Representing Pedestrian Tours in Contemporary Travel Forecasting Models

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Presentation for
iCity-ORF: 4th Annual Research Day
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Toronto, Canada
31 May 2019
Presentation Outline

1. Structure of Concepts and Background
2. Evolution of Travel Forecasting Models
3. Pedestrian Tours: Typology, Complexity, and Costs
4. Characteristics Influencing Walking Decisions
5. Primary Obstacles to Improve Pedestrian Models
6. Future Work
Structure of Concepts

Exogenous variables known to influence walking

Density
Design
Land Use Mix
Transportation System

Aesthetic Design
Cost
Safety & Security
Multi-mode
Assessibility
Connectivity
Friendliness

Built Environment

Transport options

Non-Motorized Travel Forecasting Model

Trip Generation

Mode Choice

Generalized Cost

Activity-based Model

How many activities can be accomplished by walking in different built environments

Data gathering

Introduction to activity-based models

Enhanced models necessary

Household representation

Social Network
Mobility Culture
Habit

Individual

......

Activity List Recurring

Motorized Mode

Pedestrian Tour

Individual

......

Household

Travel Length, Travel Duration, Location, # of activities

Empirically Derived Data from Novel Source

Environment

Climate
Location
Topography

Transport options

Climate
Location
Topography

Introduction to activity-based models

Household representation

Enhanced models necessary

Data gathering
Some Facts: Mode of Transportation to Work

<table>
<thead>
<tr>
<th>Province</th>
<th>Walked (%) 2006</th>
<th>Walked (%) 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>6.4</td>
<td>5.5</td>
</tr>
<tr>
<td>N.L.</td>
<td>7.7</td>
<td>4.9</td>
</tr>
<tr>
<td>P.E.I.</td>
<td>6.6</td>
<td>5.4</td>
</tr>
<tr>
<td>N.S.</td>
<td>8.2</td>
<td>6.3</td>
</tr>
<tr>
<td>N.B.</td>
<td>6.6</td>
<td>4.6</td>
</tr>
<tr>
<td>Que.</td>
<td>6.6</td>
<td>5.6</td>
</tr>
<tr>
<td>Ont.</td>
<td>5.6</td>
<td>5.3</td>
</tr>
<tr>
<td>Man.</td>
<td>7.4</td>
<td>5.6</td>
</tr>
<tr>
<td>Sask.</td>
<td>5.6</td>
<td>5.6</td>
</tr>
<tr>
<td>Alta.</td>
<td>5.9</td>
<td>4.5</td>
</tr>
<tr>
<td>B.C.</td>
<td>6.9</td>
<td>6.8</td>
</tr>
</tbody>
</table>

**KW Region**

<table>
<thead>
<tr>
<th>Mode of Transportation</th>
<th>2006 (%)</th>
<th>2016 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car, Truck or Van (Driver)</td>
<td>78.7</td>
<td>81.0</td>
</tr>
<tr>
<td>Car, Truck or Van (Passenger)</td>
<td>9.3</td>
<td>6.7</td>
</tr>
<tr>
<td>Public Transit</td>
<td>4.6</td>
<td>5.9</td>
</tr>
<tr>
<td>Walked</td>
<td>5.1</td>
<td>4.4</td>
</tr>
<tr>
<td>Bicycle</td>
<td>1.6</td>
<td>1.1</td>
</tr>
<tr>
<td>Other</td>
<td>0.8</td>
<td>0.8</td>
</tr>
</tbody>
</table>

SOURCE: Region of Waterloo Census 2016, Place of work and commuting to work
Behavioral Representation in Models

- **Household Travel:**
  - Decision-making: long-term; mid-term; short-term
  - Generate different types of activities
  - Share resources and experiences
  - Budget: Money/Time/Resources/Chauffer
Evolution of Travel Forecasting Models

Trends:

- Trips: Few large TAZs → Thousands of TAZs
- Activities: Individual → Household
- Parcels: Discrete time periods → Time of day → All
- CBD: Paper-based survey → Novel methods

Behavioral representation, decision-making...

