On-Demand Goods Delivery:
An Implementation of Data Driven Methods

2019 ITE Western District Annual Meeting
June 26, 2019
Motivation

• One out of 25 people in the US produce one e-commerce delivery per day, and this rate is expected to increase, especially in urban areas.

• Home deliveries per person, stable prior to 2009, double between 2009 and 2017 and are projected to double again by 2023.

• It's neither clear how the frequency of delivery vehicles and people's travel choices will change as on-demand goods delivery become more prevalent, nor is it clear how predictive tools will need to evolve.

• Are traditional MPO travel demand models capable of capturing and evaluating on-demand goods delivery services?

• What other tools, analysis, and data could be used to evaluate on-demand goods delivery services?

• Develop a model to forecast daily deliveries that is responsive to demographics, shop location, and delivery location.
## Literature Review

<table>
<thead>
<tr>
<th>Title</th>
<th>Source</th>
<th>Topics Addressed</th>
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<tbody>
<tr>
<td>The Delivery Economy Changes Everything: New Requirements for Urban Freight Research</td>
<td>University of Washington Urban Freight Lab</td>
<td>VMT</td>
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<td>Shared mobility workshop white paper</td>
<td>UC Berkeley</td>
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<td>USCF Innovation Briefs - Autonomous Delivery Technologies</td>
<td>Fehr &amp; Peers</td>
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<td>The City College of New York; Renessalaer Polytechnic Institute</td>
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<tr>
<td>Evaluating The Environmental Impacts Of Online Shopping: A Behavioral Analysis Using The American Time Use Survey (ATUS) Data</td>
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Freight Demand Options

• Option 1: Regional Travel Demand Modeling
  • Data needed on factors influencing on-demand orders:
    • Number of trips made per order
    • Population demographics
  • Potential performance measures or results for scenario comparison such as
    • Truck volumes
    • Truck VMT
    • Curb\parking demand
  • Travel models capable of evaluating the factors and producing results:
    • No models reviewed were capable

• Option 2: Supply and Demand Suitability\Hot-spot Analysis
  • Data needed on factors influencing on-demand orders:
    • Number of trips made per order
    • Population demographics
  • Statistical relationship between the factors for supply and demand
  • Use the relationships to identify hotspot\suitability index by scenario
Methodology

Data Analysis | Survey Data

- National Household Travel Survey (NHTS)
  - Number of Shopping Trips
  - Number of Deliveries
- American Time Use Survey (ATUS)
  - No differentiation between in-store trips and online deliveries
### Methodology

#### Data Analysis | InfoGroup Land Use

- Demographic data by census block/tract
- Households
  - Income Level
  - Children (0-18)
- Employment
  - Total employees
  - Employer type (NAICS code)

### Possible for Future Analysis

#### Household

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchasing Power Income</td>
<td>Estimate of relative purchasing power of a household, derived by adjusting estimated household income (FIND) with the appropriate cost of living index for the county in which the household resides.</td>
</tr>
<tr>
<td>Internet User (DM High Tech Household)</td>
<td>Interest in new, cutting edge products (early adopters of new gadgets and technology). Information gathered from product purchases, subscriptions or survey response as well as blended with modeled data.</td>
</tr>
<tr>
<td>InfoPersona SuperCluster</td>
<td>The 42 Info Persona Clusters are further grouped into 9 larger groupings or super Clusters. For more information regarding the definition for each clusters see marketing materials on InfoPedia.</td>
</tr>
<tr>
<td>Education Level</td>
<td>Education level of adults</td>
</tr>
<tr>
<td>Auto Ownership</td>
<td>Vehicles owned and number of driver age people in household</td>
</tr>
</tbody>
</table>

#### Employment

<table>
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<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTUAL LOCATION EMPLOYMENT SIZE</td>
<td>This field contains the number of employees who work at this location of the business.</td>
</tr>
<tr>
<td>ESTIMATED LOCATION SALES VOLUME</td>
<td>A modeled figure derived from employment size and other factors to indicate the annual sales volume of the business.</td>
</tr>
<tr>
<td>GROWING/SHRINKING INDICATOR</td>
<td>The growing business flag is provided by comparing employment sizes gathered over several cycles of telephone verification.</td>
</tr>
<tr>
<td>WHITE COLLAR PERCENTAGE</td>
<td>Percentage of white collar employment at business as derived from a model.</td>
</tr>
<tr>
<td>WHITE COLLAR INDICATOR</td>
<td>&quot;1&quot; indicates over 50% white collar employment.</td>
</tr>
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</table>
Methodology

