Planning for Sustainable Accessibility

Carey Curtis
Curtin University, Australia
“Access is what cities are all about. Man invented cities as an economic and social tool to create easy accessibility through co-location” (Schaeffer and Sclar, 1975, p.2)

Cities worldwide - interest in a more coordinated approach to growth management → sustainable urban form → sustainable transport outcomes.

A popular planning strategy → public transport oriented development (PTOD), more commonly referred to as transit oriented development (TOD)

→ need to consider both land use planning and transport planning in an integrated way

→ city planning framed around public transport
   → address both the form and structure of the city and
   → quality of the public transport network to ensure each are mutually supportive and provide for improved accessibility.
We need to distinguish between these terms...

**Accessibility**

The ease and convenience of reaching some destination

Measured by:
- Number of people with access to certain facilities;
- Access to the transport system itself

**Mobility**

Reflects the travel needs and behaviour of individuals and businesses

Measured by:
- Vehicle kilometres travelled
- Traffic speed

My belief is we should focus on accessibility – who gets access and how… rather than simply how much travel is made and how fast
Sustainable Accessibility?
Achieving movement (travel) through accessibility rather than mobility
"A sustainable transport system is one that:

- Allows the basic access and development needs of individuals, companies and societies to be met safely and in a manner consistent with human and eco-system health, and promotes equity between successive generations…

(Centre for Sustainable Transportation, 2002).
Is affordable, operates fairly and efficiently, offers a choice of transport mode, and supports a competitive economy, as well as balanced regional development...
- Limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and uses non-renewable resources at or below the rates of development of renewable substitutes, while minimising the impact on the use of land and the generation of noise"
The New Realism

- Goodwin et al, 1991 – the package approach:
  - improvements to public transport;
  - traffic calming;
  - provision for cyclists and pedestrians;
  - traffic management to maximise the efficiency of the existing road network;
  - road pricing;
  - using land use and urban form to manage transport demand; and
  - providing minimal or no increases to road capacity.
Land use transport integration emerges as the solution (the birth of sustainable accessibility?)

- UK – 1984 - PPG13 : Transport a critical point where transport planning seen as an integral part of the land use planning process.
- Planning policy on:
  - location, scale, density, design and mix of land uses with the aims of reducing the need to travel, reducing journey lengths and making it easier for people to walk, cycle and use public transport.
Australia

- Better Cities – 1992-1996:
  - urban consolidation
  - Mixed use higher density devt. at transit nodes
...what is sustainable transport?

Planning for all modes of transport – but dominant mode is not private car

Integrating transport planning with land use planning

Multi-Scalar – from city wide to street-cross section design

Walking
Cycling
Public Transport
Car

Hardware, software, people (behaviour change)
Using an accessibility tool to capture the strategic transport and land use choices for the city
Reality check...

>100 activity centres (defined by non-home based trip destinations)

Some planned but many ‘unplanned’

Possibility of supplying high frequency PT system to serve all centres is a significant and expensive challenge

Starting point – Perth – ‘polka dot city’
Metroplan 1990

- Centres defined and controlled only by retail floorspace targets
- 8 Strategic centres, 14 regional centres
- Not all (100+) centres recognised as centres in plans
- ‘Lip service’ paid to LUPTI
  - No practice of considering access to centres by PT
  - PT aim was social welfare – minimum service levels not a real alternative to car
new policy context

- Mode Share Target by trips (1995)

...targets imply that public transport patronage needs to grow four-fold between 2000 and 2030...
Network City spatial framework

- did not determine which centres should perform which role within the goal of sustainable accessibility
- demanded a multi-dimensional perspective… which centres have or could have mixed use development …also which have or could have more sustainable accessibility
- centres must not be considered in isolation from each other… the way in which they are networked which forms an important component
....the driver

- How to compare regional accessibility of one place over another
  - Focus on public transport
Purpose: To assess and quantify how transport networks, in terms of geographical configuration and service levels, perform in their urban context (distribution of land use activities).

SNAMUTS is a supply-side tool: it does not provide predictions about usage or capacity levels. Rather it asks: What is the role of the public transport system in facilitating movement and activity across a city region?

SNAMUTS was inspired by the Space Syntax approach (Hillier and Hanson, 1984), and the Multiple Centrality Analysis tool (Porta, Crucitti and Latora, 2006)
Our focus is on measuring the ease of movement on a public transport network in ways that come close to user perceptions and motivations...

