

Using Mobile Ticketing Data to Estimate an Origin-Destination Matrix for New York City Ferry Service

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James Wong, Vice President/Director of Ferries, NYC EDC

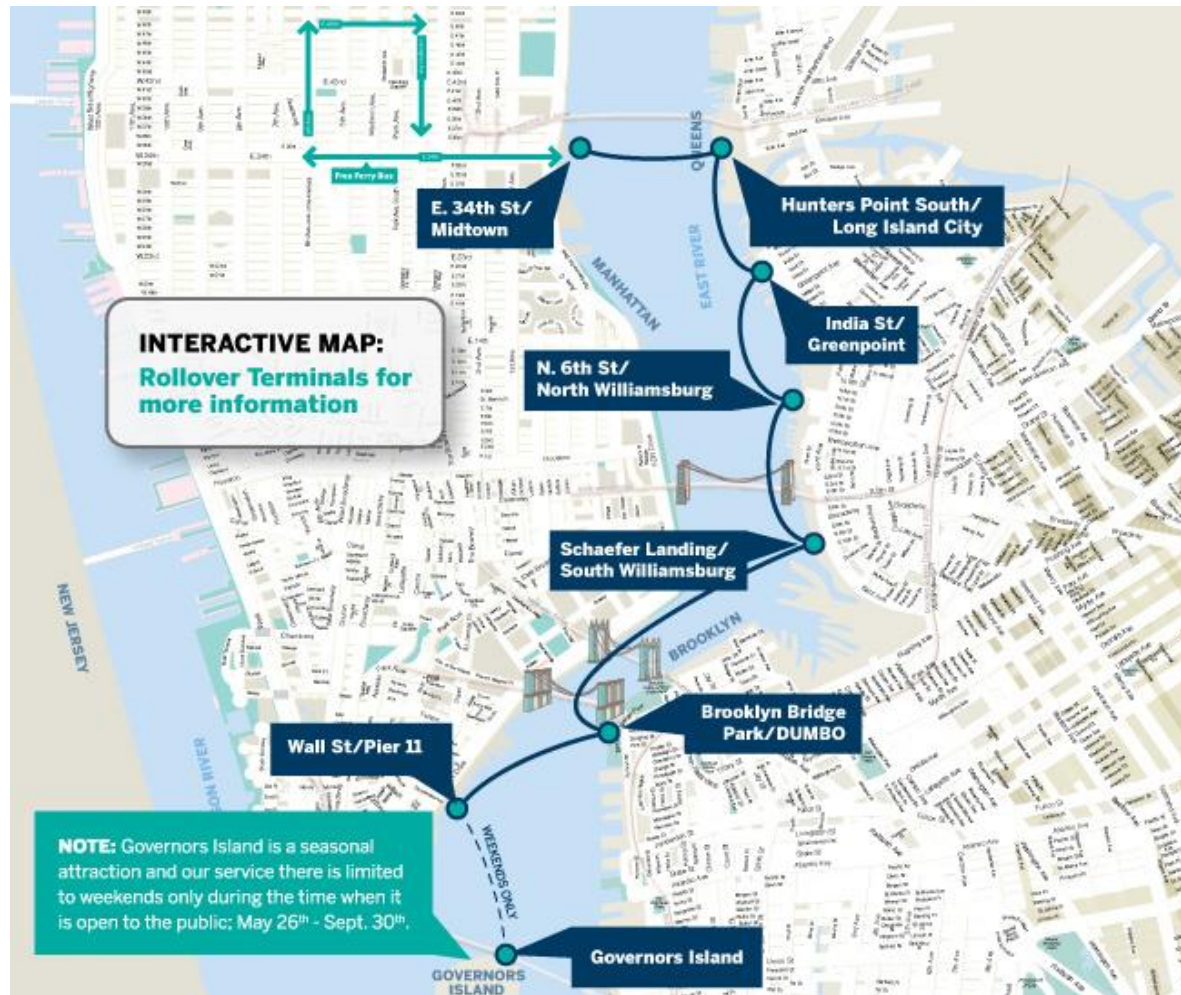
Candace Brakewood, PhD, Assistant Professor, CCNY

The views and opinions expressed in this presentation are those of the authors and do not necessarily represent those of New York City Economic Development Corporation or The City of New York.

Outline

- Background
- Research Question and Objective
- Data Sources
- Methodology
- Results from OD Estimation & Survey
- Conclusions and Future Research

