Using the Three-Factor Theory to Examine the Transit Preferences of Riders from Different Income Levels

Xinyi Wu
Humphrey School of Public Affairs
University of Minnesota

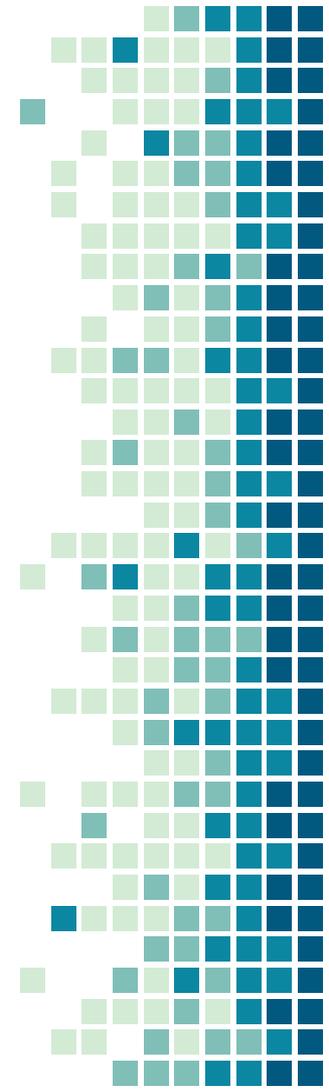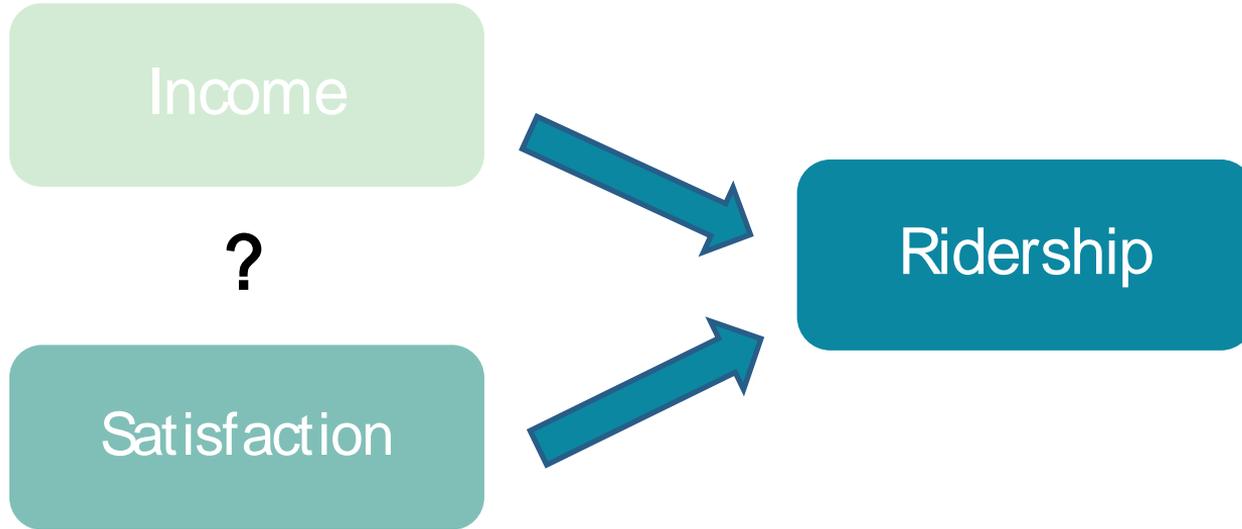28th Annual Transportation Research Conference, Center for Transportation Studies
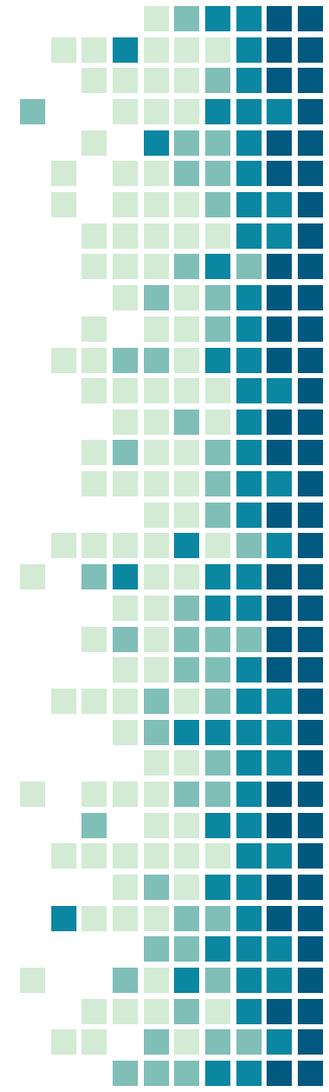
1

