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

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Outline

- Motivation
- Research Approach
- Results
  - Tampa, FL
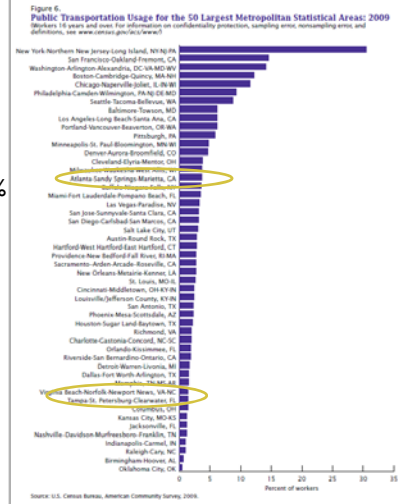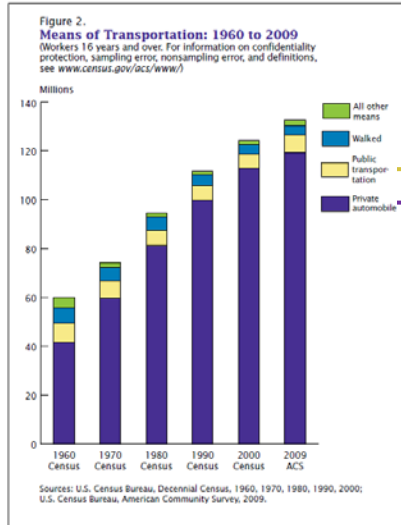 - Atlanta, GA
- Comparison & Conclusions

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…

5%

86.1%

Source: American Community Survey: http://www.census.gov/prod/2011pubs/acs-15.pdf

Challenges with Transit

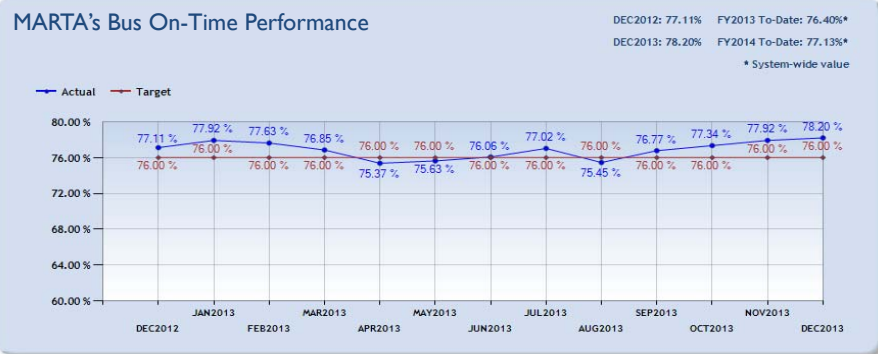- Reliability is a key issue (Li et al. 2010; Walker 2012)

Image source: MARTA: http://www.itsmarta.com/kpichart_dd.aspx?id=bsc_Bus_OTP

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).

Image: OneBusAway iPhone App

Key Prior on the Impacts of Real-Time Information

Decreased Wait Times

could lead to

Increased Satisfaction

could lead to

Increased Ridership

- Watkins et al. (2011)
- Location: Seattle
- Conclusion: Both actual wait times and perceived wait times of real-time bus information users were less than non-users

- Zhang, Shen, Clifton (2008)
- Location: Maryland
- Conclusion: Overall satisfaction with transit service increased due to real-time shuttle bus information

- Tang & Thakuriah (2012)
- Location: Chicago
- Conclusion: Modest increase in ridership (126 rides/route on average weekday) attributable to real-time bus information

1. Watkins, K. E., Ferris, B., Borning, A., Rutherford, G. S., & Layton, D. (2011). Where Is My Bus? Impact of mobile real-time information on the perceived and actual wait time of transit riders.
2. Zhang, F., Shen, Q., & Clifton, K. J. (2008). Examination of Traveler Responses to Real-Time Information About Bus Arrivals Using Panel Data. Transportation Research Record. 2082, 107–115.
3. Tang, L., & Thakuriah, P. (Vonu). (2012). Ridership effects of real-time bus information system: A case study in the City of Chicago. Transportation Research Part C: Emerging Technologies, 22, 146–161.

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

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

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

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STUDY 1: TAMPA

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

Paper currently under review.

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?