Background: East River Ferry

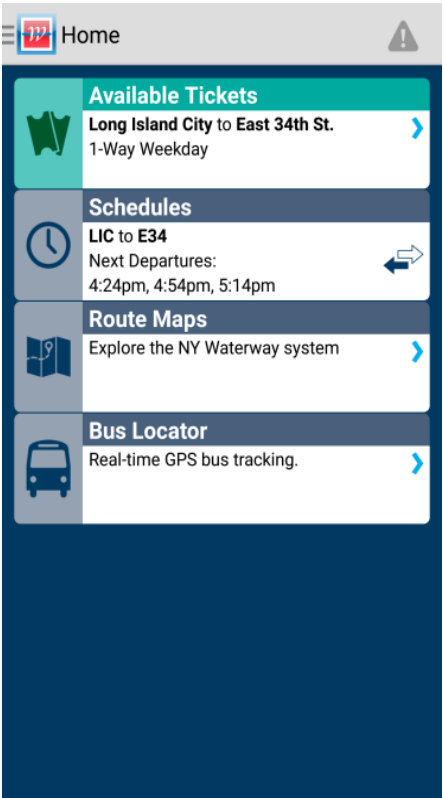
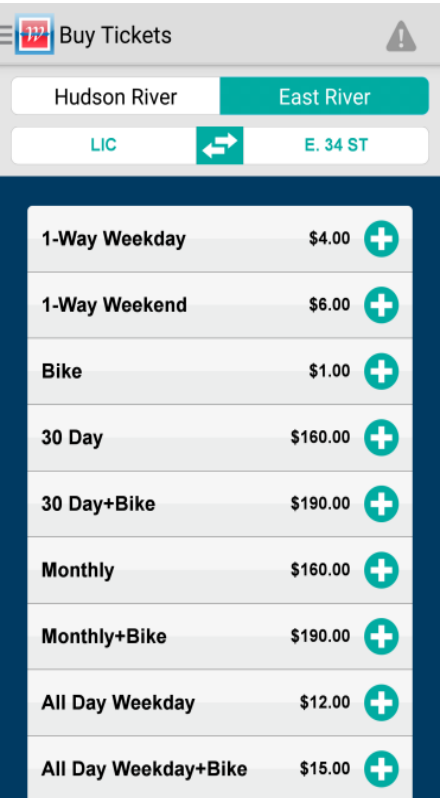
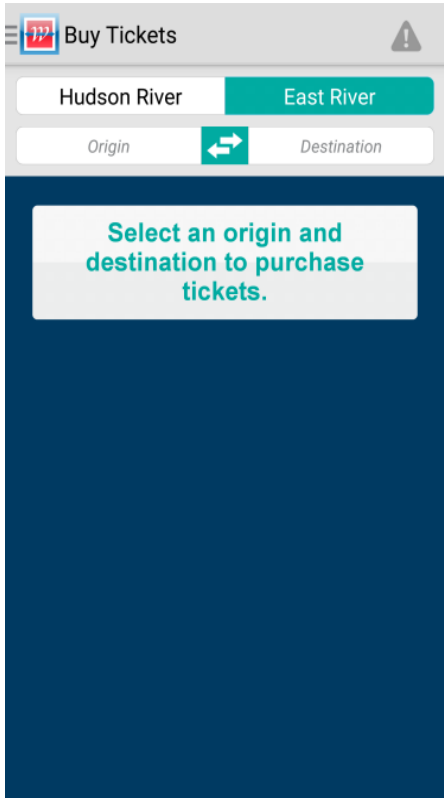


The ERF connects Brooklyn and Queens waterfronts to Manhattan job centers.

- Pilot Route started in 2011
- Permanent service started in 2014
- 8 Landings
- 30-minute route length
- 20-minute peak headways all year
- Seasonal off-peak headways

- 1.4M riders in 2015
- ~4,000 riders per day
- Fare: \$4 weekdays, \$6 weekends

Background: How does mobile ticketing work?



Ticket Purchase

Ticket Activation

Research Question and Method

- **Research Question:** Can we use the backend data from mobile ticketing systems for transportation planning?
- **Objective:** Create origin-destination (OD) matrices of passenger movements using passively collected, backend mobile ticketing data and compare them to OD matrices from survey data
- **Period of Analysis:** October 2014 (AM Peak, PM Peak, Midday and Weekend)
- **Method:**
 - Onboard survey data
 - Mobile ticketing data
 - Normalization of data sources (Iterative Proportional Fitting)
 - Comparison of data sources (Euclidean Distance)

Data

Three sources: Mobile ticketing activations, Onboard survey, On/off counts

Example: Mobile Ticketing Data

Ticket Type	Time Activated	Origin	Destination
I-Way Weekday	12:01:21 AM	South Williamsburg	East 34th St.
I-Way Weekday	12:02:30 AM	North Williamsburg	Pier 11 / Wall St.
I-Way Weekday	12:07:42 AM	Pier 11 / Wall St.	South Williamsburg
I-Way Weekday	12:07:51 AM	South Williamsburg	Pier 11 / Wall St.
I-Way Weekday	12:08:50 AM	East 34th St.	North Williamsburg
I-Way Weekday	12:09:15 AM	East 34th St.	North Williamsburg
I-Way Weekday	12:15:54 AM	East 34th St.	Long Island City
I-Way Weekday	12:17:39 AM	East 34th St.	Long Island City
I-Way Weekday	12:17:41 AM	Greenpoint	East 34th St.
30 Day	12:18:12 AM	Greenpoint	East 34th St.
I-Way Weekday	12:18:24 AM	East 34th St.	North Williamsburg
I-Way Weekday	12:18:29 AM	East 34th St.	South Williamsburg
I-Way Weekday	12:18:44 AM	Greenpoint	East 34th St.
I-Way Weekday	12:18:44 AM	North Williamsburg	East 34th St.
I-Way Weekday	12:18:54 AM	East 34th St.	North Williamsburg
I-Way Weekday	12:19:19 AM	North Williamsburg	East 34th St.
I-Way Weekday	12:19:26 AM	East 34th St.	Greenpoint
I-Way Weekday	12:19:44 AM	East 34th St.	North Williamsburg
I-Way Weekday	12:21:14 AM	North Williamsburg	East 34th St.
I-Way Weekday	12:23:33 AM	Long Island City	Greenpoint