WATERLOO PUBLIC TRANSPORTATION INITIATIVE
Advancing Transit Solutions through Research
### Typology and Complexity of Pedestrian Tours

#### Typology (Purpose & Access Mode)
- Recreational and Utilitarian \(^{(Mokhtarian \& Salomon, 2001)}\)
- Unimodal and Multimodal (access modes)

#### Complexity (Distribution of destinations, \# of activities) \(^{(Ho \& Mulley, 2013)}\)

<table>
<thead>
<tr>
<th></th>
<th>Single Purpose</th>
<th>Multiple Purposes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Destination</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Multiple Destinations</td>
<td>NA</td>
<td>✓</td>
</tr>
</tbody>
</table>
**Costs of Individual Tours (Total)**

Case 1 Total Cost = \( \sum TT + \sum AT = OD_F + D_F D_{V1} + AT_1 + D_{V1} D_{V3} + \ldots \)

Case 2 Total Cost = \( \sum TT + \sum AT = OD_F + D_F D_{V4} + AT_4 + D_{V4} O \)

Maximize \( HUF = H(u_1, u_2) \)

Choose pedestrian tour’s utility > auto tour’s utility

Social Impacts: Case 2 > Case 1
## HH Characteristics Influencing Walking Decisions

<table>
<thead>
<tr>
<th></th>
<th>Recreational Walking</th>
<th>Utilitarian Walking</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factors</strong></td>
<td><strong>Influence</strong></td>
<td><strong>Factors</strong></td>
</tr>
<tr>
<td>HH Composition:</td>
<td>+</td>
<td>Car Ownership: o</td>
</tr>
<tr>
<td>Presence of children</td>
<td></td>
<td># of drivers &gt; vehicles</td>
</tr>
<tr>
<td>Age: 65+</td>
<td>+</td>
<td>Age: 65+ &lt; 30</td>
</tr>
<tr>
<td>Gender: men</td>
<td>-</td>
<td>Gender</td>
</tr>
<tr>
<td>Income: &lt;$30k</td>
<td>+</td>
<td>Income: &gt;$30k</td>
</tr>
<tr>
<td>Education: higher</td>
<td>+</td>
<td>Education: higher</td>
</tr>
</tbody>
</table>
# Locational Attributes Influencing Walking

<table>
<thead>
<tr>
<th>Level</th>
<th>Factors</th>
<th>Influence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Utilitarian</strong></td>
<td>Higher densities, compact, and a mix of uses</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Proximity to non-residential destinations/transit</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Land use diversity</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Density of destinations</td>
<td>+</td>
</tr>
<tr>
<td><strong>Recreational</strong></td>
<td>Quality and proximity to natural facilities such as parks</td>
<td>+</td>
</tr>
<tr>
<td><strong>Route</strong></td>
<td>Shorter distance between destinations</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Sidewalk (more important in commercial areas)</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>Visually interesting and attractive landscaping and building features (Aesthetic)</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td>High traffic volume/noise/poor lighting</td>
<td>-</td>
</tr>
</tbody>
</table>

(Saelens & Handy, 2010; Cervero & Kockelman, 1997)
Locational Attributes Influence Walking

- **Residential and work area attributes:**
  - High utility destination area (support MPSD), but different desirable functions
  - Within energy expenditure
  - Accessibility to destinations
  - Diversity and density of land uses
  - Safe neighborhood
  - Within time budget
  - Comfort and pleasure design
Primary Obstacles to Improve Pedestrian Models

- A lack of empirical data (Singleton et al., 2018)
- Inappropriate travel survey design/methods (Harding, et al., 2018)
- Inappropriate zonal structure (Iacono, 2010; Clifton, 2016)
- Failure to consider pedestrian tours in satisfying activities
- Failure to develop appropriate cost representation for pedestrians

<table>
<thead>
<tr>
<th>Tour Segments/Trips</th>
<th>Mode</th>
<th>Time</th>
<th>Zone</th>
<th>Location</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Transit</td>
<td>7:09</td>
<td>221</td>
<td>Home</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>7:13</td>
<td>312</td>
<td>Location 1</td>
<td>Activity 1</td>
</tr>
<tr>
<td>2</td>
<td>Transit</td>
<td>7:17</td>
<td>312</td>
<td>Location 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>7:35</td>
<td>342</td>
<td>Location 2</td>
<td>Activity 2</td>
</tr>
<tr>
<td>3</td>
<td>Walk</td>
<td>1:56</td>
<td>342</td>
<td>Location 2</td>
<td>Activity 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1:59</td>
<td>432</td>
<td>Location 3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Walk</td>
<td>2:07</td>
<td>432</td>
<td>Location 3</td>
<td>Activity 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2:10</td>
<td>342</td>
<td>Location 2</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Transit</td>
<td>7:12</td>
<td>342</td>
<td>Location 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>7:33</td>
<td>221</td>
<td>Home</td>
<td></td>
</tr>
</tbody>
</table>

