FHWA Guidebook for Measuring Multimodal Network Connectivity

Joseph Broach
Portland State University, jbroach@pdx.edu

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A New Resource for Bicycle & Pedestrian Planning

Portland State University
Joe Broach* Jennifer Dill
Kelly Clifton Claire Lust

Project Team
FHWA (sponsor)¹
ICF (lead consultant)²
Alta Planning + Design³

Special Thanks: Dan Goodman (Toole Design), Hannah Twaddell², Eliot Rose (Metro), Kim Voros³, Hugh Louch³, Lindsay Martin², Gary Jensen¹, Christopher Douwes¹, Jon Walker², Frank Proulx (Toole Design)
Atlanta Regional Commission

How do we identify bike projects that will better serve local centers—both urban and suburban—in a consistent way?
City of Baltimore

We have a sidewalk inventory, but we need a pedestrian measure that’s more policy sensitive for planning & benchmarking.
Caltrans District 4
How are our state highways impacting local bicycle access?
City of Fort Collins (CO)

How can we measure bicycle network quality change over time?
Portland Metro

Where are the gaps in regional bike & ped networks?

How well does the Regional Transportation Plan address them?
How do we get beyond facility inventories & one-time analyses?

Measuring *connectivity* instead of *quantity* can capture...

- The value of individual facilities (or of missing pieces!) to the network as a whole
- The ability of the network to connect people walking & biking to places they want to go
- The quality of a network, in part or all together
Guidebook goals

- Define connectivity analysis
- Scan network connectivity in research & practice
- Provide menu of bike & ped measures
- Document in actual planning contexts
- Transfer lessons learned & recommend best practices
Methodology

Research & Practice Scan

Case Studies (5 Agencies)

Phone Interviews (8 agencies/orgs)

- 57 articles & reports
- 61 planning documents

4/20/2018 TREC Friday Transportation Seminar – Portland State University
Network connectivity: you know it when you see it?
Network connectivity: what if we add **bike lanes** and **bike boulevards**?
Network connectivity: how about schools & parks??
It depends on how you measure it

- We organized into 4 general analysis methods
- Facility Type or Quality Measures may be added to any of the methods.

<table>
<thead>
<tr>
<th>All</th>
<th>Designated</th>
<th>Low Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network Completeness</td>
<td><img src="image" alt="80% ALLOW BIKES" /></td>
<td><img src="image" alt="25% HAVE BIKE SPECIFIC FACILITIES" /></td>
</tr>
<tr>
<td>Network Density</td>
<td><img src="image" alt="20 INTERSECTIONS PER ACRE" /></td>
<td><img src="image" alt="5 INTERSECTIONS PER ACRE" /></td>
</tr>
<tr>
<td>Route Directness</td>
<td><img src="image" alt="1 MILE" /></td>
<td><img src="image" alt="2.5 MILES" /></td>
</tr>
<tr>
<td>Accessibility to Destinations</td>
<td><img src="image" alt="100% ACCESSED" /></td>
<td><img src="image" alt="100% ACCESSED" /></td>
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</tbody>
</table>
Connectivity Analysis Process

STEP 1
Identify the planning context
Clarify the purpose of the analysis, the decision(s) it will support, and the planning processes it will inform

STEP 2
Define the analysis method
Decide which method(s) and measures are best suited to the purpose of the analysis, and will make productive use of available resources

STEP 3
Assemble the data
Define the base network and assemble facility attribute and other relevant data

STEP 4
Compute metrics
Run the analysis to calculate connectivity for selected links, routes, and areas

STEP 5
Package Results
Develop overlays, visualizations, and other presentation materials to support the decisionmaking process
Planning Context

We identified roles for connectivity analysis throughout the planning process via:

- **Simpler...**
  - Gap identification
  - Needs assessment

- **Moderate...**
  - Monitoring & Benchmarking

- **More Difficult...**
  - Scenario analysis
  - Project prioritization
Analysis Method

Four types, falling into two major categories

- **Form-based**
  - Calculated over defined area
  - Measures mainly *potential* connectivity
  - Low to moderate complexity

- **Route-based**
  - Calculated between sets of origins & destination
  - More closely measures *realized* connectivity
  - Moderate to high complexity
Measuring Connectivity: Data

Data varies by context & method

- Bike & Ped Facility Data
  - Designated facility types
  - Intersection features
  - Slope (terrain)

- Supporting Data
  - Roadway design characteristics
  - Traffic volume and/or speed
  - Heavy vehicle traffic
  - Potential obstacles (e.g. driveways)
Measuring Connectivity: Metrics

Network component ratings

- Individual segments
  - All
  - All meeting threshold
  - Quality/preference weighted

- Routes
  - Entire network (self-connectivity)
  - From single point (travelshed)
  - Between specific origins and destinations
Measuring Connectivity: Package

