Welcome

• William Rogers
  • Senior Program Officer, National Cooperative Highway Research Program (NCHRP)

• Kirk Zeringue
  • Special Studies Research Administrator, Louisiana DOTD
  • Panel Chair

• Paul Ryus
  • Principal Engineer, Kittelson & Associates, Inc.
  • Principal Investigator, NCHRP Project 17-87
Workshop Goals

• Present NCHRP 17-87 research results to professionals at the forefront of pedestrian planning
• Obtain feedback on:
  • First-draft guidebook
  • Quality-of-service evaluation methods being developed for the Highway Capacity Manual (HCM)
• Provide opportunities to network with fellow professionals
Workshop Agenda

- NCHRP 17-87 purpose and research results
- Guidebook
  - Pedestrian volume counting
  - Pedestrian operations analysis
- Lunch
- Guidebook
  - Pedestrian quality of service analysis
  - Test of proposed HCM uncontrolled crossing method
  - Pedestrian safety analysis
- Slides e-mailed following workshop
Desired Feedback

• Usefulness of Guide content as a resource for professionals
• Identifying missing/incomplete/unnecessary content
• Possible photos/figures to incorporate
• Future research needs
• Implementation ideas
Project Background
Project Genesis

- Research problem statements developed separately by two TRB committees
  - Pedestrians
  - Highway Capacity & Quality of Service
- Statements sponsored by state DOTs and submitted for funding through the NCHRP program
- NCHRP merged the two statements into one project
  - NCHRP 17-87, Enhancing Pedestrian Volume Estimation and Developing HCM Pedestrian Methodologies for Safe and Sustainable Communities
Project Objectives

• Identify techniques for efficient and accurate estimation of pedestrian volume and exposure
• Determine field-observed factors affecting pedestrian flow at the facility level, and integrate these factors into the HCM pedestrian LOS methodology
• Determine how pedestrian safety improvements on the roadway and in signal timing designs should be reflected in the HCM pedestrian LOS methodology
• Recommend corresponding enhancements to the current HCM methodology
Project Team

- Kittelson & Associates, Inc.
  - Paul Ryus (PI), Anusha Musunuru, Bastian Schroeder, Kelly Laustsen
- Highway Safety Research Center at University of North Carolina
  - Krista Nordback, Seth LaJeunesse, Wesley Kumfer
- Portland State University
  - Sirisha Kothuri, Nathan McNeil, Chris Monsere
- Pennsylvania State University
  - S. Ilgin Guler
Project Panel

- Kirk Zeringue, Louisiana DOTD (chair)
- George Branyon, District of Columbia DOT
- DeWayne Carver, Florida DOT
- Casey-Marie Claude, Boston Region MPO
- Richard Cunard, Transportation Research Board
- Jacqueline DeWolfe, Massachusetts DOT
- Carissa McQuiston, Michigan DOT
- Barbara Ostrom, Wood Technical Consulting Solutions
- Jeremy Raw, FHWA
- Keith Robinson, Gray Bowen Scott
- Yiyi Wang, San Francisco State University
- Joyce Yassin, WSP
**Project Phases**

- **Phase 1: Fact-finding & interim report (Tasks 1–5)**
  - May–November 2018
- **Phase 2: Original research (Task 6)**
  - December 2018–September 2019
- **Phase 3: Report findings (Tasks 7–12)**
  - Task 7: Draft guidebook
  - Task 8: Draft HCM chapter updates
  - Task 9: Implementation materials
  - Task 10: Outreach
  - Tasks 11, 12: Draft & final deliverables (by April 20, 2020)
Phase 1 Results
Task 1: Literature Review (1)

• Reviewed over 300 documents relevant to the project
  • Pedestrian counting methods and practices
  • Performance measures for evaluating pedestrian safety, operations, mobility, and satisfaction
  • Effects of pedestrian safety countermeasures on pedestrian safety, operations, and quality of service (QOS)
Task 1: Literature Review (2)