Missing short walking trips in models
## Data Collection Methods: Travel Survey

### TRAVEL DIARY

<table>
<thead>
<tr>
<th>InSTRUCTIONS: PLEASE CARRY THIS DIARY WITH YOU THROUGHOUT THE TRAVEL DAY SHOWN AT THE LEFT. USE IT TO RECORD EACH TRIP YOU MAKE INCLUDING THE ITEMS SPECIFIED BELOW. DO NOT RECORD WALKING OR BICYCLE TRIPS UNLESS TO GO TO WORK. PLEASE LEAVE THE FILLED IN CARD IN A CONVENIENT PLACE AT HOME SO IT WILL BE AVAILABLE WHEN OUR INTERVIEWER CALLS. USE THE BACK OF THIS CARD AND AN EXTRA CARD IF NECESSARY.</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHERE DID THIS TRIP BEGIN?</td>
</tr>
<tr>
<td>TRIP PURPOSE</td>
</tr>
<tr>
<td>Name of person</td>
</tr>
<tr>
<td>Who paid for parking?</td>
</tr>
<tr>
<td>1. What was your activity?</td>
</tr>
<tr>
<td>3. What time did your activity start?</td>
</tr>
<tr>
<td>5. Did you have to travel to get to this activity?</td>
</tr>
<tr>
<td>Yes = Go to next activity</td>
</tr>
<tr>
<td>7. What time did your travel start?</td>
</tr>
<tr>
<td>9. How did you travel to the activity? (Circle one and follow instructions)</td>
</tr>
</tbody>
</table>

### Private vehicle | Public bus | Train | Walk | Bicycle | School bus | Other |
| Answer Q. 9-16 | Answer Q. 17-20 | Answer Q. 29-32 |

### If you traveled by public bus, train answer Q. 17-20 then 29-32

<table>
<thead>
<tr>
<th>If you traveled by public bus, train answer Q. 17-20 then 29-32</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. Were you the?</td>
</tr>
<tr>
<td>Driver</td>
</tr>
<tr>
<td>12. Where did you park?</td>
</tr>
<tr>
<td>Did not park</td>
</tr>
<tr>
<td>14. How much did you pay for parking?</td>
</tr>
<tr>
<td>$</td>
</tr>
</tbody>
</table>

### Meyer & Miller, 2001 p. 192

**WatTrack**

Press the red button to start recording your travel. Press the grey button to stop recording your travel. A minimum of 24 non-consecutive hours are required for your travel data to be incorporated into the study.

Last Sync: Feb 1, 2017 2:00 AM
Future Work

- Appropriate zonal structure
- Novel data collection methods (smartphone-based passive data collection)
- Tactical level pedestrian behavior and route choice
- Segment level pedestrian environment measurement
Future Work: Key Elements in Activity-based Model

Better Representation of Pedestrian Behaviors

Population Synthesizer
- Activity List Generation
  - Sequence of Activities (Time of Day)
  - Utility of Destination
  - Tour Mode (Unimodal/Multimodal)
- Tours/O-D Matrices by Mode, Purpose, Time of Day
- Implementation; Assignment

Built Environment
- Support/Promote Walking
- Sequence of Activities (Time of Day, Typology)
- Complexity (# of activities)
- Utility of Destination
- Tour Mode (Unimodal/Multimodal)
- Pedestrian Tour
- Activity List Completed

Activity Scheduling
- Capability
- Coupling
- Authority
- Situational
- Household Resources
- Tours/O-D Matrices by Mode, Purpose, Time of Day
- Implementation; Assignment
Contacts

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Waterloo Public Transportation Initiative
https://uwaterloo.ca/waterloo-public-transportation-initiative/
References


References


