Mechanics of the seminar

- The webinar is being recorded, the URL will be sent out to participants and posted at [www.coe-sufs.org](http://www.coe-sufs.org)
- Participants from the US and Canada can:
  - Use Adobe Connect to receive the audio (PRIMARY method)
  - Dial 1-888-446-7584, access code 1120583
- International participants can:
  - Use Adobe Connect to receive the audio (PRIMARY method)
  - Use Skype or similar to dial 1-888-446-7584, code 1120583
  - Dial 212-372-3742 (caller paid call)
- Submit questions using the Chat feature

The VREF Center of Excellence for Sustainable Urban Freight Systems (CoE-SUFS)
CoE-SUFS

- Funded by the Volvo Research and Educational Foundations (VREF)
- Main Goal: To jumpstart an integrative process, involving cities, private sector, and researchers to develop new freight systems paradigms that:
  - Are sustainable
  - Increase quality of life
  - Foster economic competitiveness and efficiency
  - Enhance environmental justice

New York City, Albany, USA
Santo Domingo, Dominican Republic
Bogotá, Medellín, Colombia
Barraquilla, Bologna, Italy
Sao Paulo and Belo Horizonte, Brazil

London, UK
Rotterdam, Netherlands
Osaka, Japan
Dalian, China
Nanjing, China

Toronto, CA
Mumbai, India
Delhi, India
Chennai, India
Sao Paulo and Belo Horizonte, Brazil

Gothenburg, Sweden
Abu Dhabi, United Arab Emirates
Melbourne, Australia
Santander, Spain
Oslo, Norway

Sao Paulo and Belo Horizonte, Brazil
Abu Dhabi, United Arab Emirates
Melbourne, Australia
Santander, Spain
Peer-to-Peer (P2P) Exchange to share global best practices and real world examples of sustainable urban freight systems

Next P2P (October 22nd, 2014):
- Freight Trip Generation Patterns in Developed Countries
  - United States
    - Miguel Jaller, University of California - Davis
    - Ivan Sanchez, Chalmers University of Technology
  - Portugal
    - Andre Alho, University of Lisboa
    - João de Abreu e Silva, University of Lisboa

Workshops to bring together public/private sectors and academia, to jointly work to address urban freight issues
- Already held at: India, Brazil, Colombia, and Canada.
- Next ones:
  - Mexico City, Mexico (October 13-14, 2014)
  - Santiago, Chile (October 16-17, 2014)
Outline

- Objectives and Scope of study
- Questionnaire Design
- Data Collection
- Pilot Survey and Final Survey
- Descriptive Statistics
- Model Results
- Summary

Objectives and Scope

- To understand the problems and trends concerning freight transport
- To analyze the data collected and develop freight trip generation models

Scope:
- Data collected in Chennai Metropolitan Region
- No establishment type was excluded from survey
- Freight trips attracted and produced are both studied
Scope: Chennai City

- Population 8.7 million
- 4th largest metro region in India
- Located in the South East coast

Modified from survey developed as part of NCFRP 25
With extensive inputs from Jose Holguin-Veras 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
  - Motor-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

Vehicle Types

Motorbikes

3-wheelers (goods auto-rickshaws)

Small pick-ups/vans

2 axle single unit trucks

Large trucks (≥3 axles) were included in the survey but rarely used by the establishments (possibly due to vehicle size restrictions)
Data Collection

- Ideal case: Random sampling from a list of all enterprises in Chennai that generate freight transport
- Sources:
  - Websites such as 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 shared a random list of 1000 establishments – used in second phase of survey
  - Fifth Economic Census in 2005 by CSO
    - A directory of establishments with >10 employees
    - Revealed in pilot studies that establishments <10 employees are also present
    - Only 10340 establishments in Chennai → Underestimate

---

Data 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
Data Sources

- Random Sampling:
  - Randomly selecting latitude and longitude within Chennai
  - Number of samples to be taken depends on the density of commercial establishments – weighted observations

Advantages:
- Guaranteed presence of establishments
- No time spent in search of addresses unlike addresses from other database

Disadvantages:
- Probability of random points turning up at locations with commercial establishments is low

Pilot Study: About 30 establishments surveyed

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 information about their operations, especially jewellery stores
- Misinformation that result in inconsistent figures between number of trips and goods produced/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
Field Survey

- Government databases
  - Visited addresses: 265
  - Successful response: 119 (45%)
  - Reasons: business closed, shifted companies, and refusal to answer

- Random sampling
  - Visited addresses – 120
  - Successful response – 79 (65.8%)
  - Only reason: Refusal to answer