- HCM 6\textsuperscript{th} Edition presents a suite of multimodal analysis methods for urban streets
  - Pedestrian, bicycle, transit, auto
- Current HCM pedestrian methods evaluated
  - Input data requirements
  - Result sensitivity to input variables
  - Applications and critiques in the literature
  - Known and newly identified limitations & issues
HCM Uncontrolled Crossing LOS

- Estimates pedestrian delay based on
  - Minimum gap needed to cross street
    - Function of traffic volume, crossing length
  - Motorist yielding rate
- Delay used to determine LOS
- Yielding portion of method found to produce unrealistic results in certain situations
HCM Signalized Crossing LOS

• Estimates delay for randomly arriving pedestrians making a one-stage crossing at a pre-timed signal

• Does not address
  • Two-stage crossings of one intersection leg
  • Crossing more than one intersection leg
  • Semi- and fully actuated signals and hybrid beacons
  • Non-random pedestrian arrivals
HCM Midsegment Crossings

• Segment ped LOS score is insensitive to segment length for all but the shortest block lengths
  • Diversion delay exceeds crossing delay
• However, Baltes and Chu (2001) found that crossing difficulty is influenced by segment length
Task 2: Interviews

• Practitioners from leading organizations interviewed to
  • Identify current usage of pedestrian QOS and operations methods (not necessarily HCM methods)
  • Obtain input on research topics of greatest interest to a broad range of practitioners

• Organization types included
  • State DOTs
  • MPOs
  • Cities and counties
  • TRB committees
## Stakeholder Input: Research Needs

<table>
<thead>
<tr>
<th>Topic</th>
<th>Overall</th>
<th>State DOTs</th>
<th>MPOs</th>
<th>Local</th>
<th>HCQS Committee</th>
<th>Pedestrian Committees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effects of signal timing changes on ped QOS</td>
<td>4.1 (13)</td>
<td>3.9 (2)</td>
<td>4.5 (4)</td>
<td>4.1 (3)</td>
<td>4.0 (1)</td>
<td>4.1 (3)</td>
</tr>
<tr>
<td>Effects of physical safety improvements on ped QOS</td>
<td>4.4 (21)</td>
<td>4.3 (5)</td>
<td>4.3 (5)</td>
<td>4.0 (3)</td>
<td>4.3 (3)</td>
<td>5.0 (5)</td>
</tr>
<tr>
<td>Evaluating pedestrian quality of service crossing a street</td>
<td>3.9 (16)</td>
<td>3.9 (4)</td>
<td>4.1 (4)</td>
<td>3.8 (3)</td>
<td>3.7 (2)</td>
<td>4.4 (3)</td>
</tr>
<tr>
<td>Evaluating pedestrian quality of service walking along a street</td>
<td>3.1 (3)</td>
<td>3.3 (1)</td>
<td>3.3 (1)</td>
<td>3.2 (0)</td>
<td>2.7 (0)</td>
<td>3.2 (1)</td>
</tr>
<tr>
<td>Determining the pedestrian volume at which pedestrians start walking out of the intended pedestrian path</td>
<td>2.7 (5)</td>
<td>2.4 (2)</td>
<td>3.0 (1)</td>
<td>3.1 (1)</td>
<td>2.5 (1)</td>
<td>2.6 (0)</td>
</tr>
<tr>
<td>Determining the required usable pedestrian sidewalk or path width for a given pedestrian volume</td>
<td>2.9 (3)</td>
<td>2.3 (1)</td>
<td>3.3 (0)</td>
<td>3.6 (1)</td>
<td>2.7 (1)</td>
<td>2.8 (0)</td>
</tr>
<tr>
<td>Determining the required crosswalk width for a given pedestrian volume</td>
<td>2.8 (3)</td>
<td>2.6 (1)</td>
<td>3.3 (1)</td>
<td>2.7 (0)</td>
<td>3.2 (1)</td>
<td>2.4 (0)</td>
</tr>
<tr>
<td>Determining how crosswalk configurations and motorist behaviors affect pedestrian quality of service</td>
<td>3.7 (11)</td>
<td>4.3 (4)</td>
<td>3.9 (3)</td>
<td>4.2 (2)</td>
<td>2.7 (0)</td>
<td>3.5 (2)</td>
</tr>
<tr>
<td>Extending current HCM pedestrian LOS methods to cover missing intersection types</td>
<td>3.6 (9)</td>
<td>3.8 (3)</td>
<td>3.6 (1)</td>
<td>3.0 (0)</td>
<td>4.8 (5)</td>
<td>2.4 (0)</td>
</tr>
<tr>
<td>Systemwide pedestrian connectivity and its relationship to pedestrian QOS</td>
<td>4.0 (18)</td>
<td>4.1 (5)</td>
<td>4.6 (7)</td>
<td>3.0 (1)</td>
<td>4.2 (3)</td>
<td>3.8 (2)</td>
</tr>
</tbody>
</table>
Task 3: State-of-the-Practice Summary
Task 4: Draft Work Plan