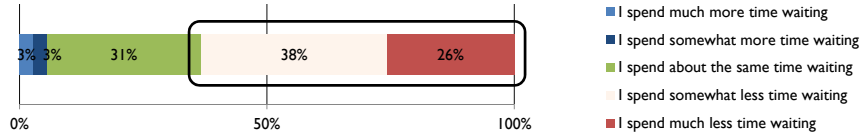| Comparison of Experimental and Control Groups				
Wilcoxon Sum Rank Test	**Sample Size**	**W**	**P-value**	**Conclusion**
Age	216	6125	0.514	Not different
Annual Household Income	207	5599	0.568	Not different
Household Car Ownership	216	5972	0.737	Not different
Kruskal-Wallis Test	**Sample Size**	**χ²**	**P-value**	**Conclusion**
Has a Valid License	216	1.885	0.17	Not different
Gender	216	1.475	0.225	Not different
Employment Status	211	0.377	0.542	Not different
Ethnicity*	216	9.546	0.002	Different

*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

Usual Wait Time (minutes)	Sample Size n	Before Mean (SD)	After Mean (SD)	Difference Mean
Control Group	102	10.71 (3.88)	10.50 (4.25)	-0.21
Experimental Group	107	11.36 (4.06)	9.56 (4.68)	-1.79
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?*

- ■ I spend much more time waiting
- ■ I spend somewhat more time waiting
- ■ I spend about the same time waiting
- I spend somewhat less time waiting
- ■ I spend much less time waiting

Bottom graphic: n=109.
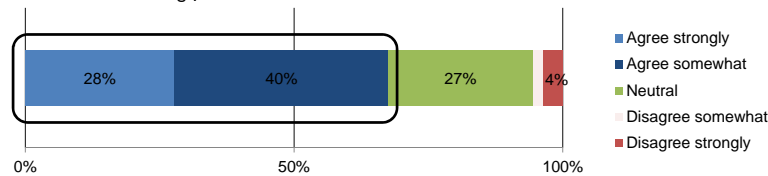Figures rounded to the nearest whole percent.

Analysis of Feelings
While Waiting for the Bus

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

	Control Group % Frequently + Always		Experimental Group % Frequently + Always		Diff. in Gain Scores Wilcoxon Test		
Feelings	Before	After	Before	After	W	p-value	
Productive	11%	10%	10%	17%	6201	0.051	*
Anxious	18%	19%	26%	25%	4548	0.082	*
Relaxed	34%	34%	27%	25%	5518	0.592	
Frustrated	24%	26%	25%	18%	4241	0.006	***

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

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

- ■ Agree strongly
- ■ Agree somewhat
- ■ Neutral
- Disagree somewhat
- ■ Disagree strongly

Bottom graphic: n=108
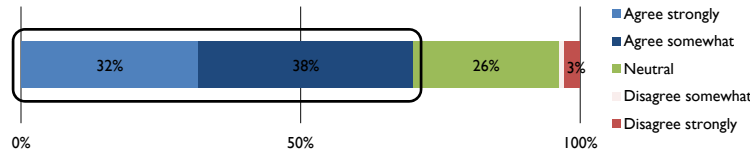Figures rounded to the nearest whole percent.

Analysis of Satisfaction

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

	Control Group % Satisfied		Experimental Group % Satisfied		Diff. in Gain Scores Wilcoxon Test		
	Before	After	Before	After	W	p-value	
How frequently the bus comes	37%	41%	40%	44%	5812	0.459	
How long you have to wait for the bus	39%	34%	36%	46%	6425	0.020	**
How often the bus arrives at the stop on time	54%	45%	45%	59%	7094	0.0001	***
How often you arrive at your destination on time	57%	53%	55%	63%	5835	0.236	
How often you have to transfer buses to get to your final destination	44%	42%	38%	36%	4916	0.342	
Overall HART bus service	63%	59%	57%	58%	5717	0.410	

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

- Experimental group post-wave survey only asked: *Since you began using OneBusAway, do you feel more satisfied riding HART buses?*
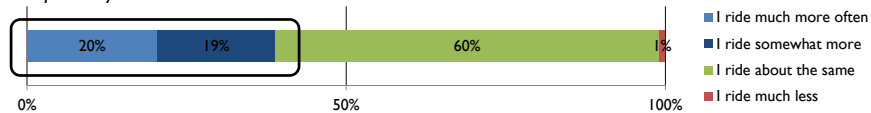
32%	38%	26%	3%

- Agree strongly
- Agree somewhat
- Neutral
- Disagree somewhat
- Disagree strongly

0%   50%   100%

Bottom graphic: n=107
Figures rounded to the nearest whole percent.

Analysis of Bus Trips/Week

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

| Trips/Week	Sample Size n	Before Mean (SD)	After Mean (SD)	Difference Mean
Control Group	107	7.03 (3.79)	6.63 (4.09)	-0.40
Experimental Group	110	7.09 (3.94)	6.40 (3.71)	-0.69
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?*

20%	19%	60%	1%

- I ride much more often
- I ride somewhat more
- I ride about the same
- I ride much less

0%   50%   100%

Bottom graphic: n=108.
0% selected "I ride somewhat less."
Figures rounded to the nearest whole percent.

