Urban Freight Trip Generation: Case of Chennai City

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Gitakrishnan Ramadurai
Freight System

- Shippers, carriers, distribution centers, consumers, government
- Characterizing the freight system is challenging
- Lack of maintenance of data at different levels by the stakeholders – makes research efforts difficult
Freight Trip Generation: Literature Review

- Trip rate per unit of site area – Brogan (1979)
  - Simple and straightforward
  - FTG varies highly from one region to another

- Regression models
  - Tadi & Balbach (1994) –
    - Independent variable – Site area
    - Average vehicle weights – Weighted trip ends
  - Iding (2002)
    - Independent variables – Site area and number of employees
    - Calculated total number of trips and applied mode share of delivery vans, light trucks and heavy trucks
Literature Review

Regression models

Shin, Kawamura (2005)

- FTG is directly related to decision-making behavior with respect to supply chain management (SCM) and logistics strategies adopted
- Commodity - fast-moving and slow-moving goods / weigh-out and cube-out goods
- Short-term factors - sales and hours of operation over time of the year
- Logit regression model for a chain of furniture and shoe stores chain which received only one or two deliveries in a week from its Distribution Centre
Literature Review

- Regression models
  - Bastida and Holguín-Veras (2008)
    - Interaction effects of commodity type with employment and sales
    - Multiple Classification Models - classification structure within the independent variable that can give a better estimation of FTG models
    - Classification by land-use category
    - Independent variable – Number of employees
    - Ordinary least squares, MCA models
Literature Review

Regression models

  - Checked transferability of regression models developed
    - External validation of developed models
      - NCFRP 25, QRFM and ITE models
      - 5 datasets
    - Econometric models to assess the statistical significance of specific geographic locations
      - Pooled the datasets
      - Included binary variables for each location
      - Evaluated significance from t-statistic
  - Under-estimation for small firms and over-estimation for large firms in constant FTG per unit of independent variable
  - Synthetic correction procedure
Regression models

Holguín-Veras et al (2013)
- Land-use constraints, network characteristics and other urban shape features affect the frequency in which firms decide to transport the cargo
- Independent variables
  - land-market value, commodity type, number of vendors, employment, Sales, dist. to truck route, minimum dist. to Large Traffic Generator (LTG)
  - mean distance to LTGs, distance to the primary network, width of street in front of establishment

- Predict volume of inbound and outbound truck volume at seaport terminals
- Independent variables - area of container terminals, number of TEUs and container boxes
Literature review

- **Time Series**
  - **Al-Deek (2000)**
    - Predict volumes of large inbound and outbound trucks at seaport terminal of Miami
    - Factors affecting truck volume - amount and direction of cargo vessel freight and the particular weekday of operation

- **Artificial Neural Networks (ANN)**
  - **Al-Deek (2001)**
    - Compared methods of regression and ANN to predict the daily inbound and outbound truck trips at seaport terminal of Miami
    - **Drawbacks**
      - Regression – too many assumptions
      - ANN - lack of well-defined guiding rules regarding choice of network, method of training, number of neurons, topology, and configuration
    - Applied modal split of freight traffic to trucks and rail cars
Literature Review

- Data collection techniques in NCHRP Synthesis 410
  - State of the practice methods in conducting surveys at different levels of freight transportation
    - Roadside intercept, Commercial trip diary, Establishment survey, Commodity flow survey
  - Face-face and telephone interviews:
    - Better response rate, better quality
    - Detailed information and in-depth discussions
    - Provides opportunity to query responses
    - Expensive and time consuming
  - Self-completion forms:
    - Cheaper, but low-response rates
    - Difficult to ensure that right person in organization will respond,
    - Whether the respondent has understood the questions
    - No opportunity to check/clarify or discuss responses
LITERATURE REVIEW: Summary

- Constant trip rate
  - Constant trips per establishment or employee
  - Simple and straightforward
  - Underestimation for smaller establishments and overestimation for larger establishments

- Regression
  - Ordinary least squares method
  - Most predominant
  - Interaction effects – ex. Employment with sales
LITERATURE REVIEW: Summary

- **Multiple Classification Analysis**
  - Classification structure within the independent variable
  - Resulted in better prediction of models