• Candidate research activities identified for Phase 2
  • Group 0: Research design and pilot testing
  • Group 1: Pedestrian safety countermeasures satisfaction
  • Group 2: Sidewalk and intersection QOS
  • Group 3: Operations measures

• Research approach, cost developed for 17 potential research activities
  • Some activities could be repeated (e.g., different countermeasures, different intersection control types)
Task 5: Panel Meeting — Selected Research Topics

• 6A: Detailed work scopes & IRB approval
• 6B: Pilot testing
• 6C: Naturalistic walking study
• 6D: Pedestrian safety countermeasure LOS
  • Rectangular rapid-flashing beacon (RRFB)
  • Median refuge islands
  • Leading pedestrian intervals
• 6E: Pedestrian network connectivity LOS
• 6F: Improvements to HCM pedestrian delay methods
• 6G: Progress reporting
Phase 2 Research
Task 6D: Pedestrian Safety Countermeasures (1)

• Three-pronged approach:
  • Field surveys of pedestrians + video to identify the conditions experienced by surveyed pedestrians
    • Relate pedestrian satisfaction to crosswalk-related factors
  • Longer-duration video observations of pedestrian–vehicle interactions at same crosswalks on different days
    • Do countermeasures affect these interactions?
  • Data from naturalistic walking study at same crosswalks, when participants happened to pass through them
    • Measure participants’ stress levels using biosensing wristbands
Task 6D: Pedestrian Safety Countermeasures (2)

• Data collection in 2 cities
  • Chapel Hill, NC (spring 2019)
  • Portland, OR (summer 2019)

• Three countermeasures (RRFBs, LPIs, median islands)
  • 10 treated sites & 10 control sites per countermeasure
  • Control sites matched to treated sites based on
    • Posted speed
    • AADT
    • Number of through lanes
    • Travel direction (one-way or two-way)
  • Control sites a mix of marked and unmarked crosswalks
Surveys (1)

- Pedestrians intercepted after making crossing
- Asked to rate satisfaction with crossing experience
  - Very satisfied, satisfied, dissatisfied, very dissatisfied
- Asked about trip purpose, trip length, familiarity with crossing, and if diverted to use the crossing
- Video observations of surveyed pedestrians
  - Delay, motorist yielding, avoidance maneuvers
- Field data collection about site characteristics
- Crossing ratings compared to crossing experiences
Surveys (2)
Surveys (3)

- 700 pedestrians interviewed
  - 0 to 50 per site (average 12 per site)
  - Unmarked crosswalks generally had the lowest volumes
- 57% response rate
### Summary Survey Results (1)

Table B9. Survey respondent satisfaction by crossing type

<table>
<thead>
<tr>
<th>Crossing Type</th>
<th># of Pedestrians Interviewed</th>
<th>Very Dissatisfied</th>
<th>Dissatisfied</th>
<th>Satisfied</th>
<th>Very Satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Signalized</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPI</td>
<td>150</td>
<td>0%</td>
<td>14%</td>
<td>67%</td>
<td>19%</td>
</tr>
<tr>
<td>Marked Control</td>
<td>117</td>
<td>4%</td>
<td>19%</td>
<td>59%</td>
<td>18%</td>
</tr>
<tr>
<td><strong>Unsignalized</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median Island</td>
<td>167</td>
<td>2%</td>
<td>10%</td>
<td>53%</td>
<td>34%</td>
</tr>
<tr>
<td>RRFB</td>
<td>108</td>
<td>8%</td>
<td>8%</td>
<td>44%</td>
<td>39%</td>
</tr>
<tr>
<td>Marked Control</td>
<td>104</td>
<td>13%</td>
<td>24%</td>
<td>52%</td>
<td>12%</td>
</tr>
<tr>
<td>Unmarked Control</td>
<td>56</td>
<td>32%</td>
<td>30%</td>
<td>29%</td>
<td>9%</td>
</tr>
</tbody>
</table>

