Perception and Acceptability Analysis on User Location-Based Transit Mobile Application

Presenters: Young-Jae Lee, PhD & Seyedehsan Dadvar, PhD Candidate
Introduction

• Many transit agencies provide real-time operational information (routing and scheduling) through phone, web, and smartphone applications and trip-planning tool for a given origin and destination.

• They use one-directional information flow from transit agencies to transit users.
Introduction (Cont.)

• What about a *two-directional* information flow that includes information from users to transit agencies and transit vehicles?
  
  • Due to current smartphone technology and connected vehicle infrastructure (CVI)
Objectives

• Developing a rudimentary architectural framework for two CVI applications:
  • An application for demand-responsive transit (DRT)
  • An enhanced traveler safety application that allows individuals to notify a transit vehicle that they are within a specified distance of the vehicle’s current stop.

• Investigating perception and acceptability of the developed two-way user location-based mobile app through a survey on:
  • Safety
  • Efficiency
  • Privacy
User Location-based Applications

• Search engines provide user-location based services like search results on “Google Maps”.

• Social media: Using current GPS enabled devices (smartphones, tablets and etc.) many social network services including “Facebook”, provide some kind of user location-based services (finding friends or locations)

• Shared mobility services such as “Uber” and “Lyft” also use location-based service to make their services more convenient

• The app service such as “Waze” utilizes user locations to share the traffic information

➡️ What about user location-based services for public transportation?
Flexible Routing and User Location-based Transit Apps

• Some relevant US patents (1982 → 2016) indicating emergence, acceptance and usage of underlying technologies and systems which made possible flexible routing and user location-based systems.

• The main features of these patents:
  • Communication network and systems
  • Improvements for real-time mapping and navigation
  • Location information services
  • User location driven services
  • Improvements for fixed-route transport
  • Introduction of flexible-route transport
  • Decentralized transportation
Flexible Routing and User Location-based Transit Apps (Cont.)

• The race started with some frontier individuals who tried to see the world ahead of their time.

• But gradually corporate names also got involved like AT&T and Institute for Information Industry, and, recently, Uber (founded as UberCab in 2009).

• Many competitors in the industry such as Curb, Didi Chuxing, Flywheel, Grab, Hailo, Kabbee, Lyft, Ola Cabs, and Shuddle
Location-Aware Transportation Tools

- Core & Incumbent Services
  - Car Rental
  - Liveries/Limos
  - Paratransit
  - Pedicabs
  - Public Transit
  - Shuttles
  - Taxis

- Innovative Services
  - Carpool
  - Vanpool
  - Casual Carpool
  - Bikesharing
  - Carsharing
  - Courier Network Services
  - e-Hail
  - High-Tech Company Shuttles
  - Microtransit
  - P2P Bikesharing
  - P2P Vehicle Sharing
  - Ridesourcing/TNCs
  - Scooter Sharing

US DOT ITS T3e Webinar
System Architecture for Proposed User Location-based Transit App

- **P2I**
  - OD information from passengers to agency
  - Route information from agency to passengers

- **V2I**
  - Routing information and passenger information from agency to vehicle
  - Vehicle location/speed from vehicle to agency

- **P2V**
  - GPS location from passengers to vehicle
  - Vehicle location information from vehicle to passengers
A. Functions of a user mobile

- Sending a travel request (Origin, destination, preferred departure time or arrival time)

- Receiving a potential travel route, modified by the agency

- Confirm the modified route acceptance (yes or no)

- Map of the travel route including stop locations, bus location, driver information, etc.
Compositions of the User Location-Based Transit App System

B. Functions of an agency's server

• Collecting users' travel requests
• Making groups with similar travel requests
• Creating travel routes with modifying travel requests (stops, stop sequences, departure and arrival times, driver information)
• Sending modified travel requests to users
• Receiving final travel confirmations from the users
• Finalizing travel routes
• Creating a travel route map
Compositions of the User Location-Based Transit App System

C. Functions of a driver's tablet device

- Viewing a route map with stop locations, user locations, user information, vehicle locations, stop sequence, departure and arrival times for each stop

- Possible communication with a passenger when the passenger is not at the stop on time
Sequence of Usual Process

1. User submits the travel request
2. Agency collects the travel requests
3. Agency groups the travel requests
4. Agency creates a route with potentially modifying travel requests
5. Agency disseminates the route information with modified travel requests
6. User confirms the travel acceptance
7. Agency finalize the travel routes
8. Agency submit the route information to users and a driver
9. A driver uses a travel map to drive and collect passengers
10. In case a passenger is not at the bus stop, a driver can communicate with a passenger
User Location-Based Transit App Elements

Example of the User App Interface

[Image of a user interface showing options for travel date and time, origin, destination, planned arrival and departure times, and compute route.]
User Location-Based Transit App Elements (Cont.)