LBCS Function Classification

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durable goods</td>
<td>Wholesale trade establishment: durable goods</td>
</tr>
<tr>
<td>Retail</td>
<td>Retail sales or service</td>
</tr>
<tr>
<td>Food service</td>
<td>Food services</td>
</tr>
<tr>
<td>Nondurable goods</td>
<td>Wholesale trade establishment: nondurable goods</td>
</tr>
<tr>
<td>Miscellaneous 2</td>
<td>Communication and information, education and other institutions, construction related business</td>
</tr>
<tr>
<td>Miscellaneous 1</td>
<td>Manufacturing</td>
</tr>
<tr>
<td>Grocery</td>
<td>Grocery stores, supermarkets, bakery, specialty food stores, fruit and vegetables stores, beer, wine and liquor store</td>
</tr>
<tr>
<td>Pharmacy</td>
<td>Retail sales or service: include pharmacies, drug stores, cosmetic and beauty supplies, scientific and technical services</td>
</tr>
<tr>
<td>Textiles</td>
<td>Manufacturing:</td>
</tr>
<tr>
<td>Hospitals</td>
<td>Hospitals</td>
</tr>
<tr>
<td>Courier</td>
<td>Courier services</td>
</tr>
</tbody>
</table>
### Descriptive Statistics

#### Variable
- **Years in operation**: Min 0.1, Max 170, Mean 20.6, St. Dev 21.0, CoV 1.0
- **Number of Employees**: Min 1.0, Max 700, Mean 36.9, St. Dev 77.6, CoV 2.1
- **Floor Area**: Min 120.0, Max 174240, Mean 8710.3, St. Dev 25225, CoV 2.9
- **Number of Vehicles Owned/Leased**: Min 0.0, Max 35.0, Mean 1.8, St. Dev 4.2, CoV 2.3

#### Count of Establishments

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>75</td>
</tr>
<tr>
<td>Food</td>
<td></td>
</tr>
<tr>
<td>Retail</td>
<td>3</td>
</tr>
<tr>
<td>Medical</td>
<td>3</td>
</tr>
<tr>
<td>Gasoline</td>
<td>2</td>
</tr>
<tr>
<td>Food</td>
<td>3</td>
</tr>
<tr>
<td>Personal Service</td>
<td>3</td>
</tr>
<tr>
<td>Non-Durable</td>
<td>2</td>
</tr>
<tr>
<td>Durable</td>
<td>1</td>
</tr>
<tr>
<td>Non-Food</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
</tr>
</tbody>
</table>

#### Descriptive Statistics: Trips Attracted and Produced by Vehicle Type

1. **by vehicle type**
2. **count of establishments**
3. **daily trip attraction per day per establishment by vehicle type**
4. **daily trip production per day per establishment by vehicle type**
Descriptive Statistics: Trip Attractions

- Nearly 50% trips by pick-up veh.
- > 1/3rd by motorbikes and 3-W
- Trucks account for about 11% only!
- Motorbikes are mainly used in food and pharmacy sectors
Descriptive Statistics: Trip Productions

Not every establishment produced trips

- Nearly 40% trips by motorbikes
- Trucks account for less than 10%
- Motorbikes are mainly used in food and grocery stores
Model Results

Trip Attraction Model: Establishments not in retail sector

\[ \text{Trips attracted per day} = 2.26 + (0.02 + 0.02 \times \text{Pharmacy} + 0.6 \times \text{Food}) \times \#\text{employees} \]

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Coefficient</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>2.26</td>
<td>8.12\times10^{-7}</td>
</tr>
<tr>
<td>Number of employees</td>
<td>0.02</td>
<td>8.51\times10^{-7}</td>
</tr>
<tr>
<td>Food \times Number of employees</td>
<td>0.02</td>
<td>0.082</td>
</tr>
<tr>
<td>Pharmacy \times Number of employees</td>
<td>0.60</td>
<td>0.0183</td>
</tr>
</tbody>
</table>

N = 120, R^2 = 0.24, F-test p-value = 1.155\times10^{-7}

- Exclusion of retail stores gave better results
- Retail sector is an aggregation of different type of establishments that operate very differently to each other
- Number of employees in an establishment has significant effect on the number of trips generated and also that effect increases in Food and Pharmacy sectors
Comparison between Chennai and New York City

<table>
<thead>
<tr>
<th>Sector</th>
<th>FTA - Chennai</th>
<th>NCFRP 25 - New York</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N  c  b</td>
<td>R²</td>
</tr>
<tr>
<td>Retail</td>
<td>73  1.88</td>
<td>-</td>
</tr>
<tr>
<td>Food</td>
<td>33  2.24</td>
<td>0.03</td>
</tr>
<tr>
<td>Miscellaneous 1</td>
<td>25  2.08</td>
<td>0.02</td>
</tr>
</tbody>
</table>

c: constant intercept, b: co-efficient of number of employees

Trip attractions to an establishment in New York city are multiplied by two

- NYC retail stores attract more trips than Chennai’s
- Food sector: for the same number of employees, the freight trip attraction in Chennai is larger than in NYC
- Miscellaneous 1 (a group of manufacturing industries): freight trip attraction depends on employment, in NYC it is constant