Public transport users are only marginally interested in geographical distance: the main factors of travel impediment (or spatial separation) are travel time, and the ubiquity of travel opportunities (service frequency).
Our network model:
- applies a minimum service standard
- a 30-minute frequency (or better) during the weekday inter-peak period

- determines a transfer point according to intersections of routes that offer a level of convenience that is functionally and visually co-located, with signposting as required and (relatively) barrier-free access between modes.
6 key snamuts indicators

- **Service Intensity**
  - ‘Operational Input Required’

- **Closeness Centrality**
  - ‘Ease of Movement’

- **Degree Centrality**
  - ‘Transfer Intensity’

- **30-minute Contour Catchment**

- **Betweenness Centrality**
  - ‘Geographical Distribution of Travel Opportunities’

- **Network Stress**
  - ‘Identifying Squeeze Points and Underused Potential’
6 key snamuts indicators

Service Intensity
# trains, buses, trams, ferries needed

Closeness Centrality
Ease of movement – time/frequency

Degree Centrality
How many transfers separate one node from the rest

30-minute Contour Catchment
How many residents & jobs are accessible within 30 mins

Betweenness Centrality
‘Geographical Distribution of Travel Opportunities’

Network Stress
‘Identifying Squeeze Points and Underused Potential’
Closeness Centrality
‘Ease of Movement’
Degree Centrality
‘Transfer Intensity’
30-minute Contour Catchment
Black hole for buses, trains

A high proportion of the western suburbs is a public transport-unfriendly "black hole", according to a study.

Much of Cambridge, parts of Clarendon and Glenelg and regional suburbs got the worst possible rating by the study.

They are described as "urbanised areas without minimal service", the lowest of eight ratings in the Spatial Network Analysis of Multimodal Transport Systems.

The 32-page study was produced last year but hasn't been publicly launched.

The study's main focus is the Mandurah rail line, which it says has generally improved public transport across the metropolitan area.

But relative accessibility for the Paramount rail line stayed the same or dropped.

Cutin University's Dr Dave Cutin said the 10/12 who were surprised by some central and western areas showing poor public transport options.

"We expected that in outlying areas," Professor Cutin said.

"It was quite a surprise because these areas were so poor."

Professor Cutin is modelling four scenarios to see what might improve the situation.

A combination of light rail services, inner and western suburbs and a middle ring of improved public transport could improve public transport options for people in the west.

"The findings are dramatic and not what we were expecting," she said.

Cambridge Mayor Helen Weisig said planners were working to make public transport more accessible to encourage public transport use.

"But they are not providing the public transport the route will be as easy," he said.

"When I lived in London our local tube was run every five minutes, and it was easy to get to the transport hub.

"I now live in City Beach and the bus comes past my house once an hour -- guess how well I catch the bus?"

He said there would have to be a massive increase in public transport spending to get people out of their cars and on to buses and trains.

"And I don't see that happening any time soon," he said.
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<tbody>
<tr>
<td><strong>High Accessibility</strong></td>
<td></td>
<td></td>
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<tr>
<td>Perth Central-Northbridge</td>
<td>9,992</td>
<td>50,987</td>
<td>60,979</td>
<td>352,512</td>
<td>245,786</td>
<td>31.3</td>
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<tr>
<td>Perth Esplanade</td>
<td>4,011</td>
<td>30,589</td>
<td>34,600</td>
<td>328,179</td>
<td>233,050</td>
<td>27.9</td>
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<tr>
<td>Bull Creek</td>
<td>14,462</td>
<td>2,019</td>
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<td>215,569</td>
<td>182,530</td>
<td>20.4</td>
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<td>18,255</td>
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<td>8,353</td>
<td>1,653</td>
<td>10,006</td>
<td>227,962</td>
<td>190,196</td>
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<td></td>
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<td>Cottesloe-Mosman Park</td>
<td>12,497</td>
<td>1,205</td>
<td>13,702</td>
<td>142,927</td>
<td>157,303</td>
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<tr>
<td>Gosnells</td>
<td>6,687</td>
<td>1,219</td>
<td>7,906</td>
<td>161,131</td>
<td>164,651</td>
<td>16.6</td>
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<tr>
<td>Subiaco</td>
<td>11,355</td>
<td>4,073</td>
<td>15,428</td>
<td>145,324</td>
<td>178,868</td>
<td>15.1</td>
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<td>Thornlie</td>
<td>16,828</td>
<td>1,803</td>
<td>18,631</td>
<td>131,001</td>
<td>164,672</td>
<td>14.5</td>
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<tr>
<td><strong>Low Accessibility</strong></td>
<td></td>
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<td></td>
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<tr>
<td>Balcatta</td>
<td>16,828</td>
<td>1,803</td>
<td>18,631</td>
<td>131,001</td>
<td>164,672</td>
<td>14.5</td>
</tr>
<tr>
<td>Melville</td>
<td>14,505</td>
<td>13,190</td>
<td>27,695</td>
<td>147,934</td>
<td>129,693</td>
<td>14.3</td>
</tr>
</tbody>
</table>