- **Recent studies**
  - **Land-use** – land use type, land-market value
  - **Economic** – commodity type, number of vendors, employment, sales
  - **Network** – distance to truck route, minimum distance to Large Traffic Generator (LTG), mean distance to LTGs, distance to the primary network, width of street in front of establishment
OBJECTIVES

- To collect data on freight trips in Chennai by conducting face-to-face interviews

- To understand the problems and trends concerning freight transport

- To analyse the data collected and develop freight trip generation models
SCOPE

- Area of study - Chennai

- Data collection units - Include all kinds of commercial establishments that generate freight transport
**FREIGHT TRIP GENERATION QUESTIONNAIRE**

**CONTACT INFORMATION OF THE ESTABLISHMENT:**

- Name:
- Address:
- Phone:
- Email:

**BUSINESS ACTIVITY:**

- Building materials
- Restaurant
- Food/Departmental store
- Hardware
- Office Services
- Electronics
- Apparel/Accessory store
- Other: __________

**TYPE OF ESTABLISHMENT:**

- Wholesale
- Retail
- Services
- In Mail
- Market/Industrial

**TYPE OF FACILITY:**

- Branch
- Headquarters
- Single establishment

**NUMBER OF PEOPLE CURRENTLY EMPLOYED AT THIS ADDRESS:**

- Full Time
- Part Time

**SITE AND GROSS FLOOR AREA:**

- Is your establishment the only one at this site? Yes  No
  
- Total site area*: __________
  - Establishment floor area*: __________
  - No. of floors:

**NUMBER OF VEHICLES OPERATED FROM THIS ADDRESS BY TYPE:**

<table>
<thead>
<tr>
<th>Type of Vehicle</th>
<th>Owned</th>
<th>Leased</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bike</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-wheeler vehicles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cars</td>
<td></td>
<td></td>
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<tr>
<td>Small pickups/vans</td>
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<tr>
<td>2 axle single unit trucks</td>
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<tr>
<td>3 or 4 axle single unit trucks</td>
<td></td>
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<tr>
<td>Large trucks</td>
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<tr>
<td>Other</td>
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</tbody>
</table>

**TRIPS RELATED TO GOODS AND SUPPLIES:**

<table>
<thead>
<tr>
<th>Type of Vehicle</th>
<th>Number of vehicles leaving</th>
<th>Number of vehicles arriving</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per day</td>
<td>Per week</td>
</tr>
<tr>
<td>Bikes</td>
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<td></td>
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<td></td>
</tr>
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<td></td>
<td></td>
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<tr>
<td>Other</td>
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</tr>
</tbody>
</table>

**TRIPS RELATED TO SERVICES:**

<table>
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<tr>
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<th>Number of vehicles leaving</th>
<th>Number of vehicles arriving</th>
</tr>
</thead>
<tbody>
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<td></td>
</tr>
<tr>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

**COMMENTS (IF ANY):**

If you would like more information about the survey, please contact Ms. Divya Priya (ceedivya@gmail.com) at her e-mail address or call 9043965068.

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Modified from survey conducted in New York as part of NCHRP program; Extensive inputs from Jose and his team at RPI.
Questionnaire Design:

- Additions:
  - Number of years the establishment has been in business
  - Working hours of the establishment and timing of shifts
  - Type of establishment:
    Wholesale/Retail/Services/Mall/Market/Industrial
  - Bikes and three-wheeler vehicles
  - Type of parking (on-street or off-street), parking space, number of loading docks
  - Record of trucks trips made per month in addition to per day and per week
  - Comments by the respondent
Sample Collection

- Ideal case: Random sampling from a list of all enterprises in Chennai that generate freight transport.

