Evaluating the Impacts of Real-Time Transit Information in Tampa and Atlanta

Candace Brakewood, PhD
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Outline

• Motivation
• Research Approach
• Results
  – Tampa, FL
  – Atlanta, GA
• Comparison & Conclusions
MOTIVATION

Motivation: Key Benefits of Transit

1. Congestion
2. Energy/environment
3. Safety
4. Equitable mobility options

… and others.
But transit has a low mode share...

Challenges with Transit

- Reliability is a key issue (Li et al. 2010; Walker 2012)

MARTA’s Bus On-Time Performance

Strategies to Address Unreliability

• Traditional methods of improving reliability are expensive, supply-side approaches, including:
  1. Dedicated right-of-way
  2. Service planning

• An inexpensive, demand-side approach is providing riders with real-time information (Carrel et al. 2013; Schweiger 2011).

Key Prior on the Impacts of Real-Time Information

<table>
<thead>
<tr>
<th>Decreased Wait Times</th>
<th>Increased Satisfaction</th>
<th>Increased Ridership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location: Seattle</td>
<td>Location: Maryland</td>
<td>Location: Chicago</td>
</tr>
<tr>
<td>Conclusion: Both actual wait times and perceived wait times of real-time bus information users were less than non-users</td>
<td>Conclusion: Overall satisfaction with transit service increased due to real-time shuttle bus information</td>
<td>Conclusion: Modest increase in ridership (126 rides/route on average weekday) attributable to real-time bus information</td>
</tr>
</tbody>
</table>

References:
RESEARCH APPROACH
Impacts of Real-Time Information on Bus Riders

Research Approach: OneBusAway

• Evaluation of real-time information focusing on OneBusAway, which is an open source system

• Where is OneBusAway used?
  – Seattle, WA
  – New York, NY
  – Tampa, FL
  – Atlanta, GA
  – Washington, DC (Beta)

• Open Data accompanies OneBusAway

• See http://onebusaway.org/
Comparison of Cities

<table>
<thead>
<tr>
<th></th>
<th>Tampa</th>
<th>Atlanta</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transit Agency</strong></td>
<td>HART</td>
<td>MARTA</td>
</tr>
<tr>
<td><strong>Size of Ridership</strong></td>
<td>Small (12,665,359)</td>
<td>Medium (68,008,900)</td>
</tr>
<tr>
<td>(Annual Unlinked Bus Trips*)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Real-Time Information Deployment</strong></td>
<td>OneBusAway spring 2013 (pilot); OneBusAway full deployment in summer 2013</td>
<td>OneBusAway spring 2013 (beta); MARTA apps in fall 2013; OneBusAway full deployment in February 2014</td>
</tr>
<tr>
<td><strong>Primary Data Sources</strong></td>
<td>Web-based surveys</td>
<td>Web-based survey combined with smart card data</td>
</tr>
<tr>
<td><strong>Methodology</strong></td>
<td>Behavioral experiment with a before-after control group design</td>
<td>Disaggregate analysis of daily number of transit trips using smart card data</td>
</tr>
</tbody>
</table>

*Reference: 2012 APTA Fact Book, which uses 2010 National Transit Database statistics

STUDY 1: TAMPA

Co-authors: Dr. Sean Barbeau (USF) and Dr. Kari Watkins (Georgia Tech)
Methodology

Before-After Control Group Research Design

- Motivation: HART provided USF & Georgia Tech special access to real-time data
- Recruitment: HART website/email list (Incentive of 1 day bus pass)
- Measurement: Web-based surveys
- Group Assignment: Random number generator
- Treatment: 5 interfaces of OneBusAway (3 websites & 2 smartphone apps)

Limiting the Treatment: iPhone & Android Apps

Are the 2 Groups Equivalent?

