SPATIAL MODELS FOR THE STATEWIDE EVALUATION OF TRANSIT-SUPPORTIVE ZONES

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What are the challenges of transit in rural states?

- Spatial Constraints
- Long Travel Distances
- Low Densities

What needs to be done?

- Move beyond large-rural analysis for local services
- Define areas that are transit serviceable statewide
- Develop objective process to determine transit demand
- Determine demand potential and VMT reduction
What has been done for spatial transit demand research?

- Quality of Transit Service
- Access and Coverage
- Density and Land Use

What are the shortfalls of past spatial research?

- Zonal level and/or small extents with urban focus
- Assumptions of homogeneity within zones
Vermont E911 Database

Number of Dwelling Units for Multi-Family Structures

Employment Statistics by Land-Use Type

Trip Generation Rates by Land-Use Type

Hourly Distribution of Trips

Vermont Statewide-Travel Demand Model
**METHODS**

**STEP 1:** Apply dwelling unit values to multi-family structure points

E911 Points
- Single-Family Structures
- Multi-Family Structures
- Non-Residential Structures
METHODS

Transit- Supportive Zones

STEP 1: Apply dwelling unit values to multi-family structure points

STEP 2: Apply employment levels to each non-residence point
**METHODS**

**Transit- Supportive Zones**

**STEP 1:** Apply dwelling unit values to multi-family structure points

**STEP 2:** Apply employment levels to each non-residence point

**STEP 3:** Apply trip generation rates to all points

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**Demand Potential (DP)**

- Single Family Point
- Multi-Family Point
- Non-Residential Point
STEP 1: Apply dwelling unit values to multi-family structure points

STEP 2: Apply employment levels to each non-residence point

STEP 3: Apply trip generation rates to all points

STEP 4: Divide demand potential for each point by the demand potential for a single-family home
**STEP 5:** Sum the EDP for each acre

**EXAMPLE:** Montpelier, VT

<table>
<thead>
<tr>
<th>EDP</th>
<th>High : 2846</th>
<th>Low : 0</th>
</tr>
</thead>
</table>
**STEP 5:** Sum the EDP for each acre

**EXAMPLE:** Montpelier, VT

EDP

High : 2846
Low : 0
**STEP 5:** Sum the EDP for each acre

**STEP 6:** Calculate the spatial grid Neighborhood Measure value

**EXAMPLE: Montpelier, VT**

Neighborhood Measure

High : 11742

Low : 0
**METHODS**

**STEP 5:** Sum the EDP for each acre

**STEP 6:** Calculate the spatial grid Neighborhood Measure value

**EXAMPLE:** Montpelier, VT

Neighborhood Measure

High: 11742

Low: 0
**STEP 5:** Sum the EDP for each acre

**STEP 6:** Calculate the spatial grid Neighborhood Measure value

**STEP 7:** Determine the spatial grid Neighborhood Maximum value
**STEP 5:** Sum the EDP for each acre

**STEP 6:** Calculate the spatial grid Neighborhood Measure value

**STEP 7:** Determine the spatial grid Neighborhood Maximum value
**METHODS**

Transit- Supportive Zones

**STEP 5:** Sum the EDP for each acre

**STEP 6:** Calculate the spatial grid Neighborhood Measure value

**STEP 7:** Determine the spatial grid Neighborhood Maximum value

**STEP 8:** Identify local maximums
**STEP 5:** Sum the EDP for each acre

**STEP 6:** Calculate the spatial grid Neighborhood Measure value

**STEP 7:** Determine the spatial grid Neighborhood Maximum value

**STEP 8:** Identify local maximums

**STEP 9:** Apply service area to local maximum centroid and sum EDPs within service area
Criteria to be a Transit-Supportive Zone

- Must have a local max as centroid
- Σ EDP must be greater than or equal to seven at the central acre
- Σ EDP must be greater than or equal to 3520 for the entire service zone
Transit-Supportive Demand Proportion

- Sum of EDP in the portion of each TSZ falling within the n\textsuperscript{th} TAZ (X)
- Sum of EDP in the n\textsuperscript{th} TAZ (Y)
- Divide (X) by (Y)
- Represents the proportion of trips within a TAZ that could \textit{theoretically} be served by transit
Transit-Supportive Demand Proportion

Example: Montpelier, VT
Potential Transit Demand (Person Trips)