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"
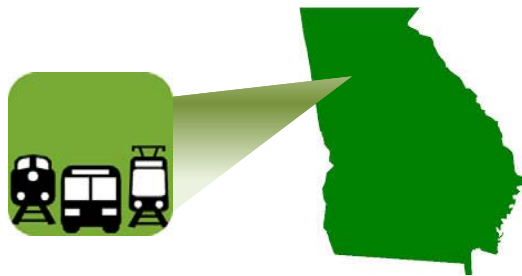
STUDY II: ATLANTA

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

Paper currently under review.

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

MARTA's On the Go Apps

Source of Images: itsmarta.com

Smart Card Data

Date: Day determines 'before' & 'after' trips

Mode: Bus + Rail

Spatial Unit: Station (Rail) & Route (Bus)

of: 20-Mar-13 14:44:14
f 3

Metropolitan Atlanta Rapid Transit Authority
pr-nbms3:nextfare
A100 / PN.14-04.2701.04 / 1108

Transit Card Transaction History

Transit Card: 0160014377218919
ted Start and End Dates and Times: 01/01/13 00:00:00 to 03/20/13 00:00:00
d Operators:
Sele Facilities:
Selecte ansaction Types:
Selected T nsaction Statuses:
Selected Bus Number(s):

Time	Operator		Facility			Route		Value		Value	Rides	Renewed In Advance	Transaction	Card Seq
	Bus ID	Cart ID	Grp ID	Hi/Lo Zone	Transaction Description		Change $	Bonus $	Left $	Left	Count'	Status	Num
21	MARTA Rail		Lindbergh Center											
RVG30621	N/A		N/A	N/A / N/A	Pass Entry (Tag On)		0.00		0.00	15	0	Success	2
02-Jan-13 13:35:24	TA Rail		Lenox											
RVG30717	N/A		N/A	N/A / N/A	Pass Exit (Tag Off)		0.00		0.00	15	0	Success	3
02-Jan-13 17:10:36	MARTA Rail		Lenox											
RVG30715	N/A		N/A	N/A / N/A	Pass Entry (Tag On)		0.00		0.00	14	0	Success	4
02-Jan-13 17:25:08	MARTA Rail		Midtown											
RVG30413	N/A		N/A	N/A / N/A	Pass Exit (Tag Off)		0.00		0.00	14	0	Success	5
02-Jan-13 10:50:37	MARTA Bus		Perry Garage			North Decatur Road :: N (36)		0.00		0.00	14	0	Success	6
DCU02349	2345	N/A	N/A	N/A / N/A	Pass Transfer								
04-Jan-13 07:05:50	MARTA Bus		Perry Garage			North Decatur Road :: N (36)		0.00		0.00	13	0	Success	7
DCU10053	2349	N/A	N/A	N/A / N/A	Pass Entry (Tag On)								
04-Jan-13 16:49:26	MARTA Bus		Perry Garage			North Decatur Road :: N (36)		0.00		0.00	12	0	Success	8
DCU02145	2346	N/A	N/A	N/A / N/A	Pass Entry (Tag On)								
07-Feb-13 07:39:04	MARTA Bus		Perry Garage			North Decatur Road :: N (36)		0.00		0.00	11	0	Success	9
DCU10053	2349	N/A	N/A	N/A / N/A	Pass Entry (Tag On)								
07-Feb-13 18:24:06	MARTA Bus		Laredo Garage			North Decatur Road :: N (36)		0.00		0.00	10	0	Success	10
DCU02215	2343	N/A	N/A	N/A / N/A	Pass Entry (Tag On)								
11-Feb-13 07:50:56	MARTA Bus		Hamilton Garage			North Decatur Road :: N (36)		0.00		0.00	9	0	Success	11
2330	2360	N/A		N/A / N/A	Pass Entry (Tag On)								

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

MARTA's On the Go Apps

Georgia Tech's OneBusAway Apps

The Transit App

Serial Number

*3. What is your 16-digit Breeze Card number?
Please do not enter spaces or dashes.

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

	All Data		Closely Congruent		Perfectly Congruent	
Use of Real-Time Information (RTI)	RTI	No	RTI	No	RTI	No
Count	302	192	60	75	38	62
April 2013* Mean	10.2	4.7	15.6	5.7	12.8	4.1
April 2013* SD	20.2	14.5	21.7	12.3	22.2	9.4
April 2014* Mean	21.9	9.6	21.7	7.9	21.1	5.1
April 2014* SD	29.3	22.4	27.5	14.7	29.8	10.6
Difference Mean	11.7	4.9	6.1	2.2	8.3	1.0
Difference SD	27.8	15.8	25.4	11.3	25.1	8.9
	$t = -3.478$		$t = -1.097$		$t = -1.732$	
	$p=0.0006$		$p=0.276$		$p=0.0905$	
Total Sample Size	494		135		100	