*Value Range: 1 (could do with more housing) to 28 (could do with more jobs) Unbalanced Node: Intensify Land Use Unbalanced Place: Improve Accessibility*
Using SNAMUTS to inform future metropolitan growth
...research questions

What is the contribution land use-transport integration can make towards the Network City and Metro Transport Strategy goals?

How can SNAMUTS help assess and inform this process...

...which development scenario provides for greatest public transport accessibility potential?
The testing of these types of scenarios enables key Network City questions to be examined:

- Which Activity Centres and Corridors can best be intensified?
- Which Centres should perform a regional role and which a local role?
- Where should public transport investment (infrastructure, service improvement) go?

Answers to these questions will provide a robust basis for decisions about the future metropolitan structure.
Scenario development...

Phase 1:
Game 1 - Strategic development priorities

Phase 1:
Game 2 – Urban growth trends – 20 yrs on

Phase 2:
Game 1 – strategic development priorities (within each scenario)

Phase 2:
Game 2 – developing a composite scenario

Building 2031 network and designation of growth areas and type;
Modelling scenarios

Building Composite network and designation of growth areas and type;
Modelling CWB scenario
Game 1: STRATEGIC DEVELOPMENT PRIORITIES

Group discussions about one given strategic direction

Accept or modify public transport infrastructure and explain why:

- Locate Centres
- Optimise the public transport network
- Hierarchy of centres
  - Population / employment
  - Size - numbers or symbols - double and triple....
scenarios for testing - 2006-2031
(locating 375,000 more houses)

**Status Quo:** Public transport network in early 2008.

**Frequency Boost:** Public transport network after a comprehensive package of service improvements, achievable in the short term.

**Future land use-transport integration scenarios with a 2031 horizon:**

- **Light Rail Corridors**
- **Middle Ring Centres**
- **Fringe Expansion**
Status quo 2008
Public transport network at early 2008.

Scenario:
Frequency boost

Service improvements ...delivered with little or no investment in additional infrastructure...

prominent measures: -- expansion of 7.5-minute service on additional rail lines and on key bus routes. Most other core bus routes are harmonised to 15-minute intervals. Better coordination of services at hubs.
Assumes that all residential and employment growth until 2031 will occur around a gradually introduced network of surface light rail, roughly following the Network City activity corridors in the inner urban area.

Contains 120 km of double-track light rail with priority over road traffic, achieved where necessary through lane conversion and traffic calming.

Land uses in the 400-metre catchment of the light rail corridor will be rezoned to accommodate an average activity density of 104 persons and jobs per hectare in 2031 (208 in Perth’s CBD) [say 40du/ha].

85% of urbanised area remains as it is...
Assumes that all residential and employment growth until 2031 will occur in selected activity hubs forming a ring around Perth’s middle suburbs.

Contains 32 km of new double-track railway with 11 new stations (largely on or adjacent to existing tracks), 55 km of light rail (including a 4-km tunnel under the CBD and Swan River), and a 15-km bus transitway along South Street.

Land uses in the 800-metre catchments of the middle ring centres will be rezoned to accommodate an average activity density of 208 residents and jobs per hectare in 2031 (plus a minimum of 104 in central Perth and Fremantle) [say 80du/ha].

94% of urbanised area remains as it is...
Assumes that all residential and employment growth until 2031 will occur on Greenfield sites at the fringe of the metropolitan area.

