TCRP H-37: Characteristics of Premium Transit Services that Affect Choice of Mode

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Overview

1. Objectives
2. Surveys
3. Transit Service Characteristics
4. Awareness and Consideration
5. Traveler Attitudes
6. Mode Choice
7. Implementation
Project Goals

1. To improve the transit industry’s understanding of mode choice determinants

2. To offer practical insights to the forecasting community so that mode choice models and transit path-builders can better represent and distinguish important mode characteristics

Methods to Improve Practice and Achieve Project Goals

- Include measurable variables that potentially distinguish premium transit services
- Include latent variables that impact modal choice
- Consider which transit paths are represented in choice sets
### Project Overview

<table>
<thead>
<tr>
<th>Project Tasks</th>
<th>Phase 1</th>
<th>Phase 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Salt Lake City</td>
<td>Charlotte</td>
</tr>
<tr>
<td>Surveys</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Traveler Attitude Models</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Service Characteristics Models</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Awareness and Consideration Models</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Mode Choice Models</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Implementation and Testing</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
Transit Service Characteristics
## Transit service attributes

<table>
<thead>
<tr>
<th>Attribute bundle</th>
<th>Attribute</th>
<th>Premium Attributes</th>
<th>Standard Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station/stop design features</td>
<td>Real-time info about next transit arrival/departure</td>
<td>Real-time info available</td>
<td>No real-time info available</td>
</tr>
<tr>
<td></td>
<td>Station/stop security</td>
<td>Enhanced (e.g., emergency call-buttons, surveillance cameras, security personnel)</td>
<td>No added security features</td>
</tr>
<tr>
<td></td>
<td>Station/stop lighting/safety</td>
<td>Well-lit with police presence</td>
<td>Normal lighting and no police presence</td>
</tr>
<tr>
<td></td>
<td>Station/stop shelter</td>
<td>Effectively protects you from bad weather</td>
<td>Limited or no shelter</td>
</tr>
<tr>
<td></td>
<td>Proximity to services</td>
<td>Close to coffee shop, dry cleaners, grocery, etc.</td>
<td>Not close to coffee shop, dry cleaners, grocery, etc.</td>
</tr>
<tr>
<td></td>
<td>Cleanliness of station/stop</td>
<td>Well-maintained and clean</td>
<td>Not well maintained</td>
</tr>
<tr>
<td></td>
<td>Station/stop benches</td>
<td>Clean and comfortable</td>
<td>Some benches</td>
</tr>
<tr>
<td>On-board features</td>
<td>On-board seating availability</td>
<td>Always available seats</td>
<td>Often crowded; you might not get a seat</td>
</tr>
<tr>
<td></td>
<td>On-board seating comfort</td>
<td>Seats are comfortable and a good size</td>
<td>Seats are standard</td>
</tr>
<tr>
<td></td>
<td>On-board temperature</td>
<td>Effective air-conditioning and heating</td>
<td>Some air-conditioning and heating</td>
</tr>
<tr>
<td></td>
<td>Cleanliness of transit vehicle</td>
<td>Very new and clean</td>
<td>Maintained, but not new</td>
</tr>
<tr>
<td></td>
<td>Productivity features</td>
<td>Wi-Fi, power outlets, etc. available</td>
<td>Productivity features not available</td>
</tr>
</tbody>
</table>
## Transit service attributes

