Park-and-Ride Success: A GIS Analysis

J. M. (Mike) Pogodzinski
San Jose State University

John Niles
Global Telematics

ESRI User Conference, July 22, 2015
Acknowledgements

- Mineta Transportation Institute (project oversight)
- California Department of Transportation (funding)
- King County Metro, Seattle, Washington (data & review)
- Santa Clara VTA, Valley Transportation Authority (data)
- Gloria Yan and Yanan Li, San Jose State University research assistants
**Agenda**

- **The Objective:** Examine the effect of park-and-ride availability on the efficiency of bus transit

- **Two basic approaches:**
  - Route-level analysis
  - Stop-level analysis

- **Two Case Studies:**
  - King County Metro (Seattle)
  - Santa Clara Valley Transportation Authority [VTA] (San Jose)

- **GIS methods employed:**
  - Proximity of bus stops and routes to Park-and-Ride (PnR) lots
  - Spatial Statistics
  - Spatial Regression

- **Future Issues and Methods**
  - Use Network Analyst
  - Develop Python Implementation
Basics of Park & Ride (P&R) in USA and Canada

• Because of existing patterns of residential development, private vehicles are an important means of access to public transit
• P&R extends access to transit beyond the end of the line
• Important in suburban locations for commuting to work
• APTA trade association reports 210K P&R spaces in 360 locations (January 2012)
• Facilities not necessarily owned by transit agencies
• Transit agencies have de-emphasized P&R in recent years – walk & bike access preferred
• But P&R popular with customers when lots offer convenient access, allow parking for low or no cost, and are served by high quality transit.
Example of Park-and-Ride Facility in Bellevue, WA
Policy Issues Background

- Transit agencies often view P&R as an expensive source of riders; walk and bike access is better for environment.
- But given the popularity of P&R, can agency and societal objections be mitigated?
- Solution elements:
  - (1) special treatment for smaller, cleaner cars;
  - (2) users pay more and get more;
  - (3) encourage more passengers per arriving vehicle.
- One potential agency motivation to make an effort: more efficient transit operations.
- Key measure of transit productivity – boardings per service hour.
GIS is critical

- Visualizing transit networks and operations
- Turning numerically coded lists of bus stops and boardings into physical understanding
- Facilitating communication between transit planners and outside analysts
- Visualizing and communicating solutions
- Generating data for statistical analyses
- Tolls like Network Analyst promise to provide great insights
Overview of VTA

- Serves Santa Clara County (and parts of Alameda and San Mateo Counties)
- Includes bus and light rail
- 440 buses in peak service
- 34th largest transit agency in USA by ridership
- 40 Park & Ride lots operated by VTA
The VTA System
VTA Routes, Stops, and PnR Lots
VTA Routes and P&R Lots by Capacity
Overview of King County Metro

- Seattle, Bellevue Washington and vicinity
- 1,500 buses in peak service
- 9th largest transit agency in USA by ridership
- 11.6% weekday average transit share of commuters
- 130 Park & Ride lots used by about 20,000 customers daily
- 39% of riders surveyed used P&R in the last 30 days.
Seattle Region’s P & R Lots
GIS Visualization of P&R Customer Origins Determined via License Plate Survey
All the King County Bus Stops

In green are all AM inbound bus stops for all KC Metro buses, but not including Sound Transit Regional Express.

In red are shown the capacity of large P&R facilities, over 170 capacity.
Large P&R Facilities are Prominent Among the Most Highly Used King County Suburban Bus Stops
Route-level Analysis vs. Stop-level Analysis

**Route-level Analysis** examines the ridership on a route or busline over the course of a specific period. It may measure the additional ridership on the route associated with stops close to P&R lots.

**Pros:** Fiscal impact is often thought of by public transit agencies at the route level

**Cons:** There are fewer routes than stops, so some stop-level detail is sacrificed, and the number of observations is smaller that with stop-level data; harder to incorporate demographic and economic data related to the neighborhood of a stop

**Stop-level Analysis** examines the ridership at a particular stop (that may be served by several routes). Stops close to P&R lots can be identified.