**Example of User Requests at the Transit Agency App**

<table>
<thead>
<tr>
<th>planned_departure</th>
<th>2014-01-01 00:00:00</th>
<th>2014-12-31 00:00:00</th>
<th>range select</th>
<th>latitude_dest, longitude_dest</th>
<th>39.328522,-76.597906</th>
<th>50</th>
<th>data search</th>
</tr>
</thead>
<tbody>
<tr>
<td>groupname</td>
<td>traveldataid</td>
<td>userid</td>
<td>req_complete</td>
<td>res_complete</td>
<td>real_departure</td>
<td>real_arrival</td>
<td>lat_orig_route</td>
</tr>
<tr>
<td>MSU-MC</td>
<td>115</td>
<td>5</td>
<td>false</td>
<td>false</td>
<td>2014-06-10 08:00:00</td>
<td>2014-06-10 08:00:00</td>
<td>39.3435122</td>
</tr>
<tr>
<td>MSU-SE</td>
<td>116</td>
<td>5</td>
<td>false</td>
<td>false</td>
<td>2013-06-08 10:00:01</td>
<td>2013-06-08 10:00:01</td>
<td>null</td>
</tr>
<tr>
<td>Route 4</td>
<td>115</td>
<td>5</td>
<td>false</td>
<td>false</td>
<td>2014-06-10 08:00:00</td>
<td>2014-06-10 08:00:00</td>
<td>39.3435122</td>
</tr>
<tr>
<td>MSU-MC</td>
<td>118</td>
<td>5</td>
<td>false</td>
<td>true</td>
<td>2013-06-08 10:00:01</td>
<td>2013-06-08 10:00:01</td>
<td>39.3435122</td>
</tr>
<tr>
<td>MSU-SE</td>
<td>145</td>
<td>3</td>
<td>false</td>
<td>true</td>
<td>0000-00-00 08:00:00</td>
<td>0000-00-00 08:00:00</td>
<td>39.3435122</td>
</tr>
<tr>
<td>Route 4</td>
<td>166</td>
<td>1</td>
<td>false</td>
<td>false</td>
<td>null</td>
<td>null</td>
<td>38.984652</td>
</tr>
<tr>
<td>Route 4</td>
<td>168</td>
<td>1</td>
<td>false</td>
<td>null</td>
<td>null</td>
<td>null</td>
<td>39.4014955</td>
</tr>
<tr>
<td>Route 4</td>
<td>170</td>
<td>1</td>
<td>true</td>
<td>true</td>
<td>null</td>
<td>null</td>
<td>39.4014955</td>
</tr>
<tr>
<td>Route 4</td>
<td>171</td>
<td>1</td>
<td>true</td>
<td>true</td>
<td>null</td>
<td>null</td>
<td>39.0992752</td>
</tr>
</tbody>
</table>

---

**US DOT ITS T3e Webinar**
User Location-Based Transit App Elements (Cont.)

Example of a Bus Routing
User Location-Based Transit App Elements (Cont.)

Example of a User Information at the Transit Agency App

Traveler Information

User ID = 1
Travel ID = 212
Requested Origin = Morgan State University
Requested Destination = Hood College, Frederick, MD 21701
Travel Origin = Morgan State University
Travel Destination = Hood College, Frederick, MD 21701
Planned departure time = 2015-07-30 09:03:18
Planned arrival time = null
Real departure time = 09:03:18
Real arrival time =

Pedestrian Information

User ID : 5
Date and Time : 2015-06-05 06:13:23
Latitude : 39.347402
Longitude : -76.586733
User Location-Based Transit App Elements (Cont.)

Example of a Bus Driver Information at the User App

**Driver Information**

Date and Time: 2014-11-26 00:31:43  
Driver ID: 1111111  
Latitude: 39.328356  
Longitude: -76.610806

*FlexRoute*, also referred to as *Flexible Bus Route*, caters to the needs of the travelers and pedestrians. Times and location may vary slightly.
User Location-Based Transit App Elements (Cont.)