<table>
<thead>
<tr>
<th>Attribute bundle</th>
<th>Attribute</th>
<th>Premium Attributes</th>
<th>Standard Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not part of a bundle</td>
<td>Route name/number identification</td>
<td>Easy to identify on outside of transit vehicle</td>
<td>Difficult to immediately identify on outside of transit vehicle</td>
</tr>
<tr>
<td></td>
<td>Reliability</td>
<td>1 in 10 trips are 5 minutes late or more</td>
<td>1 in 10 trips are 15 minutes late or more</td>
</tr>
<tr>
<td></td>
<td>Schedule span</td>
<td>Transit runs from 4 AM until 11 PM</td>
<td>Transit runs during rush hours only</td>
</tr>
<tr>
<td></td>
<td>Transit frequency</td>
<td>Arrives every 10 minutes in rush hour and every 20 minutes in non-rush hour</td>
<td>Arrives every 20 minutes in rush hour and every 60 minutes in off-peak</td>
</tr>
<tr>
<td></td>
<td>Transfer distance</td>
<td>Convenient (short walking distance or on same platform)</td>
<td>Several minute walk</td>
</tr>
<tr>
<td></td>
<td>Station/stop distance</td>
<td>Within 10 minutes walk of your home/work</td>
<td>Not within 10 minutes walk of your home/work</td>
</tr>
<tr>
<td></td>
<td>Parking distance</td>
<td>Within 10 minutes walk from station/stop</td>
<td>Not within 10 minutes walk from station/stop</td>
</tr>
<tr>
<td></td>
<td>Ease of boarding</td>
<td>Easy to board; doors are level with platform/curb</td>
<td>Must step up to board</td>
</tr>
<tr>
<td></td>
<td>Fare machines</td>
<td>Fast and easy to use</td>
<td>Slow and somewhat confusing</td>
</tr>
</tbody>
</table>
Equivalent Minutes of In-Vehicle Time Chicago

- Commute Bus
- Commute Train
- Non-Commute Bus
- Non-Commute Train

- Fare Machines
- Ease of Boarding
- Parking Distance
- Station/Stop Distance
- Transfer Distance
- Transit Frequency
- Schedule Span
- Reliability
- Route Name/Num Identification
- Productivity features
- Cleanliness of Transit Vehicle
- On-Board Temperature
- On-Board Seating Comfort
- On-Board Seating Availability
- Station/Stop Benches
- Cleanliness of Station/Stop
- Proximity to Services
- Station/Stop Shelter
- Station/Stop Lighting/Safety
- Station/Stop Security
- Real-Time Info
Traveler Attitudes
Approach to Mode Choice Modeling

- **Transit Service Attributes**
  - Maximum difference models have been used to incorporate detailed transit service attributes

- **Traveler Attitudes**
  - Factor analysis and latent variable modeling have been used to estimate attitudinal factors

- **Awareness and Consideration**
  - Joint bivariate binary probit model have been used to predict the choice sets for awareness and consideration of transit modes

- **Mode Choice**
  - Multinomial logit and integrated choice latent variable models have been used to predict modal choices
## Factor Analysis

<table>
<thead>
<tr>
<th>Factor</th>
<th>Salt Lake City</th>
<th>Charlotte</th>
<th>Chicago</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>availability</td>
<td>Pro-Car Attitude</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>pro-transit</td>
<td>Pro-Transit Attitude</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>transit averse</td>
<td>Transit Averse</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>privacy and comfort</td>
<td>Privacy and Comfort</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>environment and productivity</td>
<td>Environment and Productivity</td>
<td></td>
</tr>
</tbody>
</table>

Based on 6 Attitudinal Statements

Based on 18 Attitudinal Statements
Adding Latent Variables to Mode Choice Models

Pro-Car Attitude
- Retired
- Female
- Vehicles
- Income
- Mobility
- Drivers

Pro-Transit Attitude
- Students
- Retired
- Female
- Younger
- Vehicles
- Income
- Mobility
- Drivers

Transit Advantages Attitude
- Workers
- Income
- Younger
- Vehicles
- Drivers

Privacy and Comfort Attitude
- Female
- Vehicles
- Kids
Awareness and Consideration
Consideration and Availability of Transit Modes

All Choices
- Available
  - Considered
    - Chosen
    - Not Chosen
  - Not Considered
- Not Available

Example Chicago Rail
- 1515
  - 698
    - 601
      - 528
    - 97
      - 73
Awareness and Consideration Models Findings