Contains 110 km of new electric railway with 32 new stations (some on or adjacent to existing or reactivated tracks) and a 20-km automated light rail route to link the airport and adjacent areas to the rail system. The bus network has been adapted to provide more frequent cross-suburban links in outer areas.

The 800-metre catchment areas of the new rail stations are designed to accommodate 10,000 residents+jobs (activity density of 50/hectare) [say 20 du/ha].
Outputs phase 1...
Scenario Middle Ring Centres
Composite Public Transport Accessibility Index

- Excellent (25-40.1 points)
- Very Good (22.5-25 points)
- Good (20-22.5 points)
- Above Average (17.5-20 points)
- Average (15-17.5 points)
- Below Average (12.5-15 points)
- Poor (10-12.5 points)
- Minimal (5.6-10 points)
- Urbanised areas without minimal service

Average Score: 18.5

Scenario Fringe Expansion
Composite Public Transport Accessibility Index

- Excellent (25-37.9 points)
- Very Good (22.5-25 points)
- Good (20-22.5 points)
- Above Average (17.5-20 points)
- Average (15-17.5 points)
- Below Average (12.5-15 points)
- Poor (10-12.5 points)
- Minimal (7.8-10 points)
- Urbanised areas without minimal service

Average Score: 16.5
### Summary of Findings: Network Coverage

**Service Intensity:** Service hours per hour (weekday interpeak) on the minimum-standard network

<table>
<thead>
<tr>
<th>STQ</th>
<th>FRB</th>
<th>LRC</th>
<th>MRC</th>
<th>FEX</th>
<th>CWB</th>
</tr>
</thead>
<tbody>
<tr>
<td>279</td>
<td>355</td>
<td>382</td>
<td>371</td>
<td>446</td>
<td>430</td>
</tr>
</tbody>
</table>

**Network Coverage:** Percentage of residents and jobs in metropolitan area within walking distance of minimum-standard service

<table>
<thead>
<tr>
<th>STQ</th>
<th>FRB</th>
<th>LRC</th>
<th>MRC</th>
<th>FEX</th>
<th>CWB</th>
</tr>
</thead>
<tbody>
<tr>
<td>62.7%</td>
<td>63.4%</td>
<td>75.3%</td>
<td>76.3%</td>
<td>66.6%</td>
<td>79.5%</td>
</tr>
</tbody>
</table>

**Abbreviations:**
- **STQ** = Status Quo
- **FRB** = Frequency Boost
- **LRC** = Light Rail Corridors
- **MRC** = Middle Ring Centres
- **FEX** = Fringe Expansion
- **CWB** = Composite Wishbone
Phase 2 - Game 1
STRATEGIC DEVELOPMENT PRIORITIES
(you can’t have it all!)

Group discussions about one given scenario

As a public transport users lobby group – which aspects of the network in your scenario should be given priority and why
Phase 2 - Game 2
Creating a meaningful composite scenario

- Re-group (drawing one from each scenario group)
- Each group develops a composite scenario:
  - land use strategy;
  - public transport network.
Incorporates the best-performing elements of the three previous scenarios while allowing for all three forms of urban growth to continue concurrently.

Contains heavy rail extensions between Clarkson and Yanchep (northern corridor) and along a southern orbital between Bayswater and Fremantle via the airport (approx. 60 km), and a 109-km mixed light rail network centred on a wishbone-shaped orbital between Fremantle and Scarborough, a north-eastern radial including a short CBD tunnel and several branch lines. Also includes a bus transitway along South Street (15 km) as well as several new orbital and diagonal bus routes to link the growth areas.

Urban consolidation and growth to occur in the 400/800-metre catchments of all new public transport facilities, at an average target density of 75 residents and jobs per hectare [say 30du/ha] (except in Perth’s CBD and in the activity centres of Armadale, Fremantle, Joondalup, Midland, Murdoch, Rockingham and Stirling-Glendalough where the target density is 150 res + jobs per ha).
Scenario Composite Wishbone
Composite Public Transport Accessibility Index

- Excellent (25-38.9 points)
- Very Good (22.5-25 points)
- Good (20-22.5 points)
- Above Average (17.5-20 points)
- Average (15-17.5 points)
- Below Average (12.5-15 points)
- Poor (10-12.5 points)
- Minimal (5.6-10 points)