Background

Existing Literature

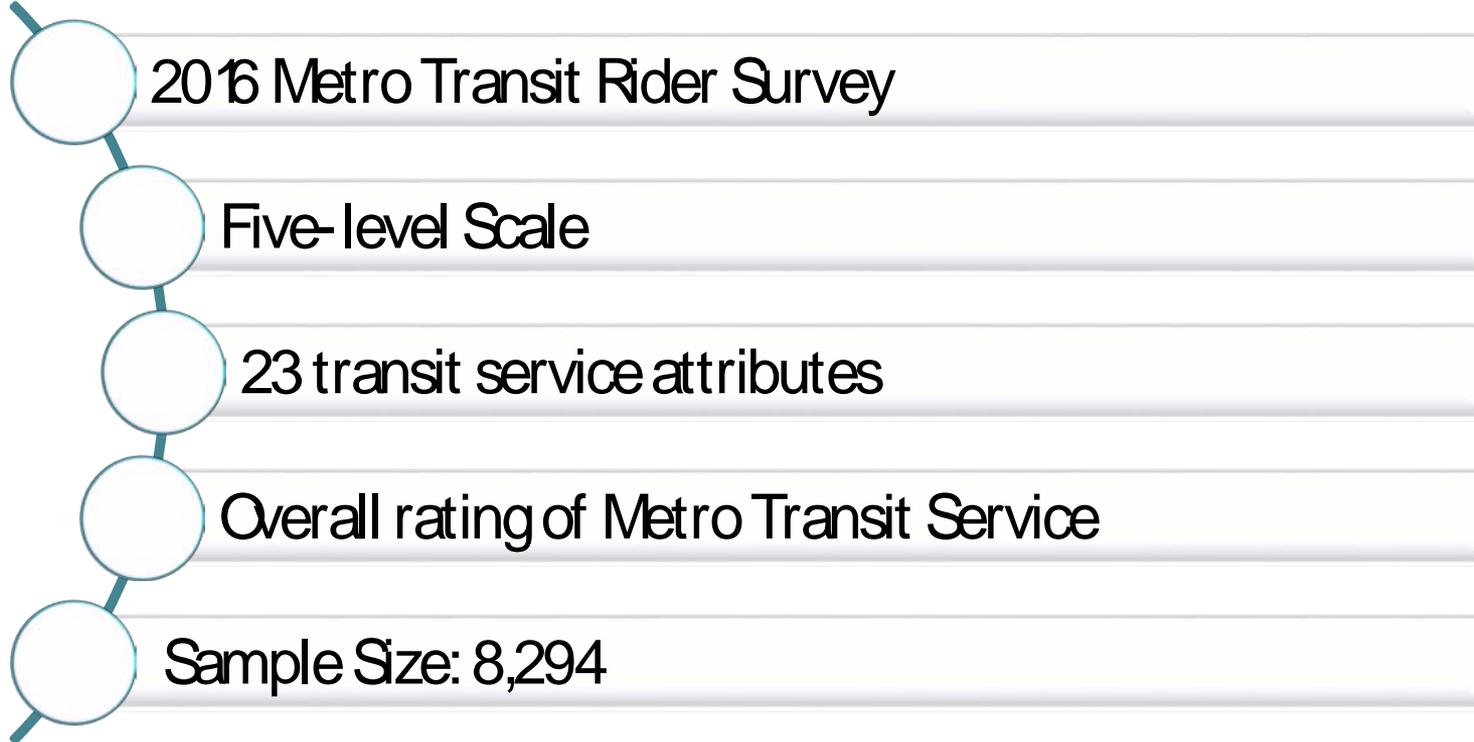# Background

Research Questions

- How do the preferences of transit attributes differ among people of different income?