**Pros:** More observations and more easily associated with economic and demographic characteristics of the neighborhood

**Cons:** Not the natural units in which to discuss fiscal impacts in transit, and traditional fiscal impacts may be difficult to analyze
Stop-level regression coefficient estimates for King County Metro (based on inbound stops)

\[ Boardings = \beta_0 + \beta_1 (\text{Dummy variable: Located with Quarter Mile of PnR Lot}) + \epsilon \]

\[ \beta_0 = 15.949857 \]
\[ \beta_1 = 49.982603 \]
Stop-level Analysis of VTA

Boardings

\[ = \beta_0 + \beta_1 (\text{Dummy variable: Located within 1/4 mile of PnR Lot}) + \epsilon \]

\[ \beta_0 = .7948004 \]
\[ \beta_1 = 1.271221 \]
Model Developed to Quantify Park & Ride Influence For King County Metro Transit

\[ \text{Boardings per hour} = \beta_0 + \beta_1 \text{(AM Park & Ride influence fraction)} + \beta_2 \text{(All – day boardings per route mile)} + \beta_3 \text{(Stops per mile over entire route)} + \epsilon \]

where the estimated values are:

- \( \beta_0 = 7.9 \)
- \( \beta_1 = 16.6 \)
- \( \beta_2 = 15.5 \)
- \( \beta_3 = -2.4 \)

- The constant measures other undetermined influences
- All coefficients are highly statistically significant
- The signs on the variable coefficients make physical sense
15% Financial Benefit from Park & Ride Across 53 Bus Routes in the King County suburbs of Seattle

• The regression coefficient on the P&R influence factor lets us estimate the number of service hours saved by picking up passengers at P&R locations.

• Instead of suburban buses having to pick up these riders at bus stops widely scattered over dispersed locations, 50,000 service hours are saved annually by the 41 routes out of 53 stopping at P&R facilities. These hours are worth $17 million.

• In other words, if the beneficial impact of the P&R facilities were not present, instead of $95 million actually spent, $112 million in service hours would be spent on the 53 routes.
Differences in network structure and data availability between the two agencies requires a different methodology for determining park & ride influence on bus productivity in the VTA System.

<table>
<thead>
<tr>
<th></th>
<th>King County Metro</th>
<th>Santa Clara VTA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service area size</td>
<td>2000 square miles</td>
<td>346 square miles</td>
</tr>
<tr>
<td>Service area population</td>
<td>2 million</td>
<td>1.8 million</td>
</tr>
<tr>
<td>Annual bus fare revenue</td>
<td>$123 million</td>
<td>$29 million</td>
</tr>
<tr>
<td>Annual bus operations cost</td>
<td>$440 million</td>
<td>$226 million</td>
</tr>
<tr>
<td>Bus cost per service hour</td>
<td>$159</td>
<td>$184</td>
</tr>
<tr>
<td>Boardings per service hour</td>
<td>36</td>
<td>27</td>
</tr>
<tr>
<td>Many long commuter bus routes from park &amp; ride lots</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Many bus routes to rail stations</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Source: 2013 National Transit Database of Federal Transit Administration and examination of maps.
VTA High Productivity Routes, High Boardings Stops, and P&R Lots by Capacity
Data and Data Sources

- The data about King County Metro:
  - Stop-level data and route level data provided by KC staff
    - Boardings by route and by bus stop for the AM peak period
    - Annual hours of service for each route
    - Length and number of stops on each of 53 bus routes.
  - GIS Data obtained from public files on the King County web site.
    - Which stops are at P&R facilities and are in the peak direction from maps.

- The data about VTA
  - Stop-level data and route level data provided by VTA
    - Boardings by route and by bus stop for AM peak periods determine from boardings and alightings data
    - Annual hours of service for each route
    - Length and number of stops on each of 97 routes
  - GIS Data about stops, routes, and P&R lots obtained from VTA
SUMMARY AND CONCLUSIONS

IMPACT OF PARK AND RIDE ON EFFICIENCY OF TRANSIT

• Route-level analysis: Park and ride variables are positive and statistically significant for King County, indicating park-and-ride contributes to greater boardings per revenue hour

• Stop-level analysis: Both park and ride dummy variables are positive and statistically significant for King County and VTA, indicating quarter mile proximity to park-and-ride expands the number of boardings at those stops

GIS IS ESSENTIAL IN THE ANALYSIS OF PARK AND RIDE IMPACT ON TRANSIT EFFICIENCY

✓ Geographic view necessary to understand context
✓ Proximity vital as a measurement of influence
✓ Spatial statistical & related methods yield essential estimates
Questions or Comments?

Mike Pogodzinski
j.m.pogodzinski@gmail.com
+1 415-516-6144

John Niles
niles@globaltelematics.com
+1 206-781-4475