Example: Onboard Survey Card

LONG ISLAND CITY

Please return this card to the staff person when you disembark

Filling out the questions below is optional

1. What is the purpose of your trip today?

- Commuting
- Leisure/ fun

2. How many trips did you take on the East River Ferry last week? (Count each direction as one trip.)

- 11 or more
- 4 to 10
- 2 or 3
- 0 or 1
- First time rider

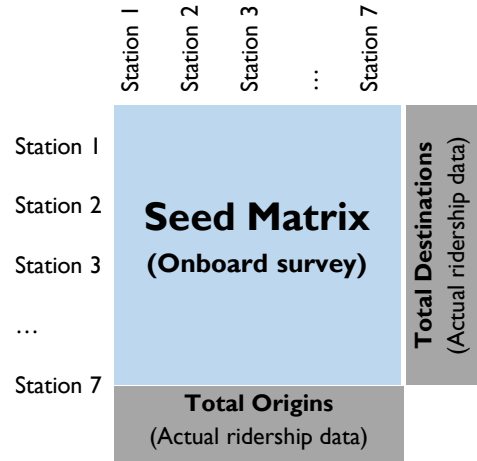
3. How did you get to the ferry today?

4. How will you get to your final destination?

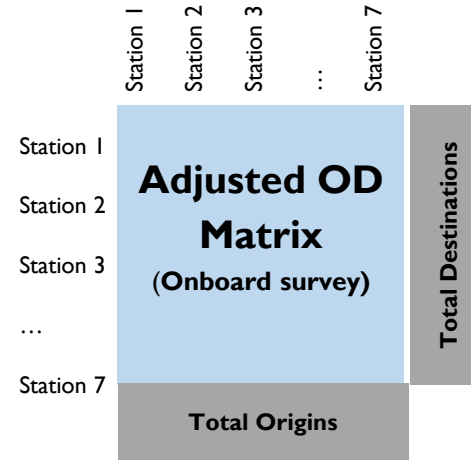
	TO FERRY	FROM FERRY	
<input type="radio"/>	<input type="radio"/>		Walked
<input type="radio"/>	<input type="radio"/>		Subway
<input type="radio"/>	<input type="radio"/>		Bicycle (locked near pier)
<input type="radio"/>	<input type="radio"/>		Bicycle (brought on board)
<input type="radio"/>	<input type="radio"/>		CitiBike
<input type="radio"/>	<input type="radio"/>		Dropped off by car
<input type="radio"/>	<input type="radio"/>		Drove and parked
<input type="radio"/>	<input type="radio"/>		MTA bus
<input type="radio"/>	<input type="radio"/>		Free shuttle bus
<input type="radio"/>	<input type="radio"/>		Taxi/car service

Methodology: Comparison of Data Sources

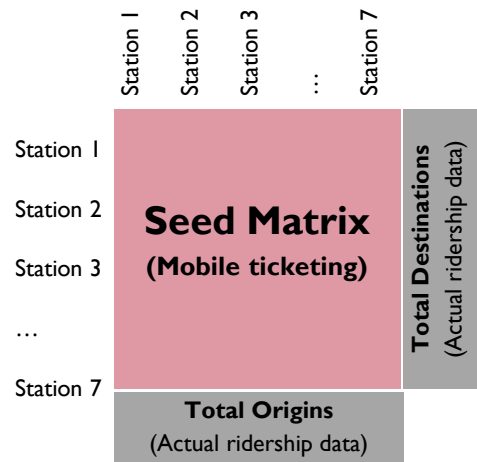
Onboard
Survey
Data



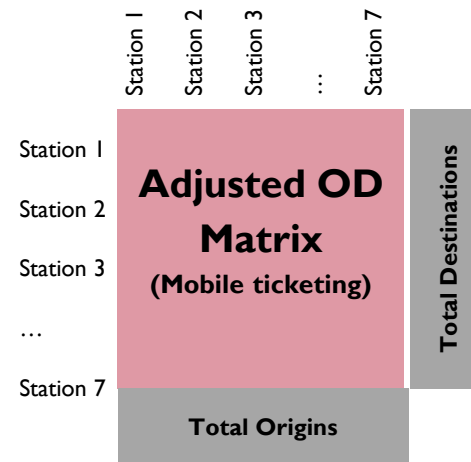
Iterative
Proportional
Fitting (IPF)



Mobile
Ticketing
Data



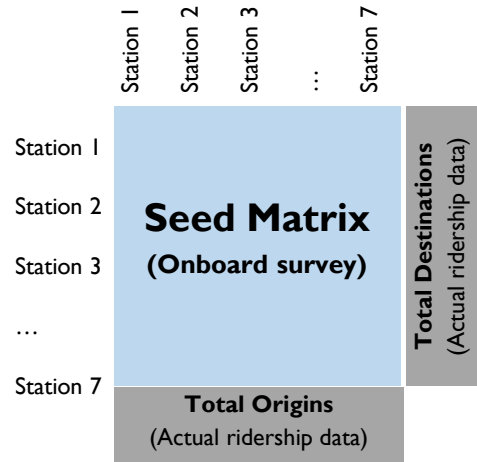
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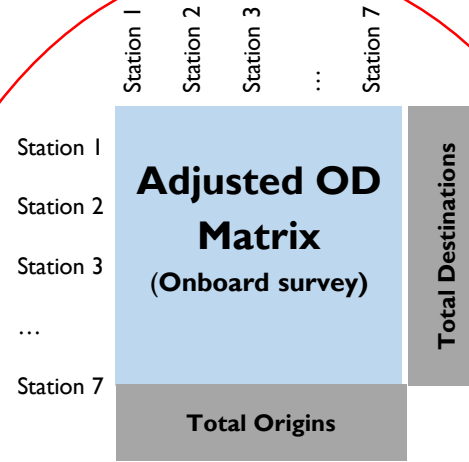
Comparison of
Matrices using
Euclidean
Distance