- What are the market segmentation implications this study could provide for transit agencies?
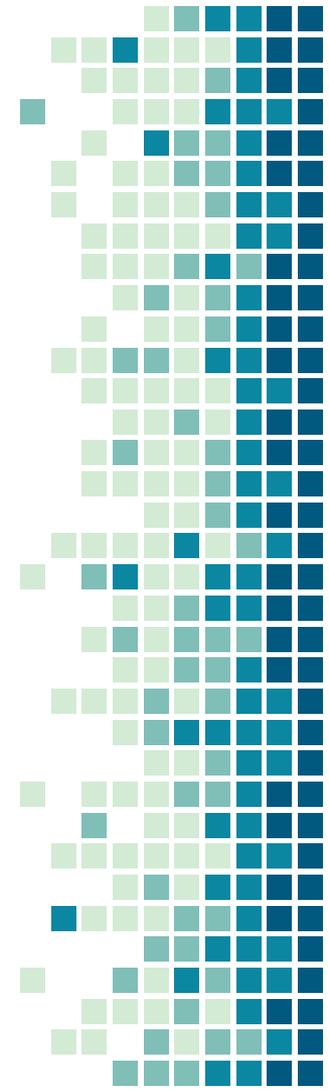
2.
Data

Data and Variables

2016 Metro Transit Rider Survey

Five-level Scale

23 transit service attributes

Overall rating of Metro Transit Service

Sample Size: 8,294

Income Levels

Table 1 Income levels, frequencies, and proportions

Household Income	Frequency	Percent
Less than $10,000	1,053	12.7
$10,000 - $14,999	533	6.43
$15,000 - $24,999	615	7.41
$25,000 - $34,999	728	8.78
$35,000 - $49,999	783	9.44
$50,000 - $59,999	474	5.71
$60,000 - $74,999	543	6.55
$75,000 - $99,999	608	7.33
$100,000+	1,242	14.97
NA	1,715	20.68

Lower income

Higher income

Reasons for Choosing Transit by Income

reasons

- ■ Multiple reasons
- ■ More convenient
- ■ Save time
- ■ Save money on parking
- ■ Subsidized by employer or other organization
- ■ Provide regular exercise
- □ Prefer car-free or car-light lifestyle
- ■ Environmental
- ■ Do not have access to car or other transportation
- ■ Save money on gas or auto expenses
- ■ Avoid stress of driving/traffic congestion
- ■ Predictable travel time compared to driving
- ■ Other

Percent

0%
25%
50%
75%
100%

0 – 10,000
10,000 – 14,999
15,000 – 24,999
25,000 – 34,999
35,000 – 49,999
50,000 – 59,999
60,000 – 74,999
75,000 – 99,000
100,000+

# 3.
Methodology

Gradient Boosting

- Similar to bagging and random forest, boosting is also an approach that could improve prediction accuracy based on decision trees.

- This decision tree based algorithm has advantages regarding flexibility, resilience, validation.