Average Score: 18.9
Using SNAMUTS to inform future public transport options
<table>
<thead>
<tr>
<th>Service Intensity:</th>
<th>2009</th>
<th>2031</th>
</tr>
</thead>
<tbody>
<tr>
<td>Train</td>
<td>44</td>
<td>80 (+81%)</td>
</tr>
<tr>
<td>Bus</td>
<td>587</td>
<td>915 (+56%)</td>
</tr>
<tr>
<td>Ferry</td>
<td>1</td>
<td>3 (+118%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>632</td>
<td>997 (+58%)</td>
</tr>
<tr>
<td>Number of Nodes</td>
<td>46</td>
<td>49</td>
</tr>
<tr>
<td>Activities in metropolitan area</td>
<td>2,629,497</td>
<td>3,655,399</td>
</tr>
<tr>
<td>Activities in serviced area</td>
<td>2,528,198 (96%)</td>
<td>3,513,548 (96%)</td>
</tr>
</tbody>
</table>
our evaluation of the network we focussed on the following objectives:

- The extent to which potential accessibility of quality public transport was expanded to a larger proportion of metropolitan residents;

- The extent to which accessibility was enhanced across fourteen key activity centres (defined by PTA);

- The public transport ‘effort’ (performance of different transport modes and across corridors).
<table>
<thead>
<tr>
<th>Composite Accessibility Index for key centres</th>
<th>2009</th>
<th>2031</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC1 (outer region)</td>
<td>12.5</td>
<td>15.4 (+2.9)</td>
</tr>
<tr>
<td>AC2 (middle region)</td>
<td>16.5</td>
<td>19.5 (+3.0)</td>
</tr>
<tr>
<td>AC3 (inner region – major employment centre)</td>
<td>16.3</td>
<td>20.5 (+4.2)</td>
</tr>
<tr>
<td>AC4 (inner region)</td>
<td>19.6</td>
<td>21.9 (+2.3)</td>
</tr>
<tr>
<td>AC5 (outer region)</td>
<td>20.0</td>
<td>24.0 (+4.0)</td>
</tr>
<tr>
<td>AC6 (outer region)</td>
<td>16.0</td>
<td>17.8 (+1.8)</td>
</tr>
<tr>
<td>AC7 (outer region)</td>
<td>17.0</td>
<td>19.0 (+2.0)</td>
</tr>
<tr>
<td>AC8 (middle region – large employment centre)</td>
<td>24.9</td>
<td>28.8 (+3.9)</td>
</tr>
<tr>
<td>AC9 (Airport)</td>
<td>7.3</td>
<td>19.9 (+12.6)</td>
</tr>
<tr>
<td>AC10 Perth Central</td>
<td>33.5</td>
<td>37.7 (+4.2)</td>
</tr>
<tr>
<td>AC11 (outer region)</td>
<td>16.2</td>
<td>18.6 (+2.4)</td>
</tr>
<tr>
<td>AC12 (middle region – major employment centre)</td>
<td>25.6</td>
<td>29.0 (+3.4)</td>
</tr>
<tr>
<td>AC13 (inner region – major employment centre)</td>
<td>17.1</td>
<td>22.4 (+5.3)</td>
</tr>
<tr>
<td>AC14 (outer region)</td>
<td>-</td>
<td>15.4</td>
</tr>
<tr>
<td><strong>Average Key Centres</strong></td>
<td>18.7</td>
<td>22.1 (+3.4)</td>
</tr>
<tr>
<td><strong>Standard Deviation Key Centres</strong></td>
<td>6.5</td>
<td>6.1</td>
</tr>
<tr>
<td><strong>Average Network</strong></td>
<td>14.9</td>
<td>18.0 (+3.1)</td>
</tr>
<tr>
<td><strong>Standard Deviation Network</strong></td>
<td>6.2</td>
<td>6.5</td>
</tr>
<tr>
<td>Contour catchment change for key activity centres</td>
<td>2009</td>
<td>2031</td>
</tr>
<tr>
<td>-------------------------------------------------</td>
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<td>-------</td>
</tr>
<tr>
<td>AC1 (outer region)</td>
<td>17.1%</td>
<td>26.6%</td>
</tr>
<tr>
<td>AC2 (middle region)</td>
<td>28.2%</td>
<td>31.9%</td>
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<tr>
<td>AC3 (inner region – major employment centre)</td>
<td>36.1%</td>
<td>46.1%</td>
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<td>AC4 (inner region)</td>
<td>45.2%</td>
<td>45.9%</td>
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<tr>
<td>AC5 (outer region)</td>
<td>35.2%</td>
<td>49.4%</td>
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<td>AC6 (outer region)</td>
<td>14.1%</td>
<td>15.9%</td>
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<td>AC7 (outer region)</td>
<td>37.8%</td>
<td>40.1%</td>
</tr>
<tr>
<td>AC8 (middle region – large employment centre)</td>
<td>62.0%</td>
<td>80.0%</td>
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<td>AC9 (Airport)</td>
<td>12.2%</td>
<td>56.8%</td>
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<td>AC10 Perth Central</td>
<td>77.8%</td>
<td>83.6%</td>
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<td>AC11 (outer region)</td>
<td>23.3%</td>
<td>26.4%</td>
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<tr>
<td>AC12 (middle region – major employment centre)</td>
<td>66.8%</td>
<td>72.9%</td>
</tr>
<tr>
<td>AC13 (inner region – major employment centre)</td>
<td>35.9%</td>
<td>59.9%</td>
</tr>
<tr>
<td>AC14 (outer region)</td>
<td>-</td>
<td>15.8%</td>
</tr>
</tbody>
</table>