- Based on cellular devices
- Observed travel behavior
- 1 month of data
- Number of trips, distance, stops, and stop duration
- Excludes passenger Transportation Network Companies (TNCs)
- Can filter by day of week, time of day, trip distance
- Aggregated trip ends to Census geography
Methodology

Model Formulation

• NHTS and InfoGroup Data
  • Household data grouped into six clusters
    • Cluster 1: Household income between 0-75K, Without Children
    • Cluster 2: Household income between 0-75K, With Children
    • Cluster 3: Household income between 75-150K, Without Children
    • Cluster 4: Household income between 75-150K, With Children
    • Cluster 5: Household income between 150K+, Without Children
    • Cluster 6: Household income between 150K+, With Children
  • Summarized the Employment data to get the total employment
  • Summarized the weighted number of deliveries and number of shopping trips for each cluster
  • Calculated the average number of deliveries and average number of in-store trips
  • Applied rate to the household and employment in each census block
Methodology

Scenario 1 | Existing Land Use

Average Daily Activity

Shopping Location

- 63%
- 37%

Delivery Location

- 39%
- 61%

Daily Delivery Intensity by Census Block
Methodology

Model Results  Daily Delivery Intensity by Census Block

Model Estimated

Observed
Methodology

Scenario 2 | Existing Land Use

Increased Online Shopping and Reduce In-Store Shopping

Average Daily Activity

Shopping Location

- 26% Home
- 74% Work

Delivery Location

- 39% Home
- 61% Work

Daily Delivery Intensity by Census Block

Graph showing the distribution of daily deliveries across different census blocks in the area.
Methodology

Scenario 3 | Existing Land Use

Increased Online Shopping Demand and Retain In-Store Demand

Average Daily Activity

Shopping Location

- 63%
- 74%

Delivery Location

- 39%
- 61%

Daily Delivery Intensity by Census Block

Conclusions

References

Acknowledgments
Methodology

Scenario 4 | Existing Land Use

Average Daily Activity

Shopping Location

Delivery Location

Increased Work Deliveries

Daily Delivery Intensity by Census Block
Conclusions

Baseline

Increase Shopping Demand

Increase Online Shopping

Increase Workplace Deliveries
Conclusions

• Regional Travel Demand models are not currently able to accurately capture or measure on-demand goods delivery

• Available data can be used to identify demand for online and in-store shopping
  • Accurate and detailed data for the location of households and employment is key
  • Current data limitations include:
    • How many online shopping trips/orders per delivery
    • How many, if any, purchases made per in-store shopping trips

• Future considerations:
  • Include salary data for employment
  • Data analysis needed to identify home and work delivery trip ends
  • Impact on curb space: delivery duration and location, truck/vehicle size
  • Apply methodology to different area and place types
  • Model of supply (productions) to correlate with the demand (attractions) to create OD patterns
References

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University of Washington Urban Freight Lab
2017

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An analytical model for vehicle miles traveled and carbon emissions for goods delivery scenarios
University of Washington Urban Freight Lab
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Urban form and last-mile goods movement: Factors affecting vehicle miles travelled and emissions
University of Washington Urban Freight Lab
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Delivery by drone: An evaluation of unmanned aerial vehicle technology in reducing CO2 emissions in the delivery service industry
University of Washington Urban Freight Lab
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The Final 50 Feet of the Urban Goods Delivery System (Final Report)
University of Washington Urban Freight Lab
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Are Cities' Delivery Spaces in the Right Places? Mapping Truck Load/Unload Locations
University of Washington Urban Freight Lab
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An evaluation of logistics sprawl in Chicago and Phoenix
University of Washington Urban Freight Lab
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Forecasting Tools for Analyzing Urban Land Use Patterns and Truck Movement: A Case Study and Discussion
University of Washington Urban Freight Lab
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Multi-Modal Intersections: Resolving Conflicts between Trains, Motor Vehicles, Bicyclists and Pedestrians
University of Washington Urban Freight Lab
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From the Last Mile to the Last 800 Feet: Key Factors in Urban Pick-up and Delivery of Goods
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UPS
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Consumer preference for green last mile home delivery - exec summary
MIT
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Shared mobility workshop white paper
UC Berkeley
2015

Understanding shipper performance in the Less than truckload market
MIT
2016

Building the database - supporting logistics research initiatives
University of Southern California
2015

Biking for Goods is Good - an assessment of CO2 savings in Paris
University of Southern California
2014
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