- This method was used to estimate the **relative importance** of different attributes among higher and lower income riders.
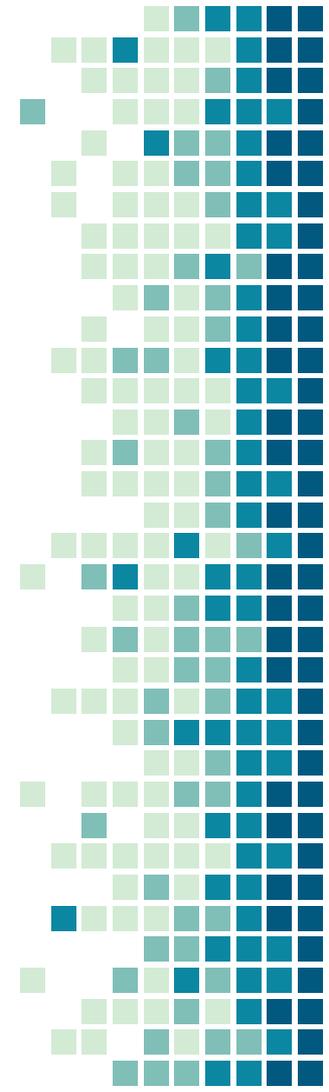
The Three-factor theory
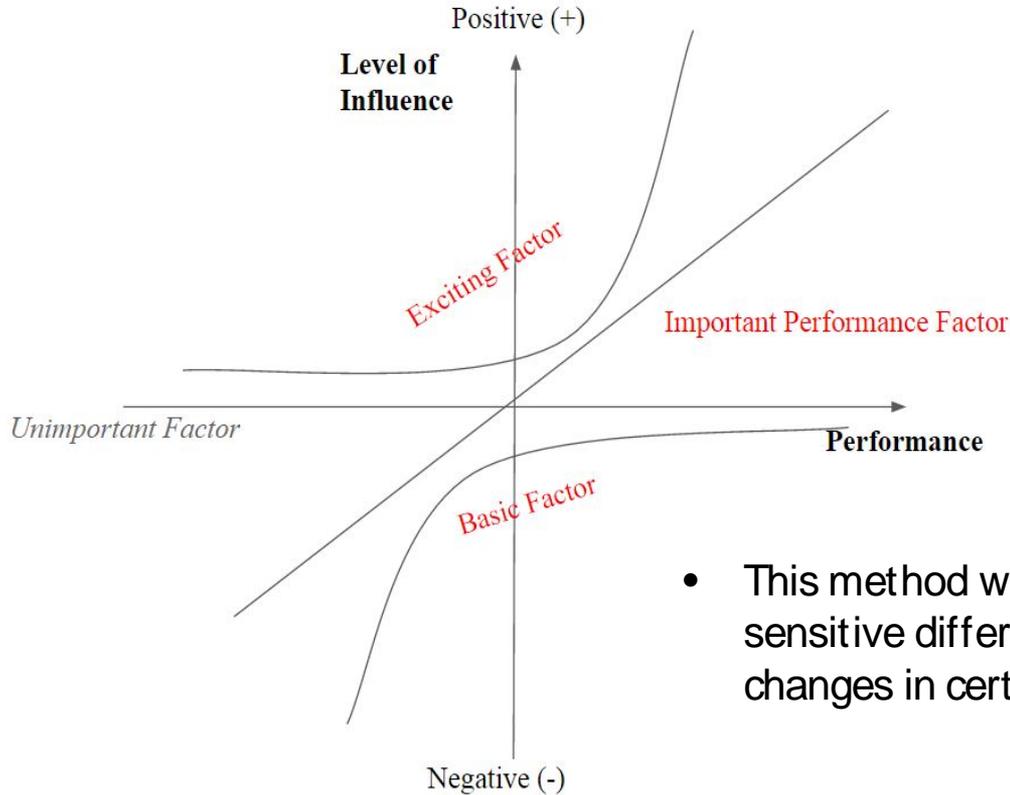
- This method was used to estimate how sensitive different riders are regarding changes in certain attributes.
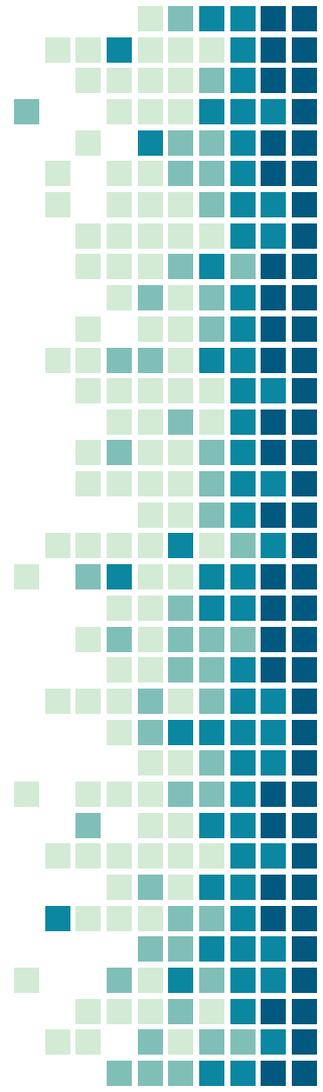
Modelling
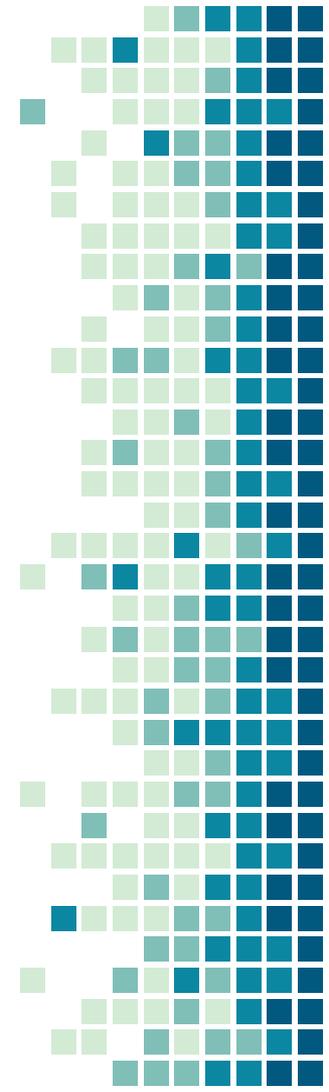
- I ran regression with dummy variables using ordered logistic regressions.

