Accessibility Impacts of Park-and-Ride Systems

Presented by: Kristin Carlson

“Accessibility Impacts of Park-and-Ride Systems” accepted for presentation at the 98th Annual Meeting of the Transportation Research Board, Washington, D.C., 2019

Accessibility

Accessibility measures the ease of reaching valued destinations

Every potential trip has a value---the benefits we get from reaching the destination

Every trip has a cost---time, money, lost opportunity
Visualizing Cumulative Accessibility

10 minute accessibility = 1

20 minute accessibility = 3

30 minute accessibility = 4

Twin Cities Study Setup

- Inputs
  - 2016 GTFS records Metro Transit, MVTA
  - 2016 Road Network
  - Origins: 3,030 Transportation Analysis Zones (TAZ)
  - PNRs: 114 Facilities
  - Destinations: 108,000 Census Blocks
  - 2016 Jobs data
- Analysis Time/Day
  - 6:00—9:00 AM
  - Wed. October 5th 2016
Park-and-Ride Accessibility Results

- PNR average access to jobs at 6:00—9:00 AM within 30 minutes of travel time.
  - Minnesota River Valley “cuts off” PNR accessibility south of the river.
- Worker-weighted average access: 51,902 jobs
  - 3x the access of walk-up transit for the average commuter.

Conclusions from Time-based Accessibility Analyses

- The Park-and-Ride accessibility profile is a blend of auto and walk-up transit profiles.

- Worker-weighted average access: 865,337 jobs
- Worker-weighted average access: 15,868 jobs
- Worker-weighted average access: 51,902 jobs
Conclusions from Time-based Accessibility Analyses

• Suburbs near dense park-and-ride zones have greater job accessibility by park-and-ride mode compared to walk-up transit.

<table>
<thead>
<tr>
<th></th>
<th>15min</th>
<th>30min</th>
<th>45min</th>
<th>60min</th>
<th>75min</th>
<th>90min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walk-up Transit</td>
<td>0.58%</td>
<td>1.15%</td>
<td>3.65%</td>
<td>7.76%</td>
<td>8.06%</td>
<td>7.98%</td>
</tr>
<tr>
<td>Park-and-ride</td>
<td>0.71%</td>
<td>4.47%</td>
<td>16.15%</td>
<td>26.01%</td>
<td>30.67%</td>
<td>32.78%</td>
</tr>
</tbody>
</table>

Walk-up transit and park-and-ride accessibility as a percent of automobile accessibility.

• Park-and-ride is more competitive than walk-up transit at every travel time threshold due to increased suburban and exurban access to transit stops.
  • Access to a vehicle improves access to transit stops.
Monetary Accessibility

Visualizing Cumulative Monetary Accessibility

- $1.00 accessibility = 1
- $2.00 accessibility = 3
- $3.00 accessibility = 4
Monetary Accessibility: Cost Factors

- The cost factors listed below are internal to the user meaning we do not include negative externalities such as environmental, health, and safety costs.

<table>
<thead>
<tr>
<th>Cost Factor</th>
<th>Auto</th>
<th>Transit</th>
<th>P&amp;R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel ($2.335/gal)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Vehicle Repair ($0.019/mi, $0.017/mi)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Vehicle Depreciation ($0.025/mi, $0.030/mi)</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Parking ($0—$15)</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Transit Fare ($3.25)</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Wage-Value of Time ($18.03/hr)</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Park-and-Ride accessibility within $15.00 of travel

- Cost scenario includes:
  - Fuel
  - Vehicle Repair per mile
  - Vehicle Depreciation per mile
  - Transit Fare
  - Wage-VOT

- The average commuter can reach 1,306 jobs within $15.00 of travel by park-and-ride mode.
- The job accessibility within $15.00 by park-and-ride is only 0.25% of the automobile accessibility for the same cost.
Walk-up transit accessibility as a percent of auto accessibility

Average Commuter Experiences
- $15.00–4.67%
- $20.00–8.55%
- $25.00–9.81%
- $30.00–8.96%
that of automobile

Park-and-Ride accessibility as a percent of auto accessibility

Average Commuter Experiences
- $25.00–2.16%
- $30.00–4.98%
- $35.00–9.49%
- $40.00–14.83%
that of automobile
Conclusions from Monetary Accessibility Analysis

- Monetary accessibility captures how drivers view their cost of travel, when negative externalities are excluded. Automobile accessibility appears much greater than other modes.
- Monetary scenarios with and without VOT suggest that increasing VOT is associated with a perceived decrease in PNR accessibility relative to automobile accessibility.