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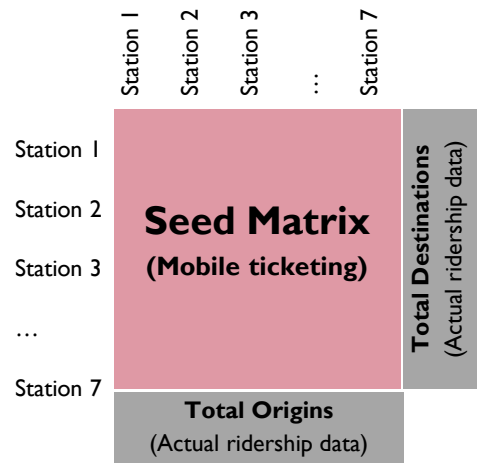
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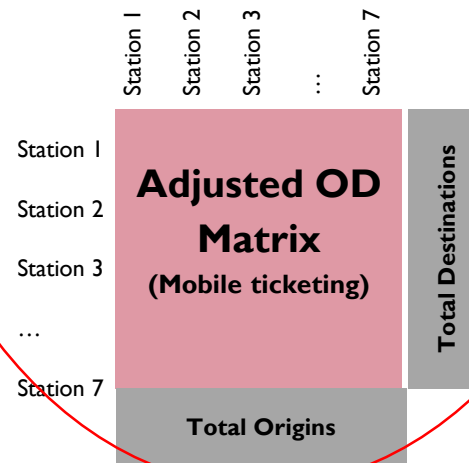
Iterative
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Mobile
Ticketing
Data



IPF



Comparison of
Matrices using
Euclidean
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Results: OD Estimation for the AM Peak

**Seed Matrix
(Onboard survey data)**

Destinations \ Origins		Destinations							Total
		Pier 11	DUMBO	S. Williamsburg	N. Williamsburg	Green point	Long Island City	E 34th street	
Actual Ridership		524	100	12	23	17	18	651	1345
Pier 11	38	0%	1%	0%	1%	1%	0%	0%	2%
DUMBO	104	7%	0%	0%	1%	0%	0%	1%	8%
S.Williamsburg	140	3%	2%	0%	0%	0%	0%	6%	11%
N.Williamsburg	530	14%	3%	0%	0%	0%	0%	21%	38%
Greenpoint	190	6%	2%	0%	0%	0%	0%	6%	15%
Long Island City	259	11%	1%	0%	0%	0%	0%	9%	22%
E 34th St	84	1%	1%	0%	1%	1%	1%	0%	4%
Total	1345	42%	10%	1%	2%	1%	1%	43%	100%

IPF Method
➔

**Adjusted OD Matrix
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Onboard
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Mobile
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Data