Table 2 Dummy variables coding

	Independent variables		Dependent variable
Categories	High Performance Dummy Variable	Low Performance Dummy Variable	Overall rating
Excellent	1	0	5
Good	0	0	4
Fair	0	1	3
Poor	0	1	2
Unacceptable	0	1	1

Modelling

Table 2 Examples showing how to categorize variables

	Coefficients	P-value
Paying fare is easy (Low)	-0.3986185	0.048
Paying fare is easy (High)	0.331497	0.030
Safety while riding (Low)	-0.6359463	0.000
Safety while riding (High)	0.4733442	0.011
Driver's manner (Low)	0.0330456	0.868
Driver's manner (High)	0.5534987	0.002
Vehicles are comfortable (Low)	-0.4432047	0.013
Vehicles are comfortable (High)	0.0763296	0.718
Routes and schedules are easy to understand (Low)	-0.40416	0.11
Routes and schedules are easy to understand (High)	-0.12034	0.642

*Note: significance level (P) <= 0.05

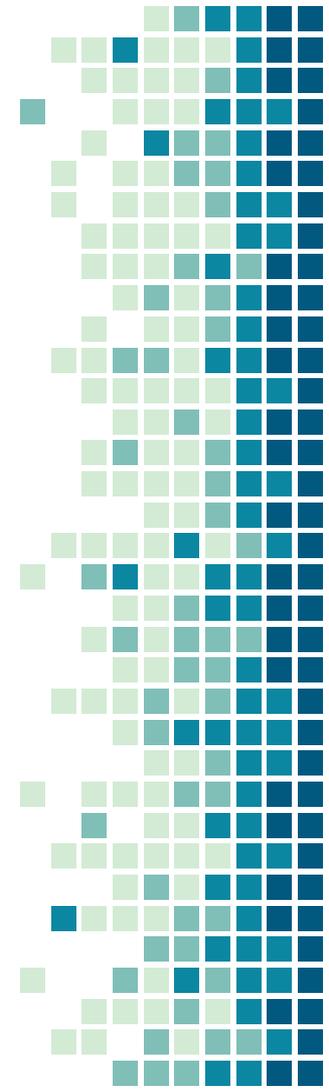Important performance Factor

Exciting Factor

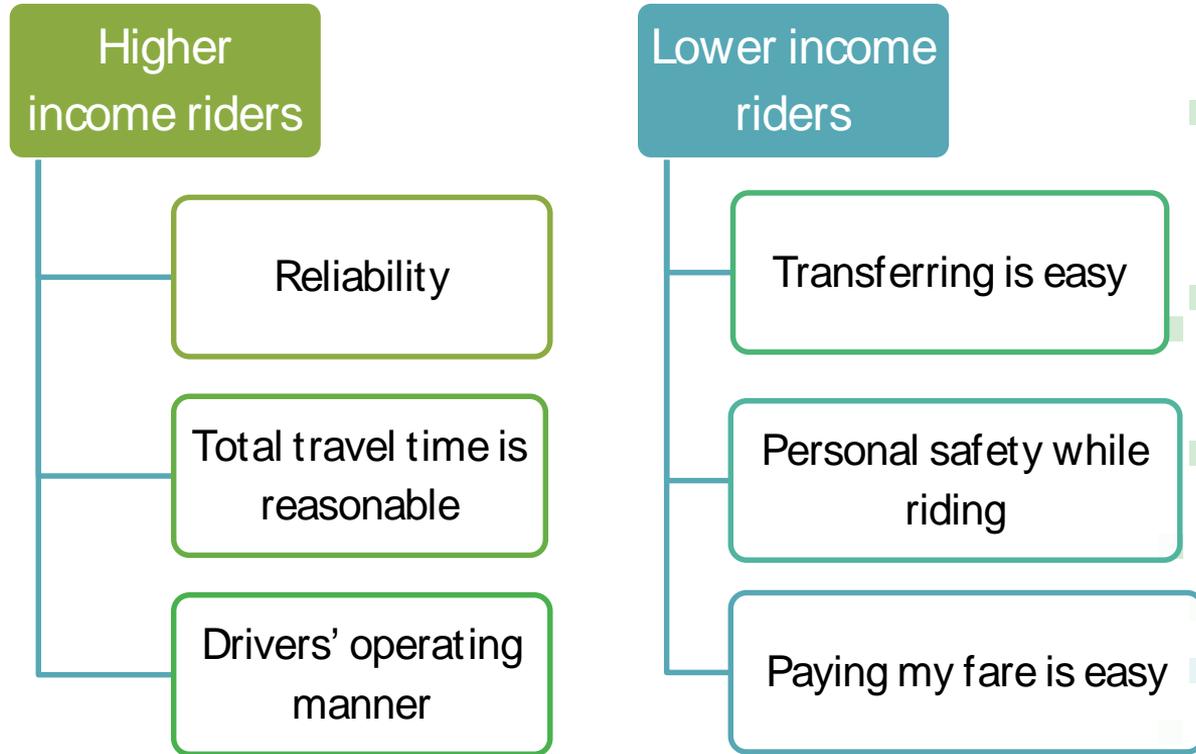Basic Factor

Unimportant Factor

4.

Results and Discussion

Gradient Boosting – Relative Importance

Higher income			Lower income		
	var	rel.inf		var	rel.inf
q3_r10	q3_r10	27.99576	q3_r9	q3_r9	13.04351
q3_r8	q3_r8	10.66925	q3_r4	q3_r4	11.32754