Table B11. Pedestrian satisfaction at unsignalized intersections by speed limit

<table>
<thead>
<tr>
<th>Speed Limit (mph)</th>
<th># of Pedestrians Interviewed</th>
<th>Very Dissatisfied</th>
<th>Dissatisfied</th>
<th>Satisfied</th>
<th>Very Satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>42</td>
<td>5%</td>
<td>10%</td>
<td>48%</td>
<td>38%</td>
</tr>
<tr>
<td>25</td>
<td>192</td>
<td>4%</td>
<td>15%</td>
<td>53%</td>
<td>28%</td>
</tr>
<tr>
<td>30</td>
<td>107</td>
<td>15%</td>
<td>21%</td>
<td>38%</td>
<td>26%</td>
</tr>
<tr>
<td>35</td>
<td>85</td>
<td>11%</td>
<td>15%</td>
<td>53%</td>
<td>21%</td>
</tr>
<tr>
<td>45</td>
<td>9</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>
### Summary Survey Results (2)

#### Table B14. Trip purpose

<table>
<thead>
<tr>
<th>Trip Purpose</th>
<th>Number of Respondents</th>
<th>Percent of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Going home</td>
<td>193</td>
<td>32%</td>
</tr>
<tr>
<td>Running errands</td>
<td>150</td>
<td>25%</td>
</tr>
<tr>
<td>Going to work/school/the university</td>
<td>141</td>
<td>23%</td>
</tr>
<tr>
<td>Other</td>
<td>86</td>
<td>14%</td>
</tr>
<tr>
<td>Visiting friends/family</td>
<td>26</td>
<td>4%</td>
</tr>
<tr>
<td>Exercising</td>
<td>9</td>
<td>1%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>605</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

30% of trips transit-related

#### Table B16. Trip length

<table>
<thead>
<tr>
<th>Trip Length</th>
<th>Number of Respondents</th>
<th>Percent of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5 min</td>
<td>246</td>
<td>40%</td>
</tr>
<tr>
<td>5–10 min</td>
<td>152</td>
<td>25%</td>
</tr>
<tr>
<td>10–15 min</td>
<td>102</td>
<td>17%</td>
</tr>
<tr>
<td>&gt;15 min</td>
<td>118</td>
<td>19%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>618</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

#### Table B17. Responses to frequency of crosswalk use

<table>
<thead>
<tr>
<th>Frequency of Crosswalk Use</th>
<th>Number of Respondents</th>
<th>Percent of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 or more days a week</td>
<td>317</td>
<td>51%</td>
</tr>
<tr>
<td>1–3 days a week</td>
<td>141</td>
<td>23%</td>
</tr>
<tr>
<td>1–3 days a month</td>
<td>66</td>
<td>11%</td>
</tr>
<tr>
<td>Less than one day a month</td>
<td>48</td>
<td>8%</td>
</tr>
<tr>
<td>First time</td>
<td>49</td>
<td>8%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>621</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>
# Level-of-Agreement Questions