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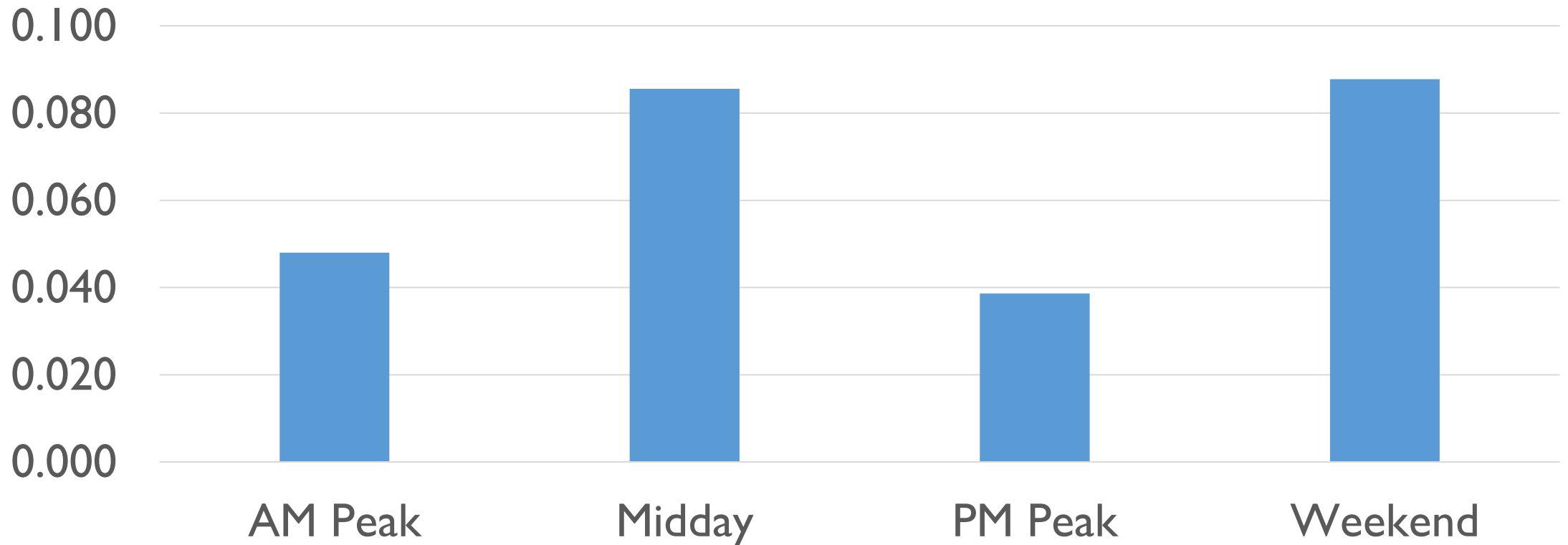
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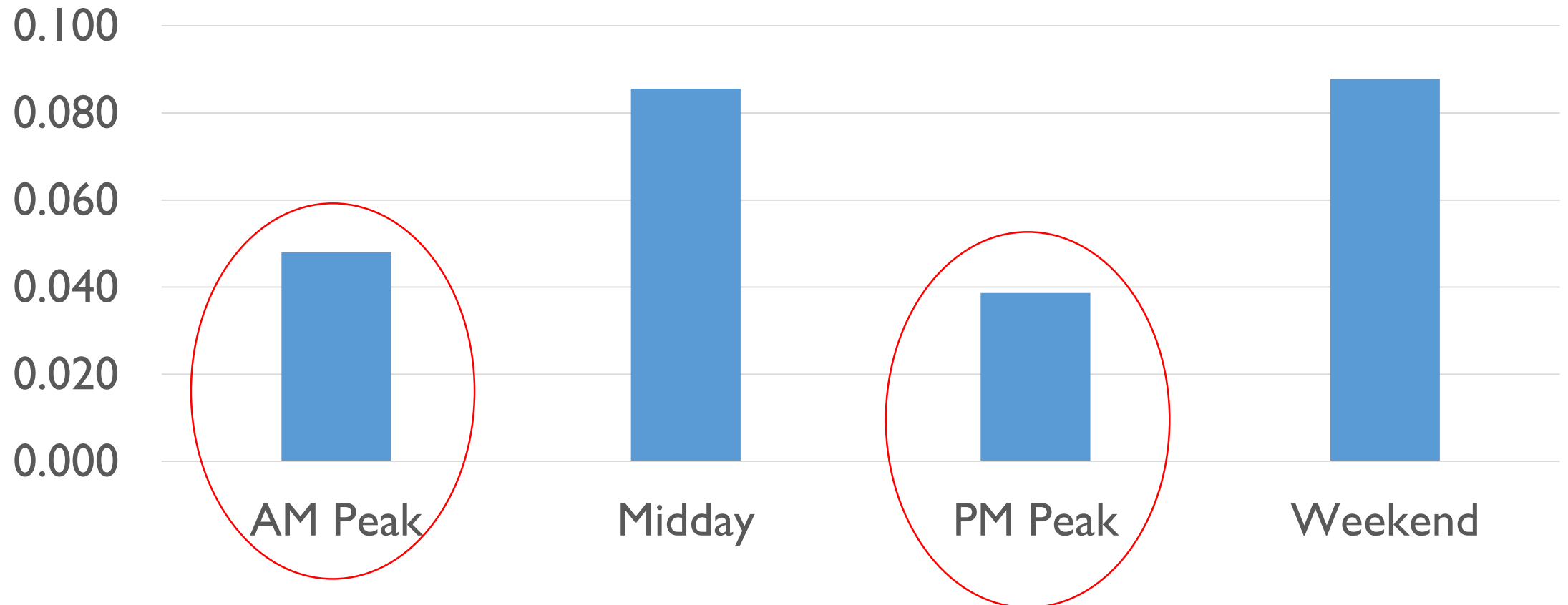
Comparison of Survey & Mobile Ticketing OD Matrices

Euclidean Distance (Final IPF Matrices)



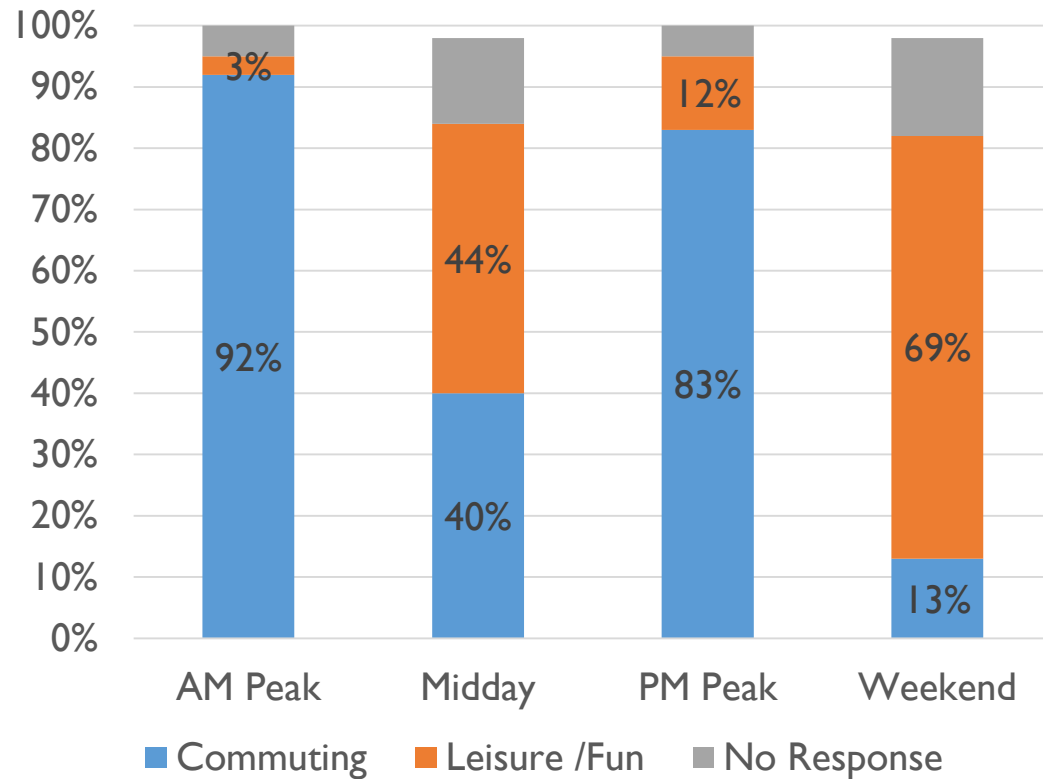
Comparison of Survey & Mobile Ticketing OD Matrices