q3_r11	q3_r11	9.521886	q3_r2	q3_r2	10.11106
q3_r24	q3_r24	8.295243	q3_r10	q3_r10	9.9765
q3_r2	q3_r2	5.688284	q3_r14	q3_r14	6.249611
q3_r7	q3_r7	4.858572	q3_r3	q3_r3	5.080887
q3_r16	q3_r16	4.14756	q3_r11	q3_r11	5.052239
q3_r3	q3_r3	3.418958	q3_r8	q3_r8	4.847396
q3_r13	q3_r13	3.304823	q3_r13	q3_r13	4.726268
q3_r5	q3_r5	2.911662	q3_r6	q3_r6	4.356733
q3_r6	q3_r6	2.598268	q3_r24	q3_r24	3.852172
q3_r14	q3_r14	2.580194	q3_r7	q3_r7	3.775123
q3_r4	q3_r4	2.161617	q3_r18	q3_r18	3.639818
q3_r18	q3_r18	1.847566	q3_r15	q3_r15	3.290178
q3_r12	q3_r12	1.834545	q3_r19	q3_r19	2.74899
q3_r20	q3_r20	1.727426	q3_r5	q3_r5	2.259472
q3_r23	q3_r23	1.646538	q3_r20	q3_r20	1.44726
q3_r19	q3_r19	1.528581	q3_r12	q3_r12	1.402461
q3_r9	q3_r9	0.959145	q3_r16	q3_r16	1.056143
q3_r21	q3_r21	0.850283	q3_r23	q3_r23	0.961792
q3_r15	q3_r15	0.556299	q3_r17	q3_r17	0.416759
q3_r22	q3_r22	0.532836	q3_r21	q3_r21	0.203238
q3_r17	q3_r17	0.364711	q3_r22	q3_r22	0.174853

Table 3 Relative importance of transit attributes among different riders.

Gradient Boosting – Relative Importance

Higher income riders
- Reliability
- Total travel time is reasonable
- Drivers' operating manner

Lower income riders
- Transferring is easy
- Personal safety while riding
- Paying my fare is easy