Example of a Passenger Information at the Driver App

Boarding
Route: MSU-MC
Travel ID: 118
Departure Time: 2013-06-08 10:00:01
Location: Morgan State University, Baltimore, MD

Boarding
Route: MSU-MC
Travel ID: 115
Departure Time: 2014-06-10 08:00:00
Location: Morgan State University, Baltimore, MD
Expected Benefits of the App

- More efficient shuttle bus operation (especially, low demand night time)
- Accurate information for the shuttle service through the mobile app
- Improved passenger safety during night time by ensuring pickup
- Pedestrian safety during night time (pedestrian can provide their location to the police department)
Perception & Acceptability Survey

• An online survey was designed and distributed to capture public perception and acceptability about the developed app.

• Survey was open online from April 25th to July 8th 2016

• 92 usable responses

• The survey was mainly recruited in Baltimore, Maryland and southern Virginia.

• Advertising on some online websites like Craigslist was also among the methods of survey recruitment.
Participants’ Demographic Characteristics

- Male: 57%
- Female: 43%

- Age Distribution:
  - 18-34: 22%
  - 35 and over: 78%

- Income Distribution:
  - Prefer not to answer: 7.6%
  - Less than $50,000: 20.7%
  - $50,000 - $100,000: 46.7%
  - More than $100,000: 23.9%

N = 92
Participants’ Travel Behavior Characteristics

Driving Regularly?
- Yes: 79%
- No: 21%

Commuting Time
- Less than 20 minutes: 58%
- More than 20 minutes: 42%

Transit Use
- Yes: 30.4%
- No: 69.6%

Transit Transfer Needed? (for transit users)
- Yes: 38.2%
- No: 61.8%

N = 92
Participants’ Travel Behavior Characteristics (Cont.)

Transit App Familiarity
- Yes: 52.7%
- No: 47.3%

Transit App Use
- Yes: 50.0%
- No: 50.0%

Transit Extra Time
- Less than 20 minutes: 28.3%
- More than 20 minutes: 30.4%
- I do not know: 35.9%

N = 92
Survey Data Analysis

Transit App-related Questions

Please rate the following questions from 1 (least agree) to 10 (most agree)

Q19. Do you think this transit app makes for a safer transit experience during the daytime? (   )
Q20. Do you think this transit app makes for a safer transit experience at night? (   )
Q21. Do you think this transit app can improve safety on the university campus? (   )
Q22. If this transit app is connected with the police department, can it be used to improve nighttime walking safety? (   )
Q23. Do you think this transit app can be used for school bus operation? (   )
Q24. Are you comfortable with letting a transit agency know your location, if this transit app is only used for the transit operation? (   )
Q25. Can you recommend this type of mobile app for transit users? (   )
Q26. Are you willing to use the app and flexible transit service, if it can meet your need? (   )
Q27. Do you think this transit app can increase transit ridership? (   )
Survey Data Analysis

Comparison of Transit App-related Questions (Cont.)

[Bar chart showing the comparison of transit app-related questions with values for each category.]

- App: Improving Nighttime: 7.804
- App: Facilitating School Bus: 7.511
- App: Willingness-to-Use: 7.489
- App: Ridership Impact: 7.261
- App: Safer Transit Nighttime: 7.250
- Average: 7.194
- App: Location Reveal: 7.109
- App: Recommendation: 6.978
- App: Campus Safety: 6.978
- App: Safer Transit Daytime: 6.370
## Survey Data Analysis