- Sources:
  - Websites like Yellow Pages, Sulekha, Just Dial
    - Specific search for each establishment type
    - Many level of sub-categories adds to the complexity of sampling process
  - Chennai Corporation (professional tax and trade licenses)
    - Central areas of Chennai - missing
    - Not all trades and professions available; several very small shops
  - Commercial Taxes Department (CTD)
  - Economic Census (2005)
Sample Collection

Ideal case: Random sampling from a list of all enterprises in Chennai that generate freight transport

Sources:
- Websites like Yellow Pages, Sulekha, Just Dial
- Chennai Corporation (professional tax and trade licenses)
- Commercial Taxes Department (CTD)
  - Online search by TIN-11 digit number: low probability of a hit
  - They have shared a random list of 1000 establishments – used in second phase of survey
- Fifth Economic Census in 2005 by CSO
  - Prepared a directory of establishments with more than 10 employees
  - Revealed in pilot studies that establishments less than 10 employees are also present
  - Only 10340 establishments in Chennai – Underestimate
Sample Collection:

- Economic Census (2005):
  - Problems while sampling
    - Old directory
    - Complete address is not specified
    - Missing letters or misspelled names - Intelligent Character Recognition (ICR) technology
    - Only name or address
    - Very small stores such as tea stall
    - No specification for an establishment
  - Decided to go ahead with this directory in first phase of survey
Pilot Studies

- 30 establishments in Adyar, T.Nagar and Sowcarpet

<table>
<thead>
<tr>
<th>Establishment type</th>
<th>Number of establishments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparels, Bags, Footwear</td>
<td>8</td>
</tr>
<tr>
<td>Departmental, Food, Groceries, Edible oil</td>
<td>6</td>
</tr>
<tr>
<td>Electrical, Electronics</td>
<td>4</td>
</tr>
<tr>
<td>Restaurant, Hotel</td>
<td>4</td>
</tr>
<tr>
<td>Pharmacy</td>
<td>2</td>
</tr>
<tr>
<td>Furniture, Home Appliances</td>
<td>2</td>
</tr>
<tr>
<td>Hardware</td>
<td>1</td>
</tr>
<tr>
<td>Miscellaneous (Chemicals, Jute)</td>
<td>3</td>
</tr>
</tbody>
</table>
Pilot Studies

Problems faced during the survey:

- Locating the addresses
- Employees are busy to respond to the surveys, wait or come back again later
- Do not want to disclose about their operations especially jewellery stores
- Misinformation that result in inconsistent figures between number of trips and goods produced or received
- Difficult to quantify certain commodities
- Too many items that are harder to classify
- Respondent does not know the exact floor area of the establishment
Pilot Studies

**Observations:**

- Interaction with the employees is more fruitful when the enumerator knows the local language.
- Bullock and man drawn carts were observed in Sowcarpet area of Chennai.
- Certain group of establishments get their consignment together in a truck when they have less than truck load goods to be transported.
- Night time deliveries.
- On street parking during loading and unloading of goods.
Pilot Studies

- **Correlation**
  - gross floor area and number of trips $= 0.22$
  - number of employees and number of trips $= 0.49$

- **Inclusion of restaurants** — lesser area but generate more number of trips due to frequent home deliveries

- **Aggregate results cannot be used to draw conclusions without classifying the establishments**
Data Collection

- Establishments Visited: 150
- Obtained responses: 88
- Response rate: 58%

- Almost all areas within Chennai city area
- Few more to be done on the newly added areas to Chennai Metropolitan Area
- Dense areas have more samples: proof of random sample?
## Descriptive Statistics

<table>
<thead>
<tr>
<th>Type of establishment</th>
<th>Number of observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wholesale/Retail</td>
<td>41</td>
</tr>
<tr>
<td>Hotel/Restaurants</td>
<td>18</td>
</tr>
<tr>
<td>Hospitals</td>
<td>8</td>
</tr>
<tr>
<td>Office Services</td>
<td>5</td>
</tr>
<tr>
<td>Other (Manufacturing, Printing, Processing metals, Repair)</td>
<td>16</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>88</strong></td>
</tr>
</tbody>
</table>
## Descriptive Statistics