**Average Key Centres**

| 37.8% | 46.5% |

**Standard Deviation Key Centres**

| 20.5% | 22.2% |

**Average Network**

| 30.0% | 40.2% |

**Standard Deviation Network**

| 19.4% | 21.7% |
Issue 1: incremental change results in lost opportunity
...towards a solution –
bus re-routing
...towards a solution – higher performing mode
Setting a benchmark for public transport accessibility
defining benchmarking (i)

“a standard or point of reference against which things may be compared” (Oxford Dictionary)

At this level of definition we might be asking simply - how do the public transport systems of European cities compare?

“a standard of excellence, achievement etc., against which similar things must be measured or judged” (Online Reference Dictionary)

This definition takes the idea a step further and adds the dimension of excellence or best practice, suggesting the need to establish a benchmark, or metric, for an excellent public transport system.
defining benchmarking (ii)

What metric should we use?
A common measure is public transport patronage, reflecting concerns about investment (demand-side approach)

Another measure relates to the cost of construction and/or operation.

Neither metric corresponds to the salient questions: who (and how many people) get(s) access to public transport, and at what level of service?
What level of public transport accessibility should Australian Cities aim for?

- What can we learn from European and North American cities:
  - Service input per person
  - Network coverage
  - Public transport trips per person per annum
how much service input is required?

number of public transit vehicles/trains (per 100,000 pop) in simultaneous revenue service

<table>
<thead>
<tr>
<th>City</th>
<th>Service Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zürich</td>
<td>25.9</td>
</tr>
<tr>
<td>Vienna</td>
<td>25.5</td>
</tr>
<tr>
<td>Vancouver</td>
<td>19.3</td>
</tr>
<tr>
<td>Portland</td>
<td>10.2</td>
</tr>
<tr>
<td>Melbourne</td>
<td>12.9</td>
</tr>
<tr>
<td>Perth</td>
<td>12.0</td>
</tr>
</tbody>
</table>

European cities have double the service input of Perth – Vancouver 50% more
network coverage: what percentage of metropolitan residents and jobs are within walking distance from public transit?

<table>
<thead>
<tr>
<th>City</th>
<th>Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vienna</td>
<td>79.7%</td>
</tr>
<tr>
<td>Zürich</td>
<td>74.2%</td>
</tr>
<tr>
<td>Vancouver</td>
<td>61.4%</td>
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<tr>
<td>Portland</td>
<td>41.7%</td>
</tr>
<tr>
<td>Melbourne</td>
<td>46.8%</td>
</tr>
<tr>
<td>Perth</td>
<td>41.7%</td>
</tr>
</tbody>
</table>

European cities have double the network coverage – Vancouver 50% more
European cities of similar population size to Perth have 5 times journeys per person per annum – Vancouver is double
network coverage and journeys ppa

\[ y = 18.364e^{3.4234x} \]

\[ R^2 = 0.7094 \]
Australian Cities: Composite Benchmark


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