<table>
<thead>
<tr>
<th>Topic</th>
<th>Level of Agreement Statement</th>
<th>Number of Respondents</th>
<th>1 = Strongly Disagree</th>
<th>2 = Disagree</th>
<th>3 = Agree</th>
<th>4 = Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay</td>
<td>“I felt like I had to wait a long time to cross.”</td>
<td>375</td>
<td>26%</td>
<td>54%</td>
<td>14%</td>
<td>5%</td>
</tr>
<tr>
<td>Safety</td>
<td>“I felt like I might get hit by a car when crossing here.”</td>
<td>374</td>
<td>14%</td>
<td>37%</td>
<td>32%</td>
<td>16%</td>
</tr>
<tr>
<td>Safety</td>
<td>“I felt safe crossing here.”</td>
<td>373</td>
<td>12%</td>
<td>26%</td>
<td>47%</td>
<td>15%</td>
</tr>
<tr>
<td>Rushed</td>
<td>“I had enough time to cross this street.”</td>
<td>373</td>
<td>5%</td>
<td>18%</td>
<td>56%</td>
<td>21%</td>
</tr>
<tr>
<td>Rushed</td>
<td>“I felt rushed trying to cross this street.”</td>
<td>368</td>
<td>14%</td>
<td>42%</td>
<td>29%</td>
<td>14%</td>
</tr>
<tr>
<td>Route preference</td>
<td>“I went out of my way to cross here.”</td>
<td>373</td>
<td>18%</td>
<td>50%</td>
<td>24%</td>
<td>8%</td>
</tr>
<tr>
<td>Route preference</td>
<td>“Crossing here was the most direct route to get to where I was going.”</td>
<td>371</td>
<td>2%</td>
<td>11%</td>
<td>47%</td>
<td>40%</td>
</tr>
</tbody>
</table>
## Motorist Interaction Results

### Table B22 Satisfaction of pedestrians with motorist yielding at unsignalized crossings

<table>
<thead>
<tr>
<th>Motorist Yielded to Pedestrian</th>
<th>Number of Respondents</th>
<th>Very Dissatisfied</th>
<th>Dissatisfied</th>
<th>Satisfied</th>
<th>Very Satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorist yielded</td>
<td>309</td>
<td>5%</td>
<td>13%</td>
<td>50%</td>
<td>31%</td>
</tr>
<tr>
<td>Motorist did not yield</td>
<td>109</td>
<td>25%</td>
<td>21%</td>
<td>40%</td>
<td>14%</td>
</tr>
</tbody>
</table>

### Table B1 Pedestrian crossing satisfaction when delayed due to motorist

<table>
<thead>
<tr>
<th>Pedestrian Delay Due to Motorist</th>
<th>Number of Respondents</th>
<th>Very Dissatisfied</th>
<th>Dissatisfied</th>
<th>Satisfied</th>
<th>Very Satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not delayed due to motorist</td>
<td>295</td>
<td>6%</td>
<td>15%</td>
<td>49%</td>
<td>31%</td>
</tr>
<tr>
<td>Delayed due to motorist</td>
<td>121</td>
<td>21%</td>
<td>18%</td>
<td>45%</td>
<td>16%</td>
</tr>
</tbody>
</table>

### Table B24. Pedestrian crossing satisfaction as related to pedestrian delay

<table>
<thead>
<tr>
<th>Pedestrian Delay</th>
<th>Number of Respondents</th>
<th>Very Dissatisfied</th>
<th>Dissatisfied</th>
<th>Satisfied</th>
<th>Very Satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Unsignalized Crossing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delayed</td>
<td>129</td>
<td>22%</td>
<td>19%</td>
<td>45%</td>
<td>15%</td>
</tr>
<tr>
<td>Not Delayed</td>
<td>287</td>
<td>5%</td>
<td>14%</td>
<td>49%</td>
<td>31%</td>
</tr>
<tr>
<td><strong>Signalized Crossing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delayed</td>
<td>124</td>
<td>3%</td>
<td>18%</td>
<td>65%</td>
<td>15%</td>
</tr>
<tr>
<td>Not Delayed</td>
<td>130</td>
<td>1%</td>
<td>15%</td>
<td>65%</td>
<td>19%</td>
</tr>
</tbody>
</table>
## Multinomial Logistic Regression