Euclidean Distance (Final IPF Matrices)

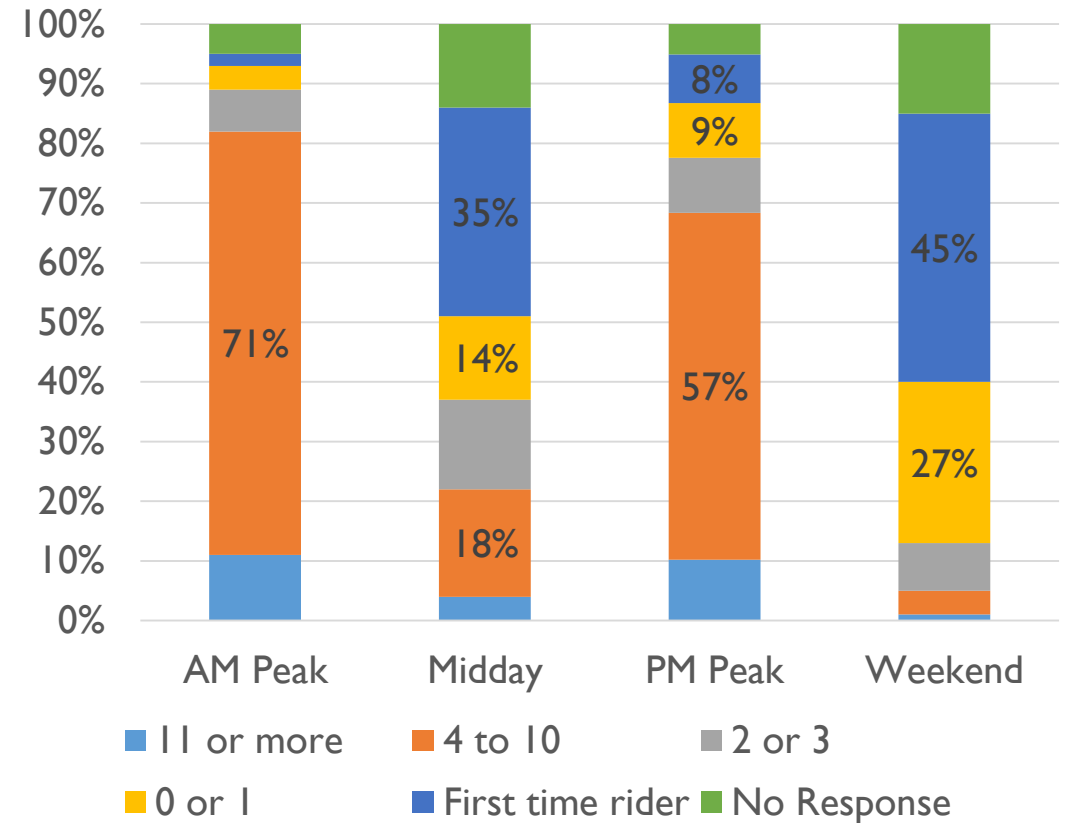


Results from the Survey

Trip Purpose

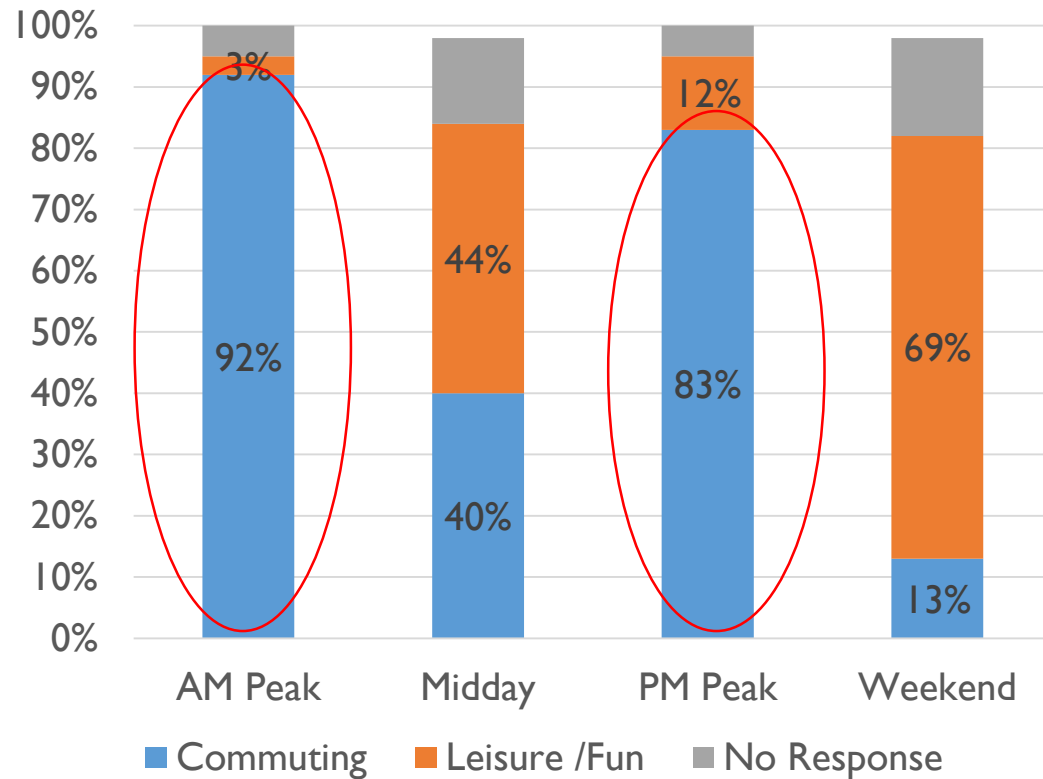