- Trip must originate in and be destined for a TSZ
- Gravity update of state model using TSDP as the “growth” factor
- Reduced by 7.6% for trips occurring outside of typical transit operation hours
- Subtracted existing transit trips

**EXAMPLE: Montpelier, VT**

<table>
<thead>
<tr>
<th>Person Trips</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 1000</td>
</tr>
<tr>
<td>1000 - 5000</td>
</tr>
<tr>
<td>5000 - 10000</td>
</tr>
<tr>
<td>10000 - 20000</td>
</tr>
<tr>
<td>&gt; 20000</td>
</tr>
</tbody>
</table>
Estimation of VMT Reduction

- Divide person-trips ($T$) by auto-occupancy for a given trip-purpose ($P$)
- Number of trips ($A$) occurring between OD pairs
- Shortest network distance ($B$) between OD pairs
- Number of trips ($C$) occurring within TAZ
- Intrazonal trip length ($D$) approximated as radius of a circle with area equivalent to TAZ area

\[
AT_{ij} = \sum_p \left[ \sum_{jp} \frac{TT_{ij}(p)}{AO_p} \right] = \frac{T}{P}
\]

\[
RVMT = \sum_{ij} (AT_{ij} \times \text{Min}[DN_{ij}]) + \sum_i (AT_i \times D_{TAZ})
\]

\[
= (A \times B) + (C \times D)
\]
### RESULTS

#### Introduction

<table>
<thead>
<tr>
<th>% WITHIN TSZs BY REGION</th>
<th>MPO</th>
<th>Non-MPO</th>
<th>Vermont (Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Area</td>
<td>6</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Residence Points</td>
<td>37</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>Employment Points</td>
<td>66</td>
<td>33</td>
<td>39</td>
</tr>
</tbody>
</table>
## RESULTS

<table>
<thead>
<tr>
<th>TRIP PURPOSE</th>
<th>AUTO TRIPS</th>
<th>AUTO VMT (miles)</th>
<th>% “REDUCTION”</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Trips</td>
</tr>
<tr>
<td>Home-Based Work</td>
<td>137,210</td>
<td>938,895</td>
<td>37</td>
</tr>
<tr>
<td>Home-Based Shopping</td>
<td>62,910</td>
<td>392,408</td>
<td>38</td>
</tr>
<tr>
<td>Home-Based School</td>
<td>4,964</td>
<td>25,443</td>
<td>38</td>
</tr>
<tr>
<td>Home-Based Other</td>
<td>133,599</td>
<td>601,829</td>
<td>34</td>
</tr>
<tr>
<td>Non-Home Based</td>
<td>194,161</td>
<td>635,924</td>
<td>64</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>532,844</strong></td>
<td><strong>2,594,499</strong></td>
<td><strong>43</strong></td>
</tr>
</tbody>
</table>

*Introduction*

*Background*

*Data*

*Methods*

*Conclusions*
Transit-Supportive Zones

- Data and methodology used
- TSZs are spread throughout the state
- 1% of VT land area is transit-supportive

Estimation of Demand

- 43% of all trips occur within or between TSZs
  - 86% Intercity
  - 14% Intracity
- Theoretically if all “potential” could be served
  - 21% statewide reduction in VMT
CONCLUSIONS

Importance of disaggregate data
- Generally much more available for urban areas
- Illustrates application of E911
- Identifies need for similar data on national scale
- Application as data-driven decision tool

TSZs and Potential Transit Demand
- Relatively large proportion of substitutable intercity trips
- Not just in the one Vermont MPO
- Unlikely all identified potential can be connected
Spatial analysis is not stand-alone
• Supplementary material
  • Social equity and need
  • Energy efficiency and network walkability

Indication of location and level of demand
• Increase transportation system efficiency
• Develop spatially-optimal fixed-route transit network
• Where to serve with fixed route or demand responsive
Preliminary work

- Model transit networks
  - Spatially-optimal
  - Equitably-augmented
  - Socially-equitable

- Able to identify
  - Underserved locations
  - Over-served locations
  - Shortest-path discrepancies
CONCLUSIONS

Preliminary work

- Model transit networks
  - Spatially-optimal
  - Equitably-augmented
  - Socially-equitable

- Able to identify
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  - Over-served locations
  - Shortest-path discrepancies
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