WALKABLE AND ACCESSIBLE CITIES
SMART MOBILITY

Guillermo E. Gutiérrez
**Introduction**

<table>
<thead>
<tr>
<th>ENVIRONMENT</th>
<th>URBAN DESIGN</th>
<th>PERCEPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connectivity</td>
<td>Imageability</td>
<td>Aesthetics</td>
</tr>
<tr>
<td>Proximity</td>
<td>Enclosure</td>
<td>Sense of safety</td>
</tr>
<tr>
<td>Residential Density</td>
<td>Human scale</td>
<td>Sense of comfort</td>
</tr>
<tr>
<td>Land Use Mix</td>
<td>Transparency</td>
<td>Sense of traffic</td>
</tr>
<tr>
<td>Sidewalks</td>
<td>Complexity</td>
<td>Sense of cleanliness</td>
</tr>
<tr>
<td>Slope</td>
<td></td>
<td>Level of interest</td>
</tr>
<tr>
<td>Greenness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Walkability measurable attributes review. By author based on Ewing and Handy (2009), Leslie et al., (2007)
Potential walking areas

\[ 100 \times \tan \left( \frac{\text{Slope}_{\text{Up}} \times \text{Length}_{\text{Up}} + \text{Slope}_{\text{Down}} \times \text{Length}_{\text{Down}}}{\text{Length}_{3D}} \right) \times \left( \frac{3.1416}{180} \right) \]

Victor and Klein (2011)

### Determine walking speed according to the slope

<table>
<thead>
<tr>
<th>Slope Range</th>
<th>Speed (km/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 2 %</td>
<td>4.8</td>
</tr>
<tr>
<td>2 - 4 %</td>
<td>4.6</td>
</tr>
<tr>
<td>4 - 8 %</td>
<td>4.2</td>
</tr>
<tr>
<td>8 - 15 %</td>
<td>3.8</td>
</tr>
<tr>
<td>&gt; 15 %</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Julien and Carré (2003)
Potential walking areas

Klein, et al. (2016)
Walkability variables

- Connectivity
- Population Density
- Accessibility
- Land Use Mix
- Proximity to Amenities
- Greenness

Datasets collected by IIC in latest projects:
Connectivity

Directness of links and the density of connection in a network. As connectivity enlarges, travel distances decrease and route options increase.

**Gamma Index:**

\[ \gamma = \frac{e}{3(n-2)} \]

- Red: Participant’s residence
- Yellow: Nodes
- Purple: Edges
- Gray: Potential walking area
Population Density

The volume of travel demand is strongly related to walking quality (Cervero and Kockelman, 1997) and to personal business trips.

$$PD = \frac{\text{Number of inhabitants}}{\text{Area (hectares)}}$$

- Participant’s residence
- Inhabitants
- Potential walking area
Degree of heterogeneity with which functionally different uses are co-located in space (Leslie et al., 2007)
Accessibility

\[ \sum_k = - (P_k \times W_k) \]

Where:
- \( P_k \) = percentage of feature’s quality \( k \)
- \( W_k \) = weight of quality \( k \)

Accessibility of features

- High (0)
- Medium (0.5)
- Low (1)
- Participant’s Residence
Proximities to amenities

- Nearness to frequent destinations, as retail areas, services, public infrastructures and recreational spaces
- The availability of potential destinations together makes walking a more competitive and attractive mode of travel to other options (Saelens et al., 2003)

\[
\Sigma_k \left( \frac{W_k}{D_k} \right)
\]

- \(W_k\) = weight of amenity \(k\)
  - (Daily = 30; weekly = 20; monthly = 10)
- \(D_k\) = Distance (travel time) to amenity \(k\)
Greenness

\[ \sum (p_k \times w_k) \]

\[ P_k = \text{percentage of greenness } k \]

\[ W_k = \text{Weight of greenness } k \]

Neighbourhood environmental quality is a substantial factor that affects human health (Maas et al., 2006). Abundant green spaces may facilitate positive social interactions between neighbourhood residents (Kweon et al., 1998).

<table>
<thead>
<tr>
<th>SAVI</th>
<th>Description</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 0.86</td>
<td>Vigorous dense vegetation</td>
<td>1</td>
</tr>
<tr>
<td>0.78 – 0.86</td>
<td>Moderately dense vegetation</td>
<td>0.5</td>
</tr>
<tr>
<td>0.86 – 0.78</td>
<td>Sparse vegetation</td>
<td>0.25</td>
</tr>
<tr>
<td>&lt; 0.78</td>
<td>Non-green areas</td>
<td>0</td>
</tr>
</tbody>
</table>

Participant’s residence
Overall scheme

- Land Use Mix
- Population Density
- Connectivity
- Accessibility
- Greenness

Walkability Score
Normalize & weigh

Proximity to Amenities
Discussion

- Approach might not be compatible for every urban and cultural context
  - Data generally available, which allows cross country comparisons
- Multi-scale approaches
  - Individual residence level
  - Municipal and Metropolitan
- The walkability index results can be crossed-checked with health surveys
- There are many other factors linked with walking behaviour
  - Traffic
  - Risk of crime
  - Aesthetics
  - Seasonal weather conditions
- Complementary studies of bikeability
Conclusions

- The walkability index provides an objective notion about the nature of the build environment significantly associated to urban mobility.
- Inform decision makers of the efficacy of sustainable development in the mitigation of adverse public health impacts of urban form.
- Potential for guiding environmental and urban planning policies to promote walking and active transportation.
Thanks

... and to all of you for your attention