Trips/Week on the East River Ferry

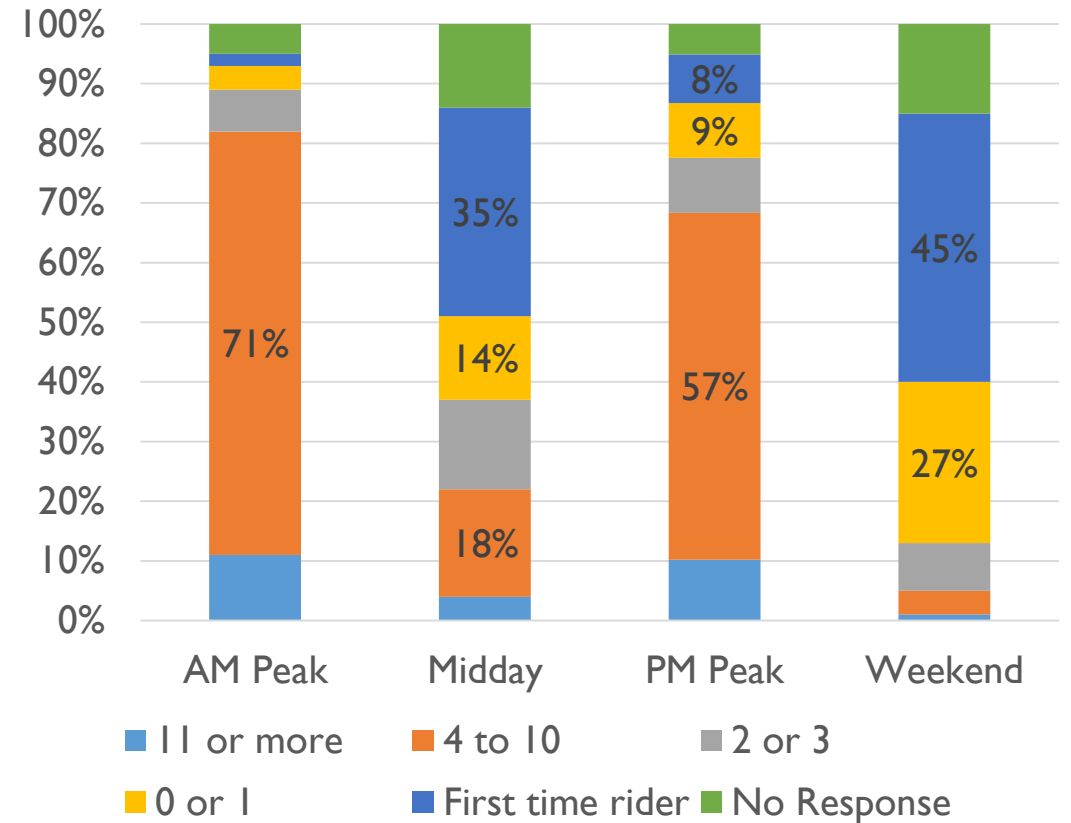


Results from the Survey

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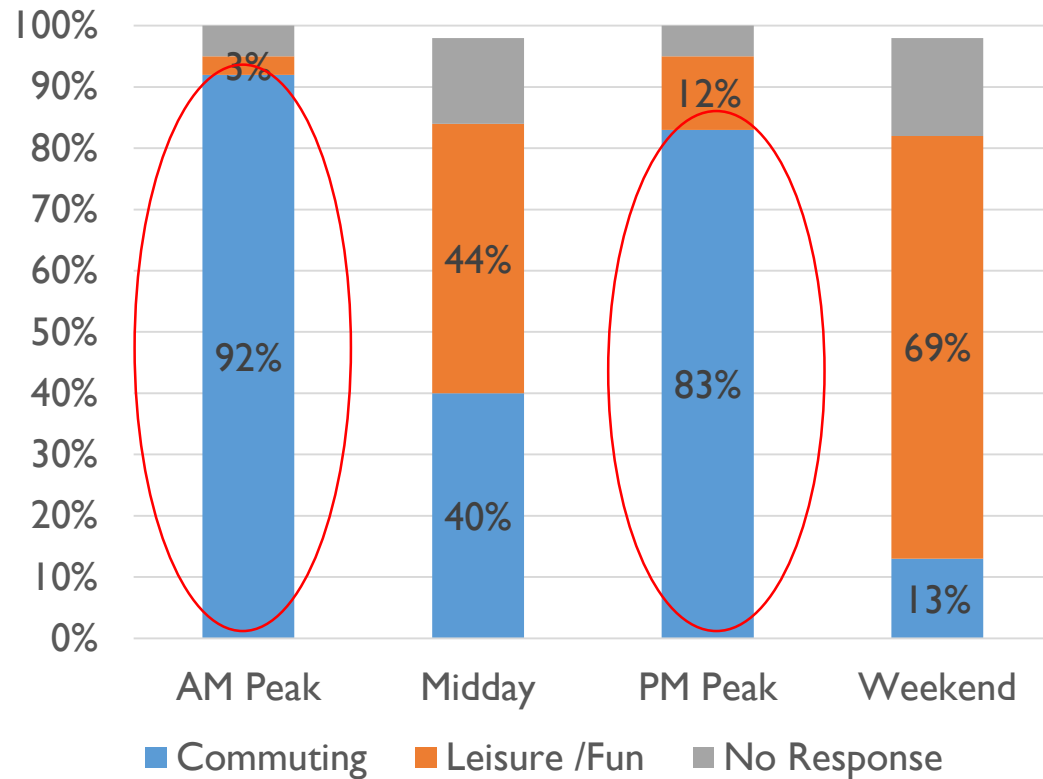


