How Time Inefficient and Uncertain are Paratransit Trips Compared to Car Trips

Akcicek, Dervis Cemal[1] , Misra, Aditi[2], Shirgaokar, Manish[2], and Marshall, Wesley[2]

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University of Colorado Denver
CU IN THE CITY

1 National Renewable Energy Laboratory
2 University of Colorado Denver

BACKGROUND

Image Source: Baruchman, M. (2020, April 7). *Access Paratransit Service has made improvements, audit says. here's what still needs work*. The Seattle Times. Retrieved December 25, 2022, from https://www.seattletimes.com/seattle-news/transportation/king-county-metro-access-paratransit-service-has-made-improvements-audit-saysheres-what-still-needs-work/

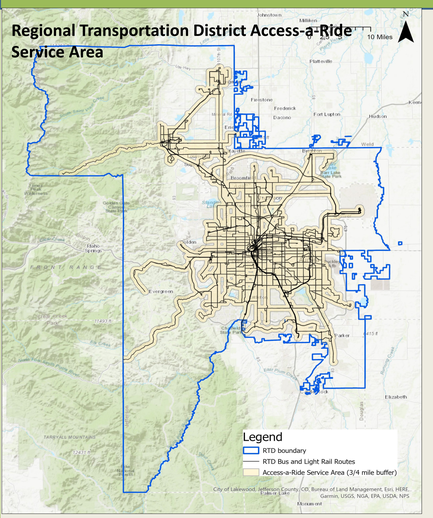
- Poor on-time performance and unpredictability are the key problems experienced by paratransit customers
- 12.2 percent of working persons with disabilities and 22.5 percent of non-working persons with disabilities live in zero-vehicle households compared to 3.9 percent and 9.5 percent respectively in the case of persons without disabilities

- Anecdotally, people with disabilities are likely to have uneven travel experiences, uneven access to infrastructure, opportunity, and economy, as well as uneven temporalities of mobility as compared to people without disabilities

Research Objectives:

- How does the trip time efficiency of paratransit compare to that of a counterfactual trip taken by automobile? (i.e., can data prove our hypothesis of uneven travel experiences for people with disabilities)
- Irrespective of experience, who are 'captive' paratransit riders?
- How is paratransit trip length related to rider sociodemographic? (e.g., do women paratransit users have longer trip times than their men counterparts?)

DATA ASSEMBLY & ANALYTIC APPROACH



- Collected between January 2019 to June 2021
- 1.16 million trips
- latitude and longitude for pick-up and drop-off locations
- sex and birth year
- cost of the trip, collected fare type
- start and end date-time

For this analysis:

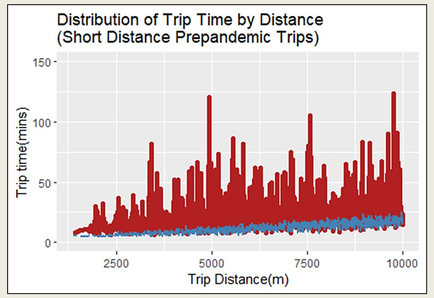
- Randomly selected 10 percent for analysis
- imputed counterfactual car trip durations estimated utilizing Google Distance Matrix API
- Imputed Average daily weather conditions based on Denver Airport Weather station

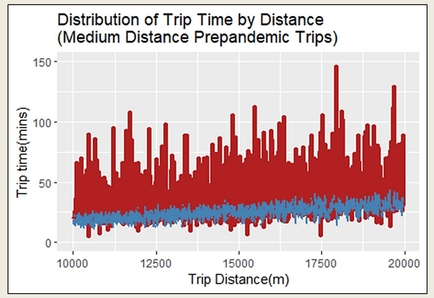
Summary Statistics

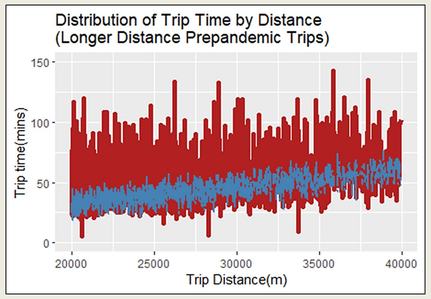
- Most Access-a-Ride patrons are captive
- Overall, recurring users of the paratransit service were
  - younger females
  - mostly ticketed customers, and
  - making trips that cost them equal to $5

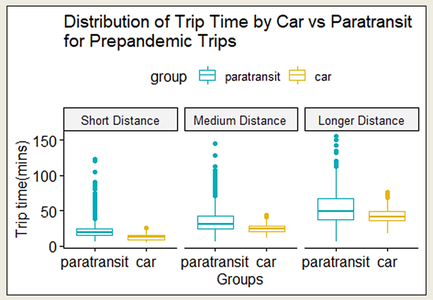
Variables of Interest	Data with Repeated Observations	Data for Unique Customer ID
Observations	94,994	6,554
Sex		
Male	47%	43%
Female	53%	57%
Mean age (years)	54.3	60.7
Mean trip distance (miles)	10.5	10.6
Mean trip time (minutes)	35.3	36.1
Fare category representation		
Cash	14%	32%
Ticket	75%	56%
No fare paid (social/medical program payments)	10%	12%
Cost		
Local <$5	12%	15%
Regular/Local $5	87%	82%
Regional	1%	3%

Comparisons of trip time by car (in blue) versus paratransit (in red) for all pre-pandemic trips

