interaction
- Travel ~ Physical spread of the contacts
- Trade-off between loosing contacts and social capital and investing in new contacts closer to home
Starting point

The members influence each other:

- Sharing knowledge about place & activity combination
- Sharing resources, e.g. vehicles, money
- Making slots in activities available
- Developing joint activities
- Developing joint attitudes
- Constraining activities through ‘coupling constraints’
Setting the benchmark
First set of research issues

Benchmarking the current state:

- Numbers of contacts
- Distance distributions
- Geographies
- Frequency and mode of contact
- Productivity
- Levels of local anomie
- Levels of local trust
- Level of place attachment
Empirical strategy

- Surveys of social geographies & mobility biographies
  - Egocentric
  - Snowball

- Travel diaries
  - One-Day
  - Multiple days

- With/without information about the presence of others
- With/without named co-travellers, co-present persons
Social network surveys @ IVT

• Ohnmacht: 50 egos qualitative/quantitative in Zürich

• Larsen/Urry: 24 egos qualitative/quantitative in NE England

• Frei: 300 egos quantitative in Zürich

• Kowald: snowball; 750 egos quantitative worldwide (with core in Kanton Zürich) (8 day diary included)

• Guidon (2017) Egocentric networks and trust
Number of contacts reported

![Histogram showing the distribution of the number of contacts reported.](image)

- **Number of contacts reported**
- **Bars show percents**

- **Percent**:
  - 2%
  - 4%
  - 6%
  - 8%
  - 10%

- **Number of contacts named**:
  - 0
  - 10
  - 20
  - 30
  - 40
  - 50

Frei and Axhausen, 2007
Distances between home locations

Frequency

Great circle distance [km]

Frei and Axhausen, 2007
Size of network geometries

95%-confidence ellipse of the social network geography

Frei and Axhausen, 2007
Ratio of contacts to population

Ratios at 1km: 39; 2km: 9; 3km: 5

Share of contacts [%]
Share of population [%]
Ratio of contact and population shares

Frei and Axhausen, 2007
Interactions by mode and distance between homes

Faceto-face visits/year
Phone calls/year
Email messages/year
SMS messages/year

Great circle distance (km)

Frei and Axhausen, 2007
2010/11 Snowball survey
Challenges of snowball sampling

Challenges:

• Start with representative seeds
• Avoid selection bias
• React to homogeneous clusters
• Correct the overrepresentation of 'socializers' and underrepresentation of 'isolates'
Behind egos’ horizons: The connected ‘snowball’-graph

<table>
<thead>
<tr>
<th></th>
<th>Vertices</th>
<th>Edges</th>
<th>Density</th>
<th>Components</th>
<th>Triangles</th>
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<tbody>
<tr>
<td>Without sociogram</td>
<td>6'584</td>
<td>7'349</td>
<td>0.000</td>
<td>19</td>
<td>0.017</td>
</tr>
<tr>
<td>With sociogram</td>
<td>6'584</td>
<td>32'671</td>
<td>0.002</td>
<td>19</td>
<td>0.518</td>
</tr>
</tbody>
</table>

Kowald and Axhausen, 2011
### Personal networks (of egos with sociogram)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>1st qu.</th>
<th>Median</th>
<th>3rd qu.</th>
<th>St.-dev.</th>
<th>Range</th>
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</thead>
<tbody>
<tr>
<td>Number of alters</td>
<td>21.5</td>
<td>13.5</td>
<td>20.0</td>
<td>29.0</td>
<td>10.1</td>
<td>38.0</td>
</tr>
<tr>
<td>Number of relations</td>
<td>46.4</td>
<td>10.0</td>
<td>23.0</td>
<td>56.5</td>
<td>61.0</td>
<td>398.0</td>
</tr>
<tr>
<td>Isolates</td>
<td>6.7</td>
<td>2.0</td>
<td>5.0</td>
<td>10.0</td>
<td>6.1</td>
<td>33.0</td>
</tr>
<tr>
<td>Cliques</td>
<td>4.2</td>
<td>2.0</td>
<td>4.0</td>
<td>5.0</td>
<td>2.7</td>
<td>19.0</td>
</tr>
<tr>
<td>Components (w/o isolates)</td>
<td>2.6</td>
<td>1.0</td>
<td>2.0</td>
<td>3.0</td>
<td>1.5</td>
<td>8.0</td>
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<tr>
<td>Centralization</td>
<td>0.2</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>0.2</td>
<td>1.0</td>
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<tr>
<td>Betweenness</td>
<td>0.1</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Kowald and Axhausen, 2011
Comparisons
Transport motivated social network surveys

East York, Ontario (Wellman, Carrasco et al.)

Eindhoven, Netherlands (Arentze, Van der Berg)

Concepcion, Chile (Carrasco)

City of Zürich (Frei)

Kanton Zürich snowball (Kowald)

Singapore (Tan, Chua)
### Great circle distances between ego and alter diads

<table>
<thead>
<tr>
<th>Location</th>
<th>Median</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concepcion</td>
<td>4.9 km</td>
<td>223 km</td>
</tr>
<tr>
<td>Singapore</td>
<td>6.5 km</td>
<td>510 km</td>
</tr>
<tr>
<td>Switzerland (Snowball)</td>
<td>8.9 km</td>
<td>106 km</td>
</tr>
<tr>
<td>Zurich</td>
<td>9 km</td>
<td>287 km</td>
</tr>
<tr>
<td>Eindhoven</td>
<td>10 km</td>
<td>153 km</td>
</tr>
<tr>
<td>Toronto</td>
<td>11.2 km</td>
<td>1036 km</td>
</tr>
</tbody>
</table>
Contact “density” – shares by distance class
Shares of contact by mode

**Face-to-face**

**Telephone**

**Internet**

- **Zurich**
- **Eindhoven**
- **Switzerland**
- **Concepcion**
Low level networks as a building block
Tuesday
... the weekly summary
A small world network in Singapore‘s busses

- One component by Wednesday
- Diameter: 6
- Characteristic path length: 2.95
  - (random: 2.63)
- Average clustering coefficient: 0.19
  - (random: 4.5x10^{-4})
- Small-world
A small world network in Singapore’s busses, but uneven

![Diagram showing median degrees in quintiles]

Median of y coordinate

- <= 267.00
- 267.01 - 350.50
- 350.51 - 415.00
- 415.01 - 477.00
- 477.01+

Median of x coordinate
How to use this?
Example: Improve impact assessment

Video available at http://www.vimeo.com/24822377
Next steps

• Generation of social networks for the synthetic population (See Arentze et al., 2011, Dubernet and Axhausen, 2016)
• New models of joint scheduling

• Measurement of local trust (See e.g. Rick Grannis) (Guidon, Wicki, Bernauer, Axhausen, Ongoing)
Policy implications
Expected impacts: localised anomie

Reduced number and intensity of local contacts should reduce the local level of trust:

- Growing investment into safeguarding the person and the home
- Reduced exposure to risk during travel, i.e. less travel by public transport, cycling and walking
Expected impacts: Improved welfare

The social networks should be more homogeneous and therefore more productive for their members.

But, the selectivity excludes the „less attractive“ persons who are disadvantaged through a reduced ability to travel or a reduced ability to participate in activities.
When will the marginal benefits become zero?

.... the localised anomie stresses the other mechanism of social inclusion too strongly

.... the costs of private protection become too high

.... the environmental impacts become too threatening

.... the trend in the costs of travel changes
Back to the future?
Questions?

www.ivt.ethz.ch


Literature and references


What next?