Comparison of Experimental and Control Groups

<table>
<thead>
<tr>
<th>Wilcoxon Sum Rank Test</th>
<th>Sample Size</th>
<th>W</th>
<th>P-value</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>216</td>
<td>6125</td>
<td>0.514</td>
<td>Not different</td>
</tr>
<tr>
<td>Annual Household Income</td>
<td>207</td>
<td>5599</td>
<td>0.568</td>
<td>Not different</td>
</tr>
<tr>
<td>Household Car Ownership</td>
<td>216</td>
<td>5972</td>
<td>0.737</td>
<td>Not different</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Kruskal-Wallis Test</th>
<th>Sample Size</th>
<th>$\chi^2$</th>
<th>P-value</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has a Valid License</td>
<td>216</td>
<td>1.885</td>
<td>0.17</td>
<td>Not different</td>
</tr>
<tr>
<td>Gender</td>
<td>216</td>
<td>1.475</td>
<td>0.225</td>
<td>Not different</td>
</tr>
<tr>
<td>Employment Status</td>
<td>211</td>
<td>0.377</td>
<td>0.542</td>
<td>Not different</td>
</tr>
<tr>
<td>Ethnicity*</td>
<td>216</td>
<td>9.546</td>
<td>0.002</td>
<td>Different</td>
</tr>
</tbody>
</table>

*Multiple selections allowed. Those who selected more than 1 race categorized as "other."
Analysis of Usual Wait Times

- Identical questions about usual wait time on regular route on the before and after surveys

<table>
<thead>
<tr>
<th>Usual Wait Time (minutes)</th>
<th>Sample Size</th>
<th>Before Mean (SD)</th>
<th>After Mean (SD)</th>
<th>Difference Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group</td>
<td>102</td>
<td>10.71 (3.88)</td>
<td>10.50 (4.25)</td>
<td>-0.21</td>
</tr>
<tr>
<td>Experimental Group</td>
<td>107</td>
<td>11.36 (4.06)</td>
<td>9.56 (4.68)</td>
<td>-1.79</td>
</tr>
</tbody>
</table>

Comparison: Difference of Means: t=2.65, two-tailed p=0.009 < 0.01

- Experimental group post-wave survey only: Has using OneBusAway changed the amount of time you wait at the bus stop?

![Bar chart showing wait time distribution]

Analysis of Feelings While Waiting for the Bus

- Identical questions about feelings while waiting asked on the before and after surveys

<table>
<thead>
<tr>
<th>Feelings</th>
<th>Control Group % Frequently + Always</th>
<th>Experimental Group % Frequently + Always</th>
<th>Diff. in Gain Scores Wilcoxon Test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
<td>Before</td>
</tr>
<tr>
<td>Productive</td>
<td>11%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Anxious</td>
<td>18%</td>
<td>19%</td>
<td>10%</td>
</tr>
<tr>
<td>Relaxed</td>
<td>34%</td>
<td>34%</td>
<td>26%</td>
</tr>
<tr>
<td>Frustrated</td>
<td>24%</td>
<td>26%</td>
<td>25%</td>
</tr>
</tbody>
</table>

Significance: * p<0.10; ** p<0.05; *** p<0.01

- Experimental group post-wave survey only: Since you began using OneBusAway, do you feel more relaxed when waiting for the bus?

![Bar chart showing feelings distribution]
Analysis of Satisfaction

- Identical questions about satisfaction asked on the before and after surveys

<table>
<thead>
<tr>
<th></th>
<th>Control Group</th>
<th>Experimental Group</th>
<th>Diff. in Gain Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Satisfied</td>
<td>% Satisfied</td>
<td>Wilcoxon Test</td>
</tr>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
<td>Before</td>
</tr>
<tr>
<td>How frequently the bus comes</td>
<td>32%</td>
<td>41%</td>
<td>40%</td>
</tr>
<tr>
<td>How long you have to wait for the bus</td>
<td>39%</td>
<td>34%</td>
<td>46%</td>
</tr>
<tr>
<td>How often the bus arrives at the stop on time</td>
<td>54%</td>
<td>45%</td>
<td>59%</td>
</tr>
<tr>
<td>How often you arrive at your destination on time</td>
<td>57%</td>
<td>53%</td>
<td>63%</td>
</tr>
<tr>
<td>How often you have to transfer buses to get to your final destination</td>
<td>44%</td>
<td>42%</td>
<td>36%</td>
</tr>
<tr>
<td>Overall HART bus service</td>
<td>63%</td>
<td>59%</td>
<td>58%</td>
</tr>
</tbody>
</table>

Significance: * p<0.10; ** p<0.05; *** p<0.01

- Experimental group post-wave survey only: Since you began using OneBusAway, do you feel more satisfied riding HART buses?