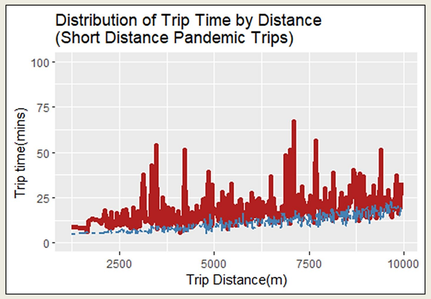


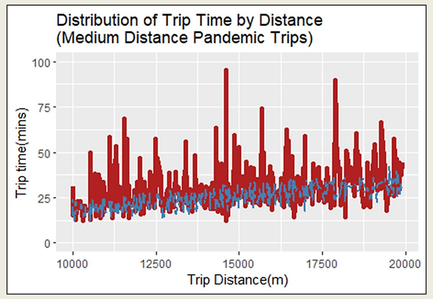


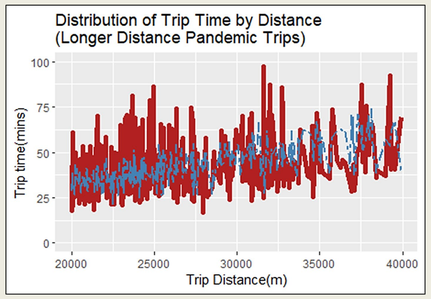


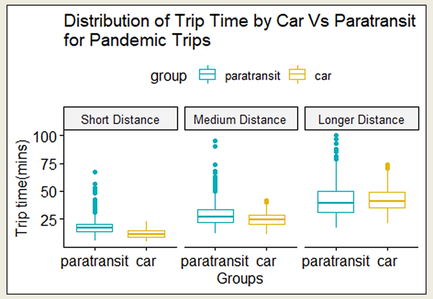


Comparisons of trip time by car (in blue) versus paratransit (in red) for all during pandemic trips







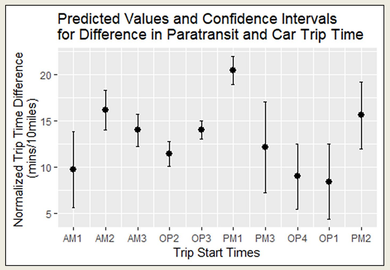


MODEL RESULTS

$$Normalized\ time\ difference = \beta_0 + \beta_1 Start\ time\ categories + \beta_2 Average\ temperature\ on\ trip\ date + \beta_3 Average\ precipitation\ on\ trip\ date + \epsilon.$$

$$Normalized\ time\ difference\ \left(\frac{mins}{mile}\right) = \frac{paratransit\ trip\ time - car\ trip\ time}{Distance}$$

Coefficients:	Estimate	Std. Error	t value	Pr(>|t|)	Significance
Trip start time (ref. AM1: 6:00 AM – 7:00 AM)					
AM2: 7:00 AM – 8:00 AM	0.642	0.237	2.712	0.007	**
AM3: 8:00 AM – 9:00 AM	0.425	0.229	1.859	0.063	.
OP2: 9:00 AM – 11:00 AM	0.171	0.221	0.775	0.438	
OP3: 11:00 AM – 3:00 PM	0.427	0.216	1.981	0.048	*
PM1: 3:00 PM – 5:00 PM	1.071	0.224	4.781	0.000	***
PM2: 5:00 PM – 6:00 PM	0.586	0.279	2.097	0.036	*
PM3: 6:00 PM – 7:00 PM	0.238	0.326	0.729	0.466	
OP4: 7:00 PM – 11:00 PM	-0.075	0.276	-0.271	0.787	
OP1: 11:00 PM – 6:00 AM	-0.133	0.295	-0.451	0.652	
Average Temperature	-0.012	0.003	-4.012	0.000	***
Average Precipitation	0.001	0.011	0.116	0.908	
(Intercept)	1.042	0.211	4.938	0.000	***
Residual standard error: 2.394 on 6486 degrees of freedom					
Multiple R-squared: 0.01869,	Adjusted R-squared: 0.01702				
F-statistic: 11.23 on 11 and 6486 DF, p-value: < 2.2e-16					



- For a 10-mile trip:

AM Peak: Extra 6.5 minutes + 10 minutes difference in means = 16.5 total average trip time difference

PM Peak: Extra 10.6 minutes + 10 minutes difference in means = 20.6 total average trip time difference

In addition to 3 times the uncertainty

AM Peak: paratransit trips were predicted to be 10 to 16.5 minutes longer than car trips

PM Peak: paratransit trips were predicted to be 12 to 21 minutes longer than car trips

AM Peak: For a 25-minute trip, riders needed to start 42 minutes before to reach their destination on time

PM Peak: For a 25-minute trip, riders needed to start 46 minutes before to reach their destination on time

FINDINGS & DISCUSSION

- Paratransit trip times are on average twice that of car travel time between the same OD pairs and 3 times more uncertain
- Paratransit trips are also particularly inefficient for shorter and medium-distance trips
- Paratransit trips were more time efficient during the pandemic, as expected.
- Paratransit trip times are significantly influenced by trip start times, especially morning and afternoon peak hours
- Paratransit trip times were also higher in winter and in rain making it a poor choice of travel in inclement weather.

Our work indicates that paratransit services could be improved for trip time efficiency by engaging in a series of policy measures. Time of trip during the day matters with high inefficiency on paratransit, compared to automobile-based mode. This suggests that sedan-based services, particularly supplied during peak travel hours, can increase time-efficient travel for PWDs.