- Separating Awareness and Consideration diluted the choices and didn’t add anything to the final choice sets
- Awareness/Consideration can be include directly in Latent Variable models
- Path building needs to be improved to adequately account for awareness
  - Constraints can be problematic (walking, driving distance, etc.)
  - Competition within modes not represented
- Limiting choice sets is useful if the choices are adequately represented
  - Path building
  - Definition of choices
  - Nesting
Mode Choice Models
Multinomial Logit Choice Models

- Accounts for traveler attitudes
  - Relies on factor analysis to produce traveler attitudes as input to MNL models
  - Forecasts of traveler attitudes would require separate or integrated models

- Uses Revealed Preference (RP) and Stated Preference (SP) data
  - Developed joint RP-SP models that included a RP-SP scaling coefficient
  - Low values of time led to estimation of a SP-only choice model which produced a ratio of in-vehicle travel time to cost that was used to constrain the joint RP-SP model coefficients; this was employed in a 2-step model estimation process for all model testing

- Incorporates awareness and consideration of transit modes
  - All models were constrained based on the awareness and consideration choice sets produced by these models i.e. a feasible transit mode was only included in the choice set if a traveler is both aware of the alternative and willing to consider the alternative

- Multinomial model structure
  - Nested modeling structures were tested in the first phase but did not yield significant differences so was not tested (yet) for this phase
Mode Choice Non-Traditional Variables

- **New Level of Service**
  - Premium on-board amenities
  - Premium station amenities
  - Reliability
  - Interaction with in-vehicle time and on-board amenities

- **Demographics**

- **Trip Characteristics**
  - Group Travel
  - Weekend Travel
  - Makes Stops for Groceries
  - Makes Stops for Other Purpose

- **Traveler Attitudes**
  - Pro-Car Attitude
  - Pro-Transit Attitude
  - Transit Averse
  - Privacy and Comfort
  - Productivity and Environment

- **Latent Variables**
  - Willingness to Walk
  - Informed about Transit
Interaction between IVTT and on-board amenities

- The longer the trip, the more important premium on-board amenities become:
  - At 30 minutes, premium on-board amenities are worth 12 minutes of travel time
  - At 60 minutes, premium on-board amenities are worth 18 minutes of travel time

![Graph showing the difference in IVTT with premium on-board amenities](image-url)
Simultaneous estimation of latent variables and modal choices produce a more comprehensive result

- Incorporate traveler attitudes in a simultaneous way where prior factor analysis and multinomial logit models incorporates attitudes in a sequential way
- Both latent variables and traveler/trip characteristics contribute to the estimation of modal choices

Explicitly allow for the impact of attitudes on mode choice

- Attitudes are unobserved (latent) and represented by indicators of the attitudes
- Directly incorporating the indicators in utility functions would create measurement error and endogeneity bias

Provide a means to apply and forecast attitudinal variables

- Attitudes are a function of demographic variables
- More reliable measures of latent variables, since these are interacted with mode choice

Coefficients similar to MNL mode choice models

Latent variables are derived from socioeconomic variables
Implementation
Calibration and Testing for TCRP

- Test different path building assumptions
  - Add premium characteristics and cost into path building
  - Create hundreds of path choices each for walk and drive access
  - Use onboard survey to
    - Identify aspects of path building that don’t fit observed behavior (bike access to transit, kiss-and-ride, schedules that don’t fit time modeled time periods, etc.)
    - Identify the best fit for path building choice sets

- Calibrate the models in Salt Lake City
  - Has 5 modes (local and express bus, BRT, LRT, commuter rail)
  - Can be used to test the transferability of coefficients
  - Represents a mid-range of size and transit system
  - Has validated networks and a currently calibrated mode choice model
Calibration and Testing for CMAP

- **Apply path building process**
  - Add premium characteristics and cost into path building
  - Create hundreds of path choices each for walk and drive access
  - Use onboard and household surveys to identify the best fit for path building choice sets

- **Estimate mode choice models for Chicago**
  - Attach premium service characteristics to household or TCRP surveys
  - Create path building choice sets
  - Estimate new mode and path choice models
    - Nested logit choice (NL)
    - Integrated choice and latent variable (ICLV)
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