Aggregate the component scores

- Map
- Small area score
- Network summary score
Simple Mapping

- Visual analysis is common to identify network gaps & opportunities
- At right, results of a network segment & intersection quality rating (Route Quality Index)
- Difficult to make objective comparisons
Small Area Scores

- Scores for many segments or routes can be summarized to small areas.
- At right, access to a basket of destination types is shown for each census block (People for Bikes BNA tool).
- Small area scores are easier to compare across areas or over time.
Network Summary Scores

- Depending on the planning context and method, scores can be summarized to the entire network.
- The results at right are based on population-weighted small area scores for entire regional bike networks (People for Bikes BNA).
- Network scores are comparable over time or between different networks (current/planned or across regions).
Overlays

Connectivity results can be overlaid with other data to suit the planning context or for additional analysis

- Sociodemographics (equity)
- Crash data (safety)
- Use data (demand)

At right, poverty rates are overlaid on bicycle network quality (Level of Traffic Stress)
Method & Measure Fact Sheets

CONNECTIVITY MEASURE

PEDESTRIAN LEVEL OF TRAFFIC STRESS (PLTS)

What is the extent to which pedestrians feel safe and comfortable using the network?

<table>
<thead>
<tr>
<th>Mode</th>
<th>Method</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Clarity: sidewalk segments by type by highest stress attribute</td>
<td></td>
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</table>

DESCRIPTION

Pedestrian LTS measures indicate the relative level of comfort for pedestrians using a given network, taking into account the variety of activities and trip purposes among different types of people. The categories of pedestrian traveler characteristics, including user types and trip purposes, are similar to those developed for bicycle LTS measures. Criteria and thresholds are customized for pedestrians, as described in the Oregon Department of Transportation's Analysis Procedures Manual (2018). Levels are classified based on their most stressful feature, including the impact of interactions. Application to measures of connectivity are done best in conjunction with form-based measures.

EXAMPLE PLANNING APPLICATIONS:

- To identify factors that contribute to low and high-stress corridors and routes
- To set priorities for locations that need specific types of improvements

TYPICAL DATA

- Sidewalk centered, width, surface types, surface quality
- Crossing locations, marking, lighting
- Curb ramps and other infrastructure supporting access for people with disabilities
- Modeled traffic data: Traffic volumes, traffic speeds
- Street network data: Number of lanes, lane width, width of paved shoulder, presence of curbs, on-street parking
- Pedestrian origins and destinations

PEER APPLICATION

- In Oregon, Pedestrian LTS is the preferred method defined by the DOT for Regional Transportation Plans and Transportation System Plans. It can also be used on a screening-level basis for project development and development review. The recommended LTS measurement methodology will be outlined in the updated DOT Analysis Procedures Manual.

ADVANTAGES

- Provides a comparable measure to BLTS
- Provides a detailed understanding of individual sidewalk centerline segments and provides visually descriptive picture of physical conditions
- The tool is sensitive to disability access concerns, including ramp quality and surface quality
- It allows adjustments for additional treatments or infrastructure intended to improve the pedestrian environment

CONSIDERATIONS

- The tool is data intensive
- The data cannot easily be used
- The results are not validated against benchmark data
- The classification is sensitive only to "weakest link" improvements
- The current methodology precludes improvements in certain areas based on lane and use type
- In rural areas, the definition of sidewalks and criteria within the measure may need to be adjusted to reflect nonurban characteristics
Case Study: Caltrans District 4

- **Context**: Measure bicycle mobility across state highway corridors (project planning, prioritization, funding, and benchmarking)
- **Method**: Route directness
- **Data**: Routable bike network, state highways, and supporting
- **Metrics**: Shortest paths along low-stress segments
Case Study: Caltrans District 4 Results (map)

- Maps for each corridor w/ individual crossing scores.
Case Study: Caltrans District 4 Results (summary scores)

- Summary scores for corridor by directness level
- Could be compared between corridors and over time
- Could also calculate a summary for all corridors in jurisdiction to benchmark overall performance over time.

Agency plans to add bike & ped permeability scores to its 20-year planning process.
- Connectivity goals common; measurement less so
- Mostly visual/qualitative
- More common & more advanced methods for bicycling
- Intersections often omitted
- Mostly urban
- Measures often modified
- Data standards & archiving lacking
- Lack of validation for many measures
- Agencies excited about possibilities!
What’s Next? (beyond the guidebook)

- Improved data standards
- “Turnkey” connectivity analysis tools
- Continued research and validation of connectivity measures
  - Use
  - Safety
  - Preference

Figure 1 Four Core Components of CIS Planning Tool
More Information

- Download the guidebook & Case study reports [https://tinyurl.com/yauxeufw](https://tinyurl.com/yauxeufw)
- Joe: [http://orcid.org/0000-0001-7753-501X](http://orcid.org/0000-0001-7753-501X) (research) | jbroach@pdx.edu
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