Factor Structure

▪ Since most high income riders use rail or express bus services, they experience more advanced transit services, thus reacting less sensitively to some basic attributes.
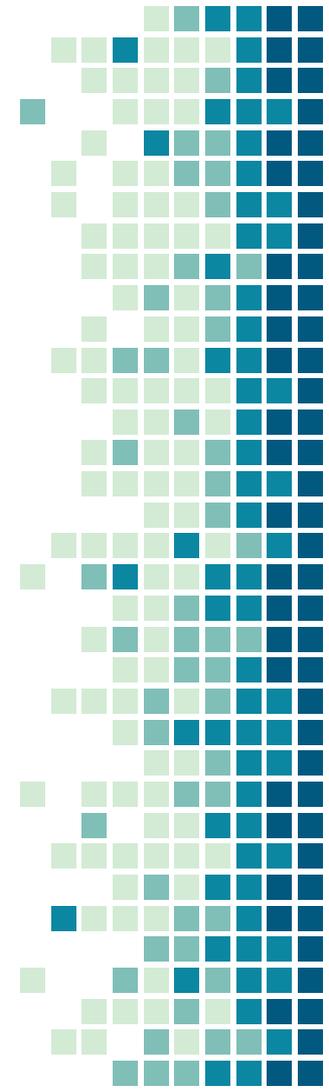
| Attributes	Higher income	Lower income
Paying my fare is easy	Exciting	Performance
Personal safe while riding	Exciting	Basic
Transferring is easy	Unimportant	Exciting
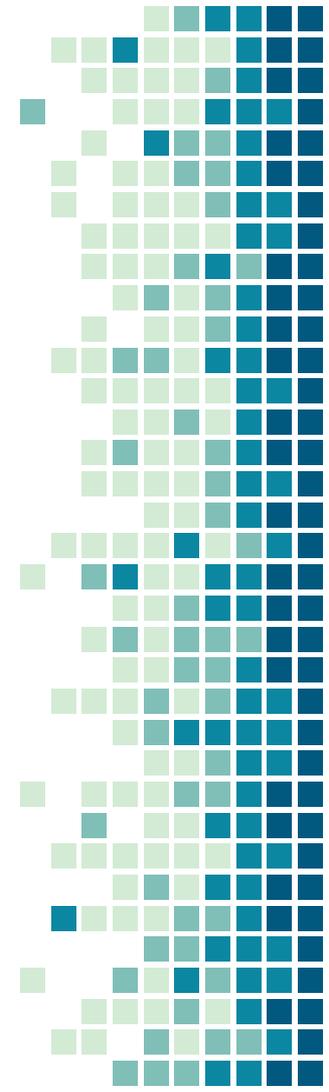
Factor Structure

▪ High income riders have more expectations on the quality of services, whereas low income riders react less sensitively to these relatively more advanced qualities.

Attributes	Higher income	Lower income
Availability of seating	Basic	Unimportant
Accessible for people with disabilities	Basic	Unimportant
Handling of concerns/complaints	Performance	Unimportant

Policy Implications

Segments	Characteristics
Higher income riders (28.85%)	• Choice riders; • Ride to save parking fees and to avoid congestion; • **More concerned with reliability, travel time, concerns handling, availability of seats, and drivers' operating manners.** • **Add or improve advanced services**
Lower income riders (26.54%)	• Transit-dependent riders; • Ride to access places; • **More concerned with transferring, riding safety, and easiness of paying fares.** • **Improve basic services**
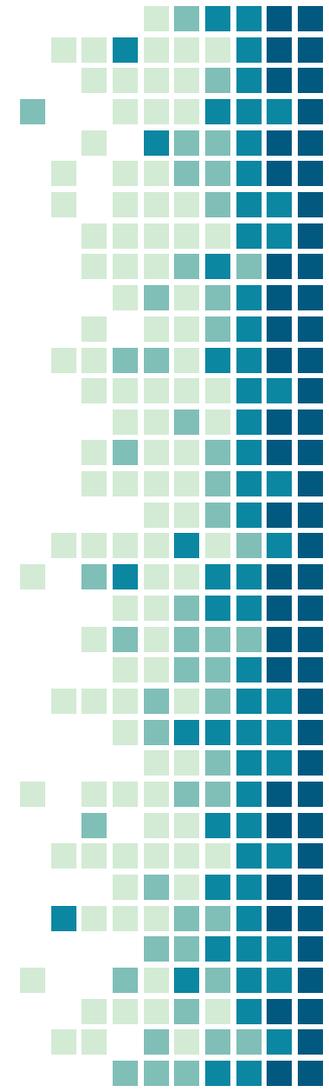
Conclusion and Summary

- I used the 2016 Metro Transit Rider survey to analyze the preferences regarding transit attributes among riders of different income, with the application of gradient boosting algorithm and the three factor theory;

- This study found that high income and low income riders have different preferences;

- Based on the findings, I made implications regarding transit market segmentations for transit agencies.

THANKS!

You can find me at:
wuxx1088@umn.edu