### Combined Rating Scores

<table>
<thead>
<tr>
<th>Question</th>
<th>Category</th>
<th>Safety</th>
<th>Efficiency</th>
<th>Privacy</th>
<th>Unweighted Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q19. Do you think this transit app makes for a safer transit experience during the daytime?</td>
<td></td>
<td>●</td>
<td></td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Q20. Do you think this transit app makes for a safer transit experience at night?</td>
<td></td>
<td>●</td>
<td></td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Q21. Do you think this transit app can improve safety on the university campus?</td>
<td></td>
<td>●</td>
<td></td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Q22. If this transit app is connected with the police department, can it be used to improve nighttime walking safety?</td>
<td></td>
<td>●</td>
<td></td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Q23. Do you think this transit app can be used for school bus operation?</td>
<td></td>
<td></td>
<td></td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Q24. Are you comfortable with letting a transit agency know your location, if this transit app is only used for the transit operation?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Q25. Can you recommend this type of mobile app for transit users?</td>
<td></td>
<td>●</td>
<td>●</td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Q26. Are you willing to use the app and flexible transit service, if it can meet your need?</td>
<td></td>
<td>●</td>
<td>●</td>
<td></td>
<td>●</td>
</tr>
<tr>
<td>Q27. Do you think this transit app can increase transit ridership?</td>
<td></td>
<td>●</td>
<td>●</td>
<td></td>
<td>●</td>
</tr>
</tbody>
</table>
Survey Data Analysis

**Combined Rating Scores**

- **Combined Safety Attribute (Avg. = 7.161)**
  - *Commute time*: “More than 20 minutes” with average rating score of 7.652 (p < 0.05)
  - *Transit transfer needed*: “No” with average rating score of 7.978 (p < 0.1)

- **Combined Efficiency Attribute (Avg. = 7.310)**
  - *Transit transfer needed*: “No” with average rating score of 8.385 (p < 0.05)
  - *Transit extra time*: “Less than 20 minutes” with average rating score of 7.942 (p < 0.1)

- **Combined Privacy Attribute (Avg. = 7.290)**
  - *Transit transfer needed*: “No” with average rating score of 8.288 (p < 0.05)

- **Unweighted Total Rating Score (Avg. = 7.194)**
  - *Commute time*: “More than 20 minutes” with average rating score of 7.661 (p < 0.05)
  - *Transit transfer needed*: “No” with average rating score of 8.009 (p < 0.05)
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (3 groups)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marital Status (2 groups)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Income (3 groups)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Race/Ethnicity (3 groups)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education (3 groups)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occupation (2 groups)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car Ownership</td>
<td>0.046</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driving Regularly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transit Use Frequency (2 groups)</td>
<td></td>
<td>0.083</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commute Time (2 groups)</td>
<td>0.000</td>
<td>0.016</td>
<td>0.066</td>
<td>0.038</td>
<td>0.014</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.022</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transit Transfer Needed</td>
<td>0.062</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transit Extra Time (3 groups)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.058</td>
<td>0.040</td>
</tr>
<tr>
<td>Transit App Familiarity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transit App Use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home Location Category</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work/Study Location Category</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commute Category (3 groups)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p-value < 0.001

*p-value < 0.05

*p-value < 0.1

29
App-related Rating Scores

by “Commute Time”

- App: Safer Transit Daytime
- App: Safer Transit Nighttime
- App: Campus Safety
- App: Improving Nighttime Walking Safety
- App: Location Reveal Comfortability
- App: Facilitating School Bus Operations
- App: Recommendation
- App: Willingness-to-Use
- App: Ridership Impact

Less than 20 minutes
More than 20 minutes
App-related Rating Scores

by “Transit Transfer Needed”
Conclusions

• Participants did not significantly consider the privacy issues by using a user location-based app (7.1/10.0)

• Participants believed that the transit app can improve nighttime safety (7.3/10.0)

• It was believed that this app can improve nighttime pedestrian safety if this app can be connected to the police department (7.8/10.0)

• This transit app was also expected to improve transit efficiency and increase transit ridership and it is eventually recommendable (7.3/10.0)

• The least expected improvement was daytime safety (6.4/10.0), which is reasonable and expectable.
More Information

• Report:

*Applications of Connected Vehicle Infrastructure Technologies to Enhance Transit Service Efficiency and Safety, Part 2*

https://vtechworks.lib.vt.edu/handle/10919/73335
Contact

Dr. Young-Jae Lee
Seyedehsan Dadvar

• Emails:
  • YoungJae.Lee@morgan.edu
  • Seyedehsan.Dadvar@morgan.edu

• Google Scholar:
  • https://scholar.google.com/citations?user=eH8nHUUAAAAAJ&hl=en
  • https://scholar.google.com/citations?user=vLrVEZoAAAAAJ&hl=en

• ResearchGate:
  • https://www.researchgate.net/profile/Young_Jae_Lee2
  • https://www.researchgate.net/profile/Seyedehsan_Dadvar