Microsimulation Model Design in Lower Manhattan: A Street Management Approach

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Outline

1. Introduction
2. Challenges
3. Model Development
4. Results
5. Current Work
Introduction

• Lower Manhattan Street Management Project
  • Multi-year, transportation planning services contract with NYCDOT and NYCEDC
• Scope of work includes:
  • Traffic Simulation Model
  • Placard Parking Analysis
  • Bus Management Analysis
  • Other Traffic Analyses
Lower Manhattan at a Glance

- 1 sq mile dense urban neighborhood
- Fourth largest central business district in America
- Over 318,000 employees
- 145% increase in residential population since 2001
- Over 8 million annual visitors
Model Purpose

- Comprehensive, detailed traffic model
- Appropriate for technical and non-technical audience
- Manage street operations resulting from:
  - Construction closures
  - Network changes
  - Planning and security scenarios
Modeling Challenges

• Large, dense urban study area
• Pedestrian/vehicular interactions
• Curbside activity
• Bus activity on streets
• Taxis and livery vehicles
• Variation in traffic flow
Model Development Process

1. DATA COLLECTION  →  3. DEMAND ESTIMATION  →  5. VALIDATE NETWORK  →  VALIDATED NETWORK

2. NETWORK DESIGN  →  4. CALIBRATE NETWORK  →  QA/TESTS
1. Data Collection

- Surveys
  - Vehicle and pedestrian counts
  - Parking (on and off street)
  - Travel time

- Existing data sources
  - BPM
  - 2000 Census (JTW)
  - Brooklyn Bridge counts

- Network configuration
  - Aerial photography
  - Site visits/photos
2. Network Design – Link Categories

• Systematic and functional approach to categorization
• Guided by LM Street Management Framework
• Informed major/minor designation, speed, widths and cost factors
2. Network Design – Pedestrians

- Vehicle-pedestrian conflict
  - Based on HCM methodology
  - Calculates amount of time pedestrians are in intersection
  - “Dummy” phasing simulates vehicle-ped conflict by reducing green time.

- Not applied to prohibited crossings or all pedestrian phases

- Turning movements at uncontrolled crossings were designated as minor to mimic stopping
3. Demand Estimation

• Pattern matrix based on regional model demands
• 159 Zones, > 25,000 possible O/D pairs
• 8 O-D matrices – separated by vehicle and trip type
• Hierarchical estimation process
  1. External cordons
  2. Off Street destinations
  3. On street parking
  4. Screenline traffic
  5. Turns
  6. Vehicle types
4. Calibration

- *Calibration* ensures that the model adequately reflects the observed traffic behavior, volume and travel times:
  - Physical network (stop lines, curbs, junctions)
  - Link costs
  - Assignment parameters
  - Visual calibration based on site visits
    - Allowance for prohibited movements

- *Validation* is an independent check of the calibrated model to assess its accuracy and confirm that the model is fit for purpose
5. Validation

- Performance criteria adopted from US and International guidelines
  - GEH – applied to link and turn flows
  - R squared – applied to link and turn flows
  - Percent Difference – applied to screenline and travel time

- Four criteria:
  - Screenlines
  - Individual Link Flows
  - Turning Movements
  - Travel Times

\[ GEH = \sqrt{\frac{2(M - C)^2}{M + C}} \]

where

\( M = \) modeled volume
\( C = \) observed volume
5. Validation

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Targets</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Screenline Flows</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage difference</td>
<td>5 - 10%</td>
<td>Outliers may be accepted depending on confidence of counts and other validation criteria.</td>
</tr>
<tr>
<td><strong>Individual link flows</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>0.85 – 0.95</td>
<td>Correlation between measured and modeled flows should tend toward 0.9.</td>
</tr>
<tr>
<td>GEH&lt;5</td>
<td>75% - 80% of counts</td>
<td>Small difference between modeled and observed links.</td>
</tr>
<tr>
<td>GEH&lt;10</td>
<td>95% of counts</td>
<td>No significant outliers, unless justification provided.</td>
</tr>
<tr>
<td><strong>Turn Flows</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>0.85 – 0.95</td>
<td>Correlation of all measured to modeled turn flows should tend toward 0.85.</td>
</tr>
<tr>
<td>GEH&lt;5</td>
<td>65% - 75% of counts</td>
<td>Small difference between modeled and observed for most turns</td>
</tr>
<tr>
<td>GEH&lt;10</td>
<td>90% of counts</td>
<td>A small number of significant outliers allowed that are shown not to significantly impact on the model's operation.</td>
</tr>
<tr>
<td><strong>Travel time</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean difference &lt;15%</td>
<td>85% of routes</td>
<td>Difficult to achieve due to the small sample of observed travel time information along each route.</td>
</tr>
<tr>
<td>Average modeled travel time within range of observed times</td>
<td>95% of routes</td>
<td>Difficult to achieve given small sample.</td>
</tr>
</tbody>
</table>
## Results

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Targets</th>
<th>Achieved AM</th>
<th>Achieved PM</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screenline Flows</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent difference</td>
<td>5 – 10%</td>
<td>All &lt;6%</td>
<td>All &lt;7%</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Individual Link Flows</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>0.85 – 0.95</td>
<td>0.99</td>
<td>0.99</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GEH&lt;5</td>
<td>75% - 80% of counts</td>
<td>74%</td>
<td>84%</td>
<td>Acceptable – AM slightly low</td>
</tr>
<tr>
<td>GEH&lt;10</td>
<td>95% of counts</td>
<td>96%</td>
<td>98%</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Turn Flows</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>0.85 – 0.95</td>
<td>0.95</td>
<td>0.98</td>
<td>Acceptable</td>
</tr>
<tr>
<td>GEH&lt;5</td>
<td>65% - 75% of counts</td>
<td>63%</td>
<td>70%</td>
<td>Acceptable – AM slightly low</td>
</tr>
<tr>
<td>GEH&lt;10</td>
<td>90% of counts</td>
<td>91%</td>
<td>94%</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Travel Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean difference &lt;15%</td>
<td>85% of routes</td>
<td>50%</td>
<td>11%</td>
<td>Doesn’t achieve targets</td>
</tr>
<tr>
<td>Average modeled travel time within range of observed times</td>
<td>95% of routes</td>
<td>22%</td>
<td>6%</td>
<td>Doesn’t achieve targets</td>
</tr>
</tbody>
</table>
Lessons Learned

• Client collaboration is essential
• Data collection is important
• Few urban microsimulation standards and guidelines
• Travel times are variable requiring careful attention
Current Work

- Model expansion
- Agent-based pedestrian simulation
- Additional data collection
- Seamless linkage to regional model
Thank you