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>Daily</th>
<th>Weekly</th>
<th>Monthly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bikes</td>
<td>168</td>
<td>1241</td>
<td>5415</td>
</tr>
<tr>
<td>3-wheeler vehicles</td>
<td>59</td>
<td>446</td>
<td>1955</td>
</tr>
<tr>
<td>Cars</td>
<td>3</td>
<td>22</td>
<td>106</td>
</tr>
<tr>
<td>Small pick-ups/Vans (Tata Ace)</td>
<td>170</td>
<td>1243</td>
<td>5387</td>
</tr>
<tr>
<td>2 axle single unit trucks</td>
<td>70</td>
<td>495</td>
<td>2207</td>
</tr>
<tr>
<td>3 or 4 axle single unit trucks</td>
<td>3</td>
<td>33</td>
<td>156</td>
</tr>
<tr>
<td>Large trucks</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Others</td>
<td>39</td>
<td>295</td>
<td>1266</td>
</tr>
<tr>
<td>Mean trips per establishment</td>
<td>5.8</td>
<td>42.9</td>
<td>187.4</td>
</tr>
</tbody>
</table>
Descriptive Statistics

Mean Daily trips

Vehicle Type

- Bikes
- 3-wheeler
- Cars
- Vans (Tata Ace)
- 2-axle trucks
- 3/4-axle trucks
- Large trucks
- Others

No. of trips

- 0.0
- 0.5
- 1.0
- 1.5
Descriptive Statistics

Mean Weekly trips

- Bikes: Highest frequency
- 3-wheeler: Moderate frequency
- Cars: Very low frequency
- Vans (Tata Ace): Moderate frequency
- 2-axle trucks: Moderate frequency
- 3/4-axle trucks: Very low frequency
- Large trucks: Very low frequency
- Others: Moderate frequency
Descriptive Statistics

Mean Monthly trips

Vehicle Type

- Bikes
- 3-wheeler
- Cars
- Vans (Tata Ace)
- 2-axle trucks
- 3/4-axle trucks
- Large trucks
- Others

No. of trips

0 20 40 60 80 100
## Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable 1</th>
<th>Variable 2</th>
<th>Correlation Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of. employees</td>
<td>Area</td>
<td>0.33</td>
</tr>
<tr>
<td>No. of. employees</td>
<td>Daily trips</td>
<td>0.25</td>
</tr>
<tr>
<td>No. of. employees</td>
<td>Weekly trips</td>
<td>0.24</td>
</tr>
<tr>
<td>No. of. employees</td>
<td>Monthly trips</td>
<td>0.24</td>
</tr>
<tr>
<td>Area</td>
<td>Daily trips</td>
<td>0.34</td>
</tr>
<tr>
<td>Area</td>
<td>Weekly trips</td>
<td>0.34</td>
</tr>
<tr>
<td>Area</td>
<td>Monthly trips</td>
<td>0.34</td>
</tr>
</tbody>
</table>
Descriptive Statistics

Mean Daily trips

- Wholesale/Retail
- Hotel/Restaurants
- Hospitals
- Office Services
- Other

Establishment Type

No. of trips
0 1 2 3 4 5 6 7 8 9
Descriptive Statistics

Mean Weekly trips

<table>
<thead>
<tr>
<th>Establishment Type</th>
<th>No. of trips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wholesale/Retail</td>
<td>30</td>
</tr>
<tr>
<td>Hotel/Restaurants</td>
<td>50</td>
</tr>
<tr>
<td>Hospitals</td>
<td>60</td>
</tr>
<tr>
<td>Office Services</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>65</td>
</tr>
</tbody>
</table>
Descriptive Statistics

Mean Monthly trips

No. of trips

Establishment Type

Wholesale/Retail  Hotel/Restaurants  Hospitals  Office Services  Other
Summary

- Bikes and small pick-up vans (Tata Ace) are commonly used mode for freight transport inside city.
- Because of the low value of correlation, both the variables - employees and floor area - can be incorporated in preliminary regression model.
- Hotels/Restaurants and Hospitals make almost twice the number of trips than Wholesale/Retail shops. Trips to offices are comparatively lesser.
Caveats

- Are we missing out on large traffic generators?
  - Have had very few cases with establishments larger than 20 employees or shops with floor area more than 1000 sq ft.
  - Random sampling or weighted sampling – which is better?

- Are we getting the right numbers?
  - “The manual counts (15 site observations) provided more accurate truck trip generation rates than did telephone interviews. The interview responses indicated approximately ten to twelve trucks per day in comparison to the average of 18 trucks per day counted at each store by observers.” - Truck trip generation by grocery stores, McCormack et al. (2010)
Acknowledgments

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Thank You!
Questions?

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