Pedestrian and transit accessibility on a micro-level: results & challenges

WSTLUR
Delft, the Netherlands

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# Accessibility

<table>
<thead>
<tr>
<th>Four components</th>
<th>Translated in five measures</th>
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</thead>
<tbody>
<tr>
<td>Land-use component</td>
<td>Spatial separation</td>
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<td>Transportation component</td>
<td>Cumulative opportunities</td>
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<td>Temporal component</td>
<td>Gravity measures</td>
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<td>Individual component</td>
<td>Utility measures</td>
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<td>Time / space measures</td>
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</tbody>
</table>
Accessibility on a zonal level
But..... A high diversity within a zone
Accessibility from anywhere to everywhere
Calculating object-fine accessibility
Calculating object-fine accessibility

Pedestrian accessibility

Public transport accessibility
Pedestrian accessibility

Calculation

origin building (location) O to all
destination buildings (location) D
within radius R.

Requirements

Activity locations
Opportunities available at building D
Costs of traveling from O to D
Distance or opportunity decay
Public transport accessibility

**Calculation**
- origin building (location) $O$ to all
- via public transport stop $T$ within
- distance $R$ to destination buildings
- (location) $D$ in region of interest

**Requirements**
- Activity locations
- Opportunities available at building $D$
- Costs of traveling from $O$ to $T$ / $D$ to $T$
- Costs of traveling from $T$ to all $T$
- Impedance
Study area & data
Singapore

Land area of 712 km² (2010; 697 km², 2000)

Total population 5.08 million (2010; 4.03 million, 2000)

GDP per capita amounts to S$ 59,813 (US$ 45,200, 2010),

Vehicle ownership 392,961 in 2000 to 597,746 in 2010,

Or 1 car per 10 households in 2004 to 1 car per 8.8 households in 2008 (Choi & Toh, 2010).
Pedestrian network
Pedestrian network

Data sources
- Road centrelines
- Lanemarkings
- Overheadbridges
- Underpasses
- Building addresses
- Building centroids
- Bus stops
- Train station entrances and platform location
Pedestrian network

Source data:
Centreline (Category B), overhead bridges

Network generation:
Sidewalks created on both sides of road, length determined by offset width (5 meters).
Crossing at overhead bridge
Pedestrian network

Source data
Lane marking

Network generation
Crossing, length determined by offset width
(5 meters)
Pedestrian network

Source data
Centreline Category C

Network generation
Sidewalks
Pedestrian network

Source data
Centreline Category E

Network generation
No sidewalks
Pedestrian network

Source data

Legend
- MRT stations
- Bus stops
- Building footprints
- Overheadbridge / Underpass
- Lanemarking
- Road centrelines

Pedestrian network

Legend
- MRT station
- Bus stop
- Building footprint
- Pedestrian network with offset sidewalks
Travel times
Travel times

MATSim Singapore (agent-based transport demand simulation)

1 million agents, > 4000 transit stops, > 400 bus lines, 4 MRT lines

Average link travel times per 15 minutes are calculated

Shortest transit route in each 15 minutes interval between each transit stop

Median travel time between 7am and 9:30 am is used.
Activity locations
Work locations

Accessibility calculation

Pedestrian accessibility
Calculation of shortest route to all buildings within **1000 meter radius**. Impedance factor of -0.2.

Public transit accessibility
Select transit stops within **700 meters** of origin building & destination building. Determine shortest total travel time combination of walking time and transit time. Impedance factor of -0.2.

\[ A_i = \sum_{j=1}^{n} d_j \exp(\alpha t_{ij}) \]
Study area
## Results

<table>
<thead>
<tr>
<th>Planning zone</th>
<th>Walk accessibility to jobs</th>
<th>Transit accessibility to jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Euclidean</td>
<td>Centreline Offset</td>
</tr>
<tr>
<td>Downtown Core</td>
<td>27,182</td>
<td>11,583</td>
</tr>
<tr>
<td>Museum</td>
<td>13,764</td>
<td>4,104</td>
</tr>
<tr>
<td>Newton</td>
<td>11,242</td>
<td>2,791</td>
</tr>
<tr>
<td>Orchard</td>
<td>15,566</td>
<td>6,484</td>
</tr>
<tr>
<td>River Valley</td>
<td>8,844</td>
<td>1,847</td>
</tr>
</tbody>
</table>
Downtown pedestrian accessibility - Euclidean
Downtown pedestrian accessibility - network
Distance to transit with different networks

![Bar chart showing distance to transit with different networks (Euclidean and Offset) for different distances in meters. The chart compares the number of buildings within a certain distance from transit points, categorized by type of transit (Bus, MRT, LRT). The percentages indicate the proportion of buildings within each distance category.]
Downtown transit accessibility - Euclidean
Downtown transit accessibility - network

Legend
Transit accessibility with offset distances
- 0 - 10000
- 10000 - 20000
- 20000 - 30000
- 30000 - 40000
- 40000 - 50000
- 50000 - 60000
- 60000 - 70000
- 70000 - 80000
- > 80000

0  1000  2000 m
Data issues.....

Missing crossings

Matching buildings to the road network
Outlook

OSM pedestrian network
Differentiated transit stop selection
Generalized link costs for pedestrians

Realistic transit travel times in generalized format (GTFS)

Destination similarity
Destination competition
Directional similarity
Multiple types of opportunities
Outlook

Different types of measures

Compare network quality based on different measures

Visualization

Calculation

Incorporation in hedonic pricing and choice models
Questions

The research conducted at the Future Cities Laboratory is funded by the Singaporean National Research Fund (NRF) and the ETH Zurich. We wish to express our gratitude to the Land Transport Authority for providing us data sets on land transport in Singapore. Also we are very thankful to the Singapore Land Authority for providing us with a wide range of data sets.
Literature


Routable road network – 500m max distance
Simple pedestrian network – distance 500m
Offset network – distance 500m
Offset network with overhead bridges