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

Regression Analysis: Difference in Trips

Dataset	All Data	Closely Congruent	Perfectly Congruent
Intercept	20.887 (5.644)***	37.115 (14.754)**	36.146 (16.956)**
Use Real-Time Information	6.61 (1.897)***	-0.664 (2.53)	2.651 (3.04)
Has a License	-18.633 (5.886)***	-38.944 (15.191)**	-38.436 (17.662)**
African American	16.544 (5.797)***	18.47 (9.266)**	10.815 -9.45
Increased Cars in Household	-8.215 (2.488)***	-4.237 (2.393)*	-2.159 (2.31)
Aware of Service Change	0.012 -2.15	6.231 (2.819)**	6.647 (3.056)**
R^2	0.15	0.35	0.30
Observations^	477	131	98

*$p<0.1$; **$p<0.05$; ***$p<0.01$;
^Number of observations reduced due to missing responses for specific questions.
Values shown in parentheses are robust standard errors.

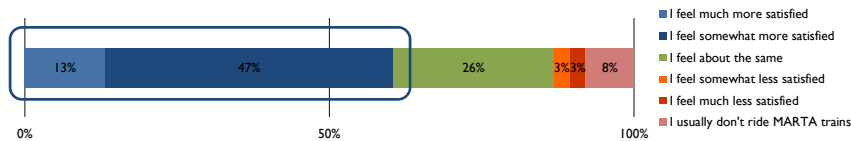## Perceived Changes: Riding MARTA Trains Perfectly Congruent

- Has using an app with real-time information changed the NUMBERS OF TRIPS that you take on MARTA TRAINS?*

5%	11%	76% 5% 3%

- I ride much more often
- I ride somewhat more often
- I ride about the same
- I usually don't check train RTI
- I usually don't ride MARTA trains

- Has using an app with real-time information changed the amount of time you spend WAITING for MARTA TRAINS?**

24%	53%	18% 5%

- I spend about the same amount of time waiting
- I spend somewhat less time waiting
- I spend much less time waiting
- I usually don't check train RTI

- Has using an app with real-time information changed how SATISFIED you are with MARTA TRAIN service?

13%	47%	26% 3% 3% 8%

- I feel much more satisfied
- I feel somewhat more satisfied
- I feel about the same
- I feel somewhat less satisfied
- I feel much less satisfied
- I usually don't ride MARTA trains

Sample Size is Real-Time Information Users Meeting Conditions 1A-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.
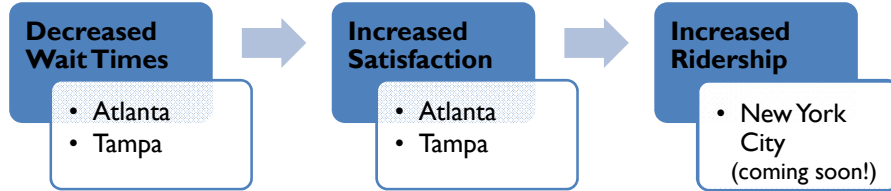

Atlanta Conclusions

- **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

	Tampa	Atlanta
Transit Agency	HART	marta
Methodology	Behavioral experiment with a before-after control group design	Before-after analysis of transit trips
Key Finding	Little evidence supporting a change in bus trips; Significant improvements in the waiting experience, particularly wait times	Little evidence supporting a change in bus/train trips; Perceived improvements in wait times and overall satisfaction with MARTA

Concluding Remarks

Decreased Wait Times
- Atlanta
- Tampa

Increased Satisfaction
- Atlanta
- Tampa

Increased Ridership
- New York City (coming soon!)

QUESTIONS?

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References

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2. Li, Z., Hensher, D., & Rose, J. (2010). *Willingness to pay for travel time reliability in passenger transport: A review and some new empirical evidence.* Transportation Research Part E, 46, 384-403.

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4. Watkins, K. E., Ferris, B., Borning, A., Rutherford, G. S., & Layton, D. (2011). *Where Is My Bus? Impact of mobile real-time information on the perceived and actual wait time of transit riders.* Transportation Research Part A: Policy and Practice, 45(8), 839–848.

5. Zhang, F., Shen, Q., & Clifton, K. J. (2008). *Examination of Traveler Responses to Real-Time Information About Bus Arrivals Using Panel Data.* Transportation Research Record: Journal of the Transportation Research Board, 2082, 107–115.

6. Tang, L., & Thakuriah, P. (Vonu). (2012). *Ridership effects of real-time bus information system: A case study in the City of Chicago.* Transportation Research Part C: Emerging Technologies, 22, 146–161.

7. American Public Transportation Association. (2012). *Public Transportation Fact Book*, Edition 63.