### Unsignalized

<table>
<thead>
<tr>
<th>Variable</th>
<th>Response Level</th>
<th>Estimate</th>
<th>p-value</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aadt_s</td>
<td>Satisfied/Dissatisfied</td>
<td>-0.0438</td>
<td>0.0005</td>
<td>0.9570</td>
</tr>
<tr>
<td>Treatment_cat (RRFB/unmarked)</td>
<td>Satisfied/Dissatisfied</td>
<td>1.9572</td>
<td>&lt;0.0001</td>
<td>7.0790</td>
</tr>
<tr>
<td>Treatment_cat (marked/unmarked)</td>
<td>Satisfied/Dissatisfied</td>
<td>0.9843</td>
<td>0.0143</td>
<td>2.6760</td>
</tr>
<tr>
<td>Treatment_cat (median island/unmarked)</td>
<td>Satisfied/Dissatisfied</td>
<td>1.5496</td>
<td>0.0003</td>
<td>4.7100</td>
</tr>
<tr>
<td>Interaction_motorist_noyield (yes/no)</td>
<td>Satisfied/Dissatisfied</td>
<td>-0.6065</td>
<td>0.0313</td>
<td>0.5450</td>
</tr>
<tr>
<td>Interaction_ped_slowed (yes/no)</td>
<td>Satisfied/Dissatisfied</td>
<td>-1.2994</td>
<td>0.0039</td>
<td>0.2730</td>
</tr>
<tr>
<td>Intercept</td>
<td>Satisfied/Dissatisfied</td>
<td>0.9951</td>
<td>0.0157</td>
<td>-</td>
</tr>
</tbody>
</table>

All variables are statistically significant at the p=0.05 level

AIC = 403.169; Chi-Square < 0.0001

418 observations used

Not significant: posted speed, # of through lanes

### Signalized

<table>
<thead>
<tr>
<th>Variable</th>
<th>Response Level</th>
<th>Estimate</th>
<th>p-value</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>City (Chapel Hill/Portland)</td>
<td>Satisfied/Dissatisfied</td>
<td>-1.027</td>
<td>0.0072</td>
<td>0.358</td>
</tr>
<tr>
<td>City (Chapel Hill/Portland)</td>
<td>Very Satisfied/Dissatisfied</td>
<td>-1.519</td>
<td>0.0018</td>
<td>0.219</td>
</tr>
<tr>
<td>Volume_left_minor</td>
<td>Satisfied/Dissatisfied</td>
<td>-0.066</td>
<td>0.0033</td>
<td>0.629</td>
</tr>
<tr>
<td>Volume_left_minor</td>
<td>Very Satisfied/Dissatisfied</td>
<td>-0.463</td>
<td>0.4855*</td>
<td>0.936</td>
</tr>
<tr>
<td>Intercept</td>
<td>Satisfied/Dissatisfied</td>
<td>1.719</td>
<td>&lt;0.0001</td>
<td>-</td>
</tr>
<tr>
<td>Intercept</td>
<td>Very Satisfied/Dissatisfied</td>
<td>2.256</td>
<td>0.0036</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: *Lack of statistical significance for the given odds ratio.

Not significant: posted speed, # of through lanes, AADT, LPI presence

### Table B1. Logistic regression model for signalized sites without survey results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Response Level</th>
<th>Estimate</th>
<th>p-value</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>City (Chapel Hill/Portland)</td>
<td>Satisfied/Dissatisfied</td>
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<td>0.0072</td>
<td>0.358</td>
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<tr>
<td>City (Chapel Hill/Portland)</td>
<td>Very Satisfied/Dissatisfied</td>
<td>-1.519</td>
<td>0.0018</td>
<td>0.219</td>
</tr>
<tr>
<td>Volume_left_minor</td>
<td>Satisfied/Dissatisfied</td>
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<td>0.0033</td>
<td>0.629</td>
</tr>
<tr>
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</tr>
<tr>
<td>Intercept</td>
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<td>-</td>
</tr>
<tr>
<td>Intercept</td>
<td>Very Satisfied/Dissatisfied</td>
<td>2.256</td>
<td>0.0036</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: *Lack of statistical significance for the given odds ratio.
Video Observation Results

- Looked at pedestrian delay, crossing time, percent yielding, percent crossings with no vehicle interaction, percent legal crossers, percent 2-stage crossers
- Uncontrolled crossings
  - Motorist yielding rates higher at treated (RFFB, median island) sites than at untreated (marked/unmarked xwalk) sites
- Signalized crossings
  - Pedestrian signal compliance better at LPI sites than at control sites
Task 6C: Naturalistic Walking Study

