Smarter Travel

Dubuque Smarter Travel

TRB Tools of The Trade

07/2016
Smart Travel

City of Dubuque
Transit in 1980’s
City of Dubuque Transit in 2010

5.0 Miles
Impact of Route changes on Jule Transit

Increase in Length of the trip & not designing to action areas

- Bigger head ways
- Less Reliability
- Increase in operating costs

Less Frequency

Negative Perception

Few funds to improve system

Less Fare Box

Decrease in Ridership

Reduction in Federal Funds

Few funds to improve system
Process to Improve Jule Transit

**Plan**
- Contrast Supply vs Demand
- Optimize Transit Routes
- Optimize Stop Placement
- Optimize Operations
- Measure unmet demand
- Suggest new bus routes

**What to do**
- Time of Day
- Activity Based
- New Service area & Demand

**How to do**
- Census Data
- Traditional Surveys
- Online surveys
- Data gathering using technology

**Implement**
- Redesign services by time of day and activity
- Design new routes
- Create new marketing plan
• Project Goal
  • Develop, test, and validate an integrated platform to leverage data captured from mobile devices complemented with travel diary surveys to generate information about travel patterns of citizens in the City of Dubuque, Iowa.

• Data Generated
  • O/D Matrices
  • Corridor Speed
  • Meaningful Locations
  • Travel Modalities
  • Trip Purpose, etc.

• Project Outcome
  • Primary - Public Transit Route Optimization
  • Secondary – Adjust Signal Timing, Reduce Accidents, Resource Planning, etc.
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Proposed Analytics/Optimization Process

Phase 1
- Travel Diary
  - Smart Phone Apps
  - Sampling Size

Phase 2
- Recruitment
  - Household Income
  - Household size
  - Number of Workers
  - Location
- Smart Phone Data
  - Trip mode estimation
  - Duration of Stay Estimation
  - Trip Segmentation
  - Trip Purpose Estimation
  - Meaningful Location Classification

Phase 3
- Points of Interest
  - Travel Diary Data
- Household Travel Survey
- O/D Travel Survey
- O/D from Smart phone
- O/D Airsage Data
- Cell phone data
  - Compare With Travel Diary info

Phase 4
- DMATS Four step model
- Travel Diary Data
- Screen line test
- Clean Sheet route Optimization
- Optimal Routes

Phase 5
The project will have approximately 750 households recruited.

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Number of Households (approx.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>May, 2015 to August, 2015</td>
<td>250</td>
</tr>
<tr>
<td>February, 2016 to April, 2016</td>
<td>250</td>
</tr>
<tr>
<td>November, 2016 to January, 2017</td>
<td>250</td>
</tr>
</tbody>
</table>

Total Study Area Households : 39,046

Volunteer Requirements

- Transmit data from smart phone for 14 days.
- Complete travel diary for three consecutive weekdays.
Sampling Plan
How do we pick people to participate in the study?

- Household Demographics
  - Household income
  - Number of people in the household
  - Number of Workers in the household
  - Transit rider

<table>
<thead>
<tr>
<th>Household Income</th>
<th>1-person</th>
<th>2-person</th>
<th>3-person</th>
<th>4-or-more persons</th>
<th>Total households</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than $25,000</td>
<td>35</td>
<td>14</td>
<td>5</td>
<td>2</td>
<td>56</td>
</tr>
<tr>
<td>$25,000 - $49,999</td>
<td>22</td>
<td>32</td>
<td>9</td>
<td>10</td>
<td>73</td>
</tr>
<tr>
<td>$50,000 - $74,999</td>
<td>7</td>
<td>22</td>
<td>8</td>
<td>15</td>
<td>52</td>
</tr>
<tr>
<td>$75,000 or more</td>
<td>3</td>
<td>26</td>
<td>14</td>
<td>26</td>
<td>69</td>
</tr>
<tr>
<td>Total</td>
<td>67</td>
<td>94</td>
<td>36</td>
<td>53</td>
<td>250</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of Workers</th>
<th>Total Households</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Worker Households</td>
<td>67</td>
</tr>
<tr>
<td>1 or more worker Households</td>
<td>183</td>
</tr>
</tbody>
</table>

| Transit Riders           | 10-20 households making at least one trip today |
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Mobile Application

Infrastructure
- Private IBM cloud
- Secure and anonymized transmission of samples
- Integration with other datasets

Supported Platforms
- iOS 7.1.1+
- Android 4.3+

User Experience
- Periodic uploads
- Battery-optimized sampling
- Accuracy enhance sampling
- Client notifications