Analysis of Bus Trips/Week

- Identical questions about the number of HART bus trips/week on the before and after surveys

<table>
<thead>
<tr>
<th>Trips/Week</th>
<th>Sample Size</th>
<th>Before Mean (SD)</th>
<th>After Mean (SD)</th>
<th>Difference Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group</td>
<td>107</td>
<td>7.03 (3.79)</td>
<td>6.63 (4.09)</td>
<td>-0.40</td>
</tr>
<tr>
<td>Experimental Group</td>
<td>110</td>
<td>7.09 (3.94)</td>
<td>6.40 (3.71)</td>
<td>-0.69</td>
</tr>
</tbody>
</table>

Comparison

Difference of Means: t=0.66, two-tailed p=0.512

- Experimental group post-wave survey only: Has using OneBusAway changed the number of HART bus trips that you take?

Bottom graphic: n=108.
0% selected “I ride somewhat less.”
Figures rounded to the nearest whole person.
Tampa Conclusions

- Significant improvements in the “waiting experience”
  - Decreases in self-reported usual wait times
  - Decreases in negative feelings, particularly frustration
  - Increases in satisfaction with wait times

- Little evidence supporting a change in transit trips
  - Approx. 1/3 of RTI users stated they ride the bus more frequently, perhaps because of:
    - Affirmation bias of respondents
    - Scale of measurement (trips per week)
  - Only riders within sphere of transit agency

- Contribution is using a behavioral experiment to evaluate “apps”

STUDY II: ATLANTA

Co-author: Dr. Kari Watkins (Georgia Tech)
Methodology

- **Background on Real-Time Information:**
  - MARTA launched apps in November 2013
  - OneBusAway launched in February 2014

- **Method:** Before-After Analysis of MARTA Trips
  - April 2013 to April 2014

- **Unit of Analysis:** Individual rider

- **Primary Data Source:** Breeze Card smart cards
  - Number of transit trips on bus and train

Smart Card Data

- **Date:** Day determines ‘before’ & ‘after’ trips
- **Mode:** Bus + Rail
- **Spatial Unit:** Station (Rail) & Route (Bus)
Survey Data

- **Data Collection**
  - Web-based survey conducted first week of May 2014

- **Recruitment**
  - Both real-time information (RTI) users and non-users

- **Matching with Smart Cards**
  - 669 participants entered survey software
  - 538 provided a 16 digit smart card number
  - 494 matched usable, active smart cards

Source of Breeze Card Image: itsmarta.com

Conditions Imposed on the Dataset

- **Initial**: Combined Survey/Smart Card Dataset (n=494)

- **Condition 1**: Panel Eligibility *(April 2013 + April 2014)*
  - Real-Time (n=431)
  - Smart Card (n=305)

- **Condition 2**: Complete & Unique *(One Card = One Person)*
  - Complete with One Breeze Card (n=219)
  - Complete with No Other Fare Media (n=193)
  - Unique without Sharing Breeze Card (n=159)

- **Condition 3**: Congruent *(That Card = That Person)*
  - Closely Congruent (n=135)
  - Perfectly Congruent (n=100)
## Before-After Comparison of MARTA Trips

**Use of Real-Time Information (RTI)**

<table>
<thead>
<tr>
<th></th>
<th>All Data</th>
<th>Closely Congruent</th>
<th>Perfectly Congruent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Count</strong></td>
<td>302</td>
<td>60</td>
<td>38</td>
</tr>
<tr>
<td><strong>April 2013</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>10.2</td>
<td>15.6</td>
<td>12.8</td>
</tr>
<tr>
<td>SD</td>
<td>20.2</td>
<td>21.7</td>
<td>22.2</td>
</tr>
<tr>
<td><strong>April 2014</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>21.9</td>
<td>21.7</td>
<td>21.1</td>
</tr>
<tr>
<td>SD</td>
<td>29.3</td>
<td>27.5</td>
<td>29.8</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>11.7</td>
<td>6.1</td>
<td>8.3</td>
</tr>
<tr>
<td>SD</td>
<td>27.8</td>
<td>25.4</td>
<td>25.1</td>
</tr>
<tr>
<td><strong>t</strong></td>
<td>-3.478</td>
<td>-1.097</td>
<td>-1.732</td>
</tr>
<tr>
<td><strong>p</strong></td>
<td>0.0006</td>
<td>0.276</td>
<td>0.0905</td>
</tr>
</tbody>
</table>