<table>
<thead>
<tr>
<th>Monetary Accessibility</th>
<th>$5.00</th>
<th>$10.00</th>
<th>$15.00</th>
<th>$20.00</th>
<th>$25.00</th>
<th>$30.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>PNR Monetary</td>
<td>0.00%</td>
<td>0.05%</td>
<td>0.25%</td>
<td>0.81%</td>
<td>2.16%</td>
<td>4.98%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time-Accessibility</th>
<th>15min</th>
<th>30min</th>
<th>45min</th>
<th>60min</th>
<th>75min</th>
<th>90min</th>
</tr>
</thead>
<tbody>
<tr>
<td>PNR Time-Accessibility</td>
<td>0.71%</td>
<td>4.47%</td>
<td>16.15%</td>
<td>26.01%</td>
<td>30.67%</td>
<td>32.78%</td>
</tr>
</tbody>
</table>

Takeaways

- The PNR methodology captures the accessibility impacts from allowing driving and parking at transit facilities as opposed to walking.
- Walk-up transit accessibility currently underestimates the impact of park-and-ride systems on regional accessibility.
- The benefit park-and-rides provide to suburban and exurban accessibility levels should be considered during transportation impact analyses and facility location studies.
- The average PNR commuter experiences 3x the accessibility compared to walk-up transit commuters. This may be an outcome of the investments made in the Twin Cities PNR system.
Thank you for your attention

Questions?

Thank you
Methodology for building mixed-mode travel time matrices (remove)

- Compute travel time matrices for:
  - **Auto travel time matrix**
    - Data: TomTom link speeds
    - Origin home $i$ to P&R $k$
  - **Transit travel time matrix**
    - Data: General Transit Feed Specification (GTFS)
    - P&R $k$ to job destination $d$

<table>
<thead>
<tr>
<th>Origin $i$</th>
<th>Park-and-Ride $k$</th>
<th>Destination $d$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$i_1$</td>
<td>$t_{i,k}$</td>
<td>$d_1$</td>
</tr>
<tr>
<td>$i_2$</td>
<td>$t_{i,k}$</td>
<td>$d_2$</td>
</tr>
<tr>
<td>$i_3$</td>
<td>$t_{i,k}$</td>
<td>$d_3$</td>
</tr>
</tbody>
</table>

Methodology for building mixed-mode travel time matrices (remove)

- For all origins $i$:
  - Select departure time $d_t$
  - Select PNR $k$
    1. Query travel time to PNR $c_{i,k}$
    2. Query travel time vector for PNR->All Destinations $v_{k,D}$
    3. Total Travel Time $v'_{k,D}$
  - Compare $v'_{k,D}$ to $v'_{k+1,D}$, Retain min travel times
Matrix Linking Algorithm Output (remove)

• Upon completion of the matrix-linking algorithm, the minimal travel time as a function of PNR is retained for the OD set.
• Figurative travel time matrix shown below.

<table>
<thead>
<tr>
<th>Origin i</th>
<th>Destination j</th>
<th>Departure Time $d_{i}$</th>
<th>Travel Time $c_{i,j}$</th>
<th>PNR k</th>
</tr>
</thead>
<tbody>
<tr>
<td>$i_1$</td>
<td>$j_1$</td>
<td>$d_{7:00}$</td>
<td>$c_{1,1}$</td>
<td>$k_1$</td>
</tr>
<tr>
<td>$i_2$</td>
<td>$j_2$</td>
<td>$d_{7:00}$</td>
<td>$c_{2,2}$</td>
<td>$k_2$</td>
</tr>
<tr>
<td>$i_3$</td>
<td>$j_3$</td>
<td>$d_{7:00}$</td>
<td>$c_{3,3}$</td>
<td>$k_3$</td>
</tr>
</tbody>
</table>

• Finally, use the mixed-mode travel time matrix in a cumulative access to destinations calculation.

Scenario A Results
Park-and-Ride accessibility within $15.00 of travel

- Cost scenario A includes:
  - Fuel
  - Vehicle Repair per mile
  - Vehicle Depreciation per mile
  - Transit Fare

- The average commuter can reach 98,000 jobs within $15.00 of travel by park-and-ride mode.
- The job accessibility within $15.00 by park-and-ride is 5.20% of the automobile accessibility for the same cost.

-- Average Commuter Experiences
- $10.00 – 0.75%
- $15.00 – 5.20%
- $20.00 – 14.53%
- $25.00 – 23.68%
that of automobile
Park-and-Ride Accessibility as a Percent of Auto Accessibility (remove)

• PNR accessibility as a percent of auto accessibility within 30 minutes of travel

• Notable zones:
  • I-35W Rosedale area
  • I-694 & Highway 252 interchange