Rules of Participation:
In order to receive your $50 HyVee gift card:
- App must run for 14 consecutive days and three days must be recorded on the provided travel diary.
- After the 14 days, once participant has FULLY COMPLETED and returned the travel diary and diary matches app data, participant will be instructed on where to pick up gift card.
Data Analytics

- Remove erroneous data points
- Identify stops and trips
  - Rule-based approach
- Compute average corridor speed
  - PWL extrapolation and integration
- Find meaningful locations
  - Clustering stops
- Generate O/D matrix
  - Map to TAZ
  - Normalized via scaling factors derived from volunteer’s socioeconomic data and census data.
<table>
<thead>
<tr>
<th>Trip #</th>
<th>Where Did You Go?</th>
<th>What About Your Route?</th>
<th>What Did You Do?</th>
<th>What Was The Time?</th>
<th>How Did You Get There?</th>
<th>How Many Traveled?</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>Hy-Vee</td>
<td>On your way to this location did you cross the Mississippi River? YES NO</td>
<td>What did you do at this location? (check all that apply)</td>
<td>What time did you ARRIVE at this location?</td>
<td>What was the primary type of transportation you used?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Locust Street</td>
<td></td>
<td></td>
<td>Time: __ Circle one: AM PM</td>
<td>○ Walk ○ School Bus ○ Auto, Van, truck ○ Transit Bus (Route: ________ )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dubuque IA</td>
<td>If YES: Which highway/road bridge did you use to cross the river?</td>
<td>What time did you DEPART this location? (enter NA if you ended your travels for the day here)</td>
<td>Time: __ :__ Circle one: AM PM</td>
<td>Other ________</td>
<td></td>
</tr>
<tr>
<td></td>
<td>City 52001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- If you used a car, van, or truck for this trip, were you the:
  - Driver OR Passenger

- Please indicate the following about the vehicle:
  - Year: 2004
  - Make/Model: Toyota Prius

- Was this your household’s vehicle? YES NO

- Including you, how many people from YOUR HOUSEHOLD were on this trip? 1

- Including you, how many other household members traveling with you? 1

- What were the ages of the other household members traveling with you? __________
• Display daily trajectories.
• Display stops and trips. Clicking on each stop or trip will display its properties, such as starting/stopping time, duration, land use, trip purpose and trip mode.
• Ability to pin custom locations on the map.
Trip Purpose Classification and O/D Matrix

- 3 categories of POIs (schools, shopping/restaurants, other)
- Classify work and home locations based on duration of stay and time of day
- Trip purpose: home-based work, non-home-based work, home-based school, non-home-based school, home-based shopping, non-home-based shopping, home-based other, and non-home-based other. These categories will be used to partition the O/D matrix
- The O/D matrix is aggregated between all the users and for different time intervals
Validation of Smartphone and Travel diary data

The Smarter phone data and Travel Diary data are compared at different levels.

**Level 1: Data collection**
The Smartphone data and Travel Diary data are compared to check accuracy of
- Location
- Missing trips
- Mode choice

**Level 2: Trip purpose**
The Smart phone data is compared to Travel Diary data to check purpose of the trip

**Level 3: Origin/Destination matrix**
The origin/Destination matrix from both sources are compared to each other once the survey sample is extrapolated to MPO
Screenline Test of O/D Data

O/D data for the region

- Travel Diary
- Smartphone
- Airsage

Screenlines
- Time options: days of week, all weekends, all weekdays and all days of week.
- View data in time periods.
- Overlay location clusters.
• Corridor speed or travel time
• Time options: Time of Day
• Direction of Travel.
**Bus Route Optimization approach**

- **Input data:**
  - Street intersections and street links
  - Travel time of various travel modes on each link
  - Maximum number of buses and bus capacities.
  - O/D matrix
  - Additional constraints/requirements

- Generate a set of candidate routes
  - Can include constraints such as hubs, limited change from current routes, etc.

- Choose an optimal set of routes minimizing average travel time by formulating objective function and optimization problem as a mixed integer program (MIP).

- Solve MIP using 2 types of algorithms: CPLEX and Volume algorithm

- Routes are adjusted based on feedback and expert guidance from Jule
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Optimized Bus routes

Bus routes based on peak period O/D
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Questions

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Web Sources

http://www.cityofdubuque.org/1496/Smarter-Travel
http://www.eciatrans.org/DMATS/SmarterTravel.cfm