### Regression Analysis: Difference in Trips

<table>
<thead>
<tr>
<th>Dataset</th>
<th>All Data</th>
<th>Closely Congruent</th>
<th>Perfectly Congruent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>20.887</td>
<td>37.115</td>
<td>36.146</td>
</tr>
<tr>
<td>Use Real-Time Information</td>
<td>6.61</td>
<td>0.564</td>
<td>2.651</td>
</tr>
<tr>
<td>Has a License</td>
<td>-18.633</td>
<td>-3.944</td>
<td>-38.436</td>
</tr>
<tr>
<td>African American</td>
<td>16.544</td>
<td>18.47</td>
<td>10.815</td>
</tr>
<tr>
<td>Increased Cars in Household</td>
<td>-8.215</td>
<td>-4.237</td>
<td>-2.159</td>
</tr>
<tr>
<td>Aware of Service Change</td>
<td>0.012</td>
<td>6.231</td>
<td>6.647</td>
</tr>
<tr>
<td><strong>R²</strong></td>
<td>0.15</td>
<td>0.35</td>
<td>0.30</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td>477</td>
<td>131</td>
<td>98</td>
</tr>
</tbody>
</table>

*rt = 4 weeks in April 2013 and April 2014 beginning with the first Tuesday of the month.*

*p<0.1; **p<0.05; ***p<0.01;#

*Number of observations reduced due to missing responses for specific questions.*

Values shown in parentheses are robust standard errors.
Perceived Changes: Riding MARTA Trains Perfectly Congruent

- Has using an app with real-time information changed the NUMBERS OF TRIPS that you take on MARTA TRAINS?*
  - I ride much more often: 7%  
  - I ride somewhat more often: 14%  
  - I ride about the same: 76%  
  - I usually don't check train RTI: 1%  
  - I usually don't ride MARTA trains: 3%

- Has using an app with real-time information changed the amount of time you spend WAITING for MARTA TRAINS?**
  - I spend about the same amount of time waiting: 24%  
  - I spend somewhat less time waiting: 53%  
  - I spend much less time waiting: 18%  
  - I usually don't check train RTI: 5%

- Has using an app with real-time information changed how SATISFIED you are with MARTA TRAIN service?
  - I feel much more satisfied: 13%  
  - I feel somewhat more satisfied: 47%  
  - I feel about the same: 26%  
  - I feel somewhat less satisfied: 3%  
  - I feel much less satisfied: 8%  
  - I usually don't ride MARTA trains: 3%

Sample Size in Real-Time Information Users Meeting Conditions (A-3B) (n=38).
*Zero answers for “I ride somewhat less” or “I ride much less.”
**Zero answers for “I spend much more time waiting” or “I spend somewhat more time waiting.”

Atlanta Conclusions

- Conclusions
  - Full Dataset (n=494): RTI users increased transit trips
  - Datasets with Conditions: No significant difference between RTI users and non-users
  - Many RTI users perceived a decreased in wait times and increased satisfaction with MARTA service

- Limitations
  - Non-probability sampling
  - Decreasing sample size

- Contribution
  - Method to combine smart card and survey data to conduct panel/before-after analyses
COMPARISON & CONCLUSIONS

Comparison of Key Findings

<table>
<thead>
<tr>
<th>Transit Agency</th>
<th>Methodology</th>
<th>Key Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tampa</strong></td>
<td>Behavioral experiment with a before-after control group design</td>
<td>Little evidence supporting a change in bus trips; Significant improvements in the waiting experience, particularly wait times</td>
</tr>
<tr>
<td><strong>Atlanta</strong></td>
<td>Before-after analysis of transit trips</td>
<td>Little evidence supporting a change in bus/train trips; Perceived improvements in wait times and overall satisfaction with MARTA</td>
</tr>
</tbody>
</table>
Concluding Remarks

Decreased Wait Times
- Atlanta
- Tampa

Increased Satisfaction
- Atlanta
- Tampa

Increased Ridership
- New York City (coming soon!)

QUESTIONS?
Contact: cbrakewood@gmail.com

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References