• Purposes:
  • Compare survey and video observations with pedestrian stress readings at study crosswalks
  • Evaluate variations in pedestrian stress during trip
• 15 recruited participants made normal walking trips over the course of a week
• Wore Empatica E4 biosensing wristband
  • Measures skin conductance (stress), heart rate
• Carried GPS unit
  • Provides location to match to wristband data
Physiological Data
Data Collection Issues

- Participants forgetting to start wristband sessions or carry GPS units
- Battery life on 3 GPS units (3 days vs. 1 week)
- GPS vendor not setting location interval to 5 seconds from default 1 minute when activating devices
- Obtained useful data for 21 out of expected 60 trips
Naturalistic Study Results

• No significant relationship found between stress and
  • Crossings at study sites
  • Crossings generally
• Stress level
  • Higher on collector & arterial roadways
  • Higher in industrial and mixed-use environments
  • Lower in low-density residential, forest, park, and university campus settings
• Heart rate
  • Higher on collectors & in industrial, mixed-use settings
  • Lower on paths & in environments with AADT < 4,000
Task 6F: HCM Pedestrian Delay

- Uncontrolled crossings:
  - Fixed yielding rate issues
  - Modeled delay compared to Task 6D field data
    - Can reliably predict delay
    - More spread in the data when turn lanes present at crossing
  - Reliability of delay estimate highly dependent on
    - Pedestrian crossing speed (4.3 ft/s HCM, 4.7 ft/s field)
    - Start-up and end clearance time (3.0 s HCM, 0.0 s field)
Task 6E: Network Connectivity LOS

- Develop and test a method for evaluating the quality of service (QOS) for a pedestrian network covering a large area, ranging in size from a neighborhood or campus to an entire city.
- FHWA’s Guidebook on Measuring Multimodal Network Connectivity identifies these factors:
  - Network quality
  - Network completeness
  - Network density
  - Route directness
  - Access to destinations
Challenges with Existing Measures

- Generally small block sizes
- High intersection density, high street density
- High internal connectivity, low external connectivity

- Range of block sizes
- Moderate intersection density, moderate street density
- Low internal connectivity, Relatively high external connectivity

- Low intersection density, low street density
- Moderate block sizes
- Few choices of routes, but network is complete and connected
Network Quality

- Investigated two planning-level measures of pedestrian facility quality
  - 2009 Florida Pedestrian LOS
  - Oregon DOT Pedestrian Level of Traffic Stress
- Tested measures on a pedestrian facility dataset covering all Florida arterials and collectors
Connectivity Island Mapping (1)

• Use GIS to identify all streets connected at a user-defined PLTS
  • ODOT PLTS method for links
  • Planning-level version of NCHRP 17-87 xing satisfaction method for intersections

Figure D4. Connectivity Island Mapping (Fort Collins, CO)

Source: FHWA Guidebook on Measuring Multimodal Network Connectivity
Connectivity Island Mapping (2)

- Network quality
  - Miles/% of network at a given PLTS
- Network completeness
- Network density
  - Average miles per island at a given PLTS
- Route directness
  - Shortest path at a given PLTS vs. straight-line (air) distance for given O-D
- Access to destinations
  - % destinations accessible at a given PLTS for a given origin
Phase 3 Products
Task 7: Guide to Pedestrian Analysis
Task 8: HCM Chapter Updates

- Major revisions to ped material in
  - Chapter 19 (signalized intersections)
  - Chapter 20 (two-way stop-control)
  - Chapters 31, 32 (example problems)

- Smaller revisions to
  - Chapter 18 (midblock xing difficulty factor)
  - Chapter 9 (glossary & symbols)

- Updates to ped section of HCM Planning Guide (NCHRP Report 825)

- Computational engines
Task 9: Implementation Materials

- Webinar slides
- Short video about the Guide
- Implementation plan
Task 10: Outreach

- Peer exchange workshop
- Webinar (spring 2020 requested)
- Updates to TRB committees
Tasks 11 & 12: Draft & Final Deliverables

- Project scheduled completion date: April 20, 2020