Trips/Week on the East River Ferry

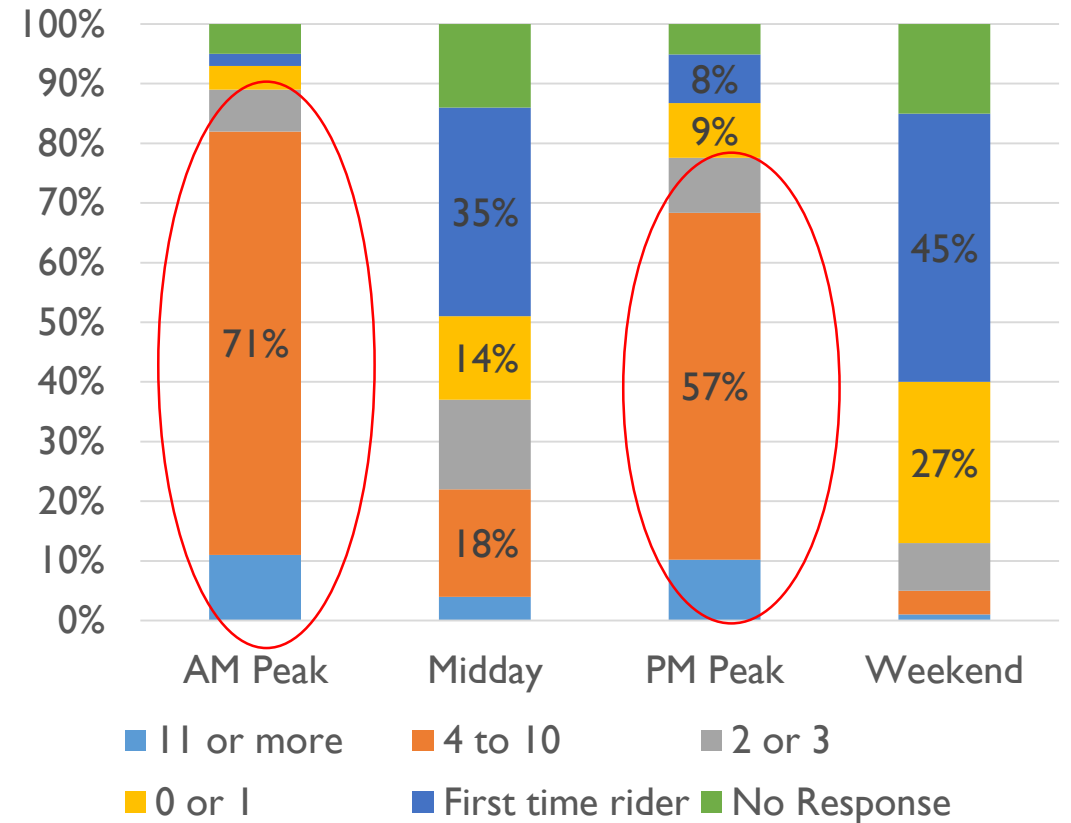


Results from the Survey

Trip Purpose



Trips/Week on the East River Ferry



Conclusions and Future Research

Conclusions

- OD matrices from mobile ticketing and survey data closely align during peak periods
- Survey data shows that the majority of peak period passengers are commuters and/or regular passengers
- Mobile ticketing data is likely to provide the most reliable travel behavior information during peak periods when travel patterns are more consistent
- Mobile ticketing data can compliment (and in some cases, perhaps substitute for) survey data

Future Research

- Expand to additional ferry routes / other transit systems
- Identify other planning / operations uses for mobile ticketing data



Questions?

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Rahman, Wong and Brakewood (2016). Use of Mobile Ticketing Data to Estimate an Origin-Destination Matrix for New York City Ferry Service. *Transportation Research Record: Journal of the Transportation Research Board*, Volume 2544, pp. 1-9.

Methodology: Iterative Proposal Fitting

- Iterative proportional fitting (IPF) to create origin-destination (OD) matrices
- A seed matrix from baseline OD data is gradually adjusted to match passenger boarding and alighting volumes that are shown on the marginals of the matrix

Row Adjustment

$$P_{ij(k+1)} = \frac{P_{ij(k)}}{\sum_j P_{ij(k)}} * Q_i$$

Column Adjustment

$$P_{ij(k+2)} = \frac{P_{ij(k)}}{\sum_i P_{ij(k)}} * Q_j$$

where

$P_{ij(k)}$ = a single element of OD matrix,

i, j, k = row, column, and iteration serial number, respectively, and

Q_i, Q_j = marginal row totals and marginal column totals, respectively.