Trip Productions by establishments

\[
\text{Trips produced per day} = 4.45 + 0.4 \times \text{NVEH} + (0.11 \times \text{nondurable} + 0.04 \times \text{Misc} + 0.46 \times \text{Grocery}) + \#\text{employees}
\]

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Co-efficient</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>4.55</td>
<td>5.13 \times 10^{-6}</td>
</tr>
<tr>
<td>Number of vehicles owned and leased</td>
<td>0.40</td>
<td>0.05416</td>
</tr>
<tr>
<td>Non-durable \times Number of employees</td>
<td>0.11</td>
<td>0.00117</td>
</tr>
<tr>
<td>Miscellaneous 1 \times Number of employees</td>
<td>0.04</td>
<td>0.07320</td>
</tr>
<tr>
<td>Grocery \times Number of employees</td>
<td>0.46</td>
<td>0.10</td>
</tr>
</tbody>
</table>

N = 115, R² = 0.23, F-test p-value = 1.484\times10^{-6}

- Number of trips produced depends on the number of vehicles owned and leased
- Number of employees working in the establishment has significant effect for Non-durable, Miscellaneous 1 (Manufacturing), and Grocery sectors
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?
  - Manufacturing industries and warehouses not covered – potential large trip generators

- 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)

Summary

- Trip attractions – 3.0 trips per establishment per day
  - Nearly 50% trips attracted are by pick-up vehicles
  - More than 1/3rd are by motorbikes and 3-W

- Trip productions – 6.7 trips per establishment per day
  - However, not all establishments produce trips
  - Nearly 40% trips produced are completed by motorbikes
  - Trucks account for less than 10%

- Regression models: Dependencies and goodness of fit similar to values seen in other studies

- Limitations:
  - High variability in the observations – wide range of different types of establishments
  - Aggregated data – difficult to draw relationships
Acknowledgments

- Divya Priya, former graduate student
- Gayathri Devi, Senior Project Officer
- Center of Excellence in Urban Transport, IIT Madras
  sponsored by Ministry of Urban Development, Govt. of India
- Center of Excellence in Sustainable Urban Freight
  Systems, RPI, Troy, NY
  - Special thanks to Prof. Jose Holguín-Veras and his team for
    supporting and guiding us throughout
- Foot soldiers: our enumerators – students and staff of
  CoE at IIT Madras!

Metropolitan Freight Survey in Medellin, Colombia

Ivan Sarmiento Ordosgoitia
Associate Professor
Department of Civil Engineering
Universidad Nacional de Colombia Sede Medellin
Outline

- Introduction
  - Key Questions
  - Metropolitan Region of Medellin
- Methodology: Freight Surveys
  - Cordon survey
  - Establishment survey
  - Carrier and households surveys
- Results
- Conclusions

Key Questions

- How many goods do we consume? (kg/day)
Key Questions

- What kind of vehicles enter or exit the city?
- How many trips are undertaken?
- How many tonnes do they transport?

Key Questions

- What kind of vehicles are used to deliver goods in the city?
Medellin Metropolitan Region (MMR)

Medellín Metropolitan Area (MMA) → 3.5 M inhabitants

Methodology: Freight Surveys
2,950 commercial vehicles (17% of the total) were surveyed in 11 tollbooths around the city to capture:
- Origins and destinations of the goods
- Commodities transported
- Commercial vehicle characteristics

Establishment and Carriers Surveys

- 2,947 establishments (4.4%) were surveyed to characterize the cargo movements and freight patterns
- The production and attraction trip patterns were captured

CARRIER INTERVIEWS AND HOUSEHOLDS SURVEYS

- 10 companies, 130 drivers to validate logistics practices
- 20,000 households surveyed about freight trips received
Results: Freight and Trips in the MMA

Freight Cargo: 25 kg/person/day
Freight Trips: 190,000 Freight trips/day

MEDELLIN METROPOLITAN AREA (MMA)
190,000 freight trips/day (including 25% empty trips)

Freight trips represent 4.5% of the total motorized trips in the MMA

Type of Vehicle and Average Number of Stops

- 4% of the vehicles were light vehicles (cars, pick-ups)
- 11% small trucks, 71% medium trucks, and 14% large trucks
- 26% of the total trips are empty

Average No. of stops in MMA = 2.6
Average No. of stops in NYC = 8.0
## Results from the Establishment Study

### Daily Attraction and Production

<table>
<thead>
<tr>
<th>Industry classification</th>
<th>Trips/day</th>
<th>% of trips</th>
<th>Tons/day</th>
<th>% of tonnage</th>
<th>Kg/trip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail trade</td>
<td>28,018</td>
<td>29.7%</td>
<td>1,200</td>
<td>19.8%</td>
<td>42.8</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>24,812</td>
<td>26.3%</td>
<td>1,317</td>
<td>21.7%</td>
<td>53.1</td>
</tr>
<tr>
<td>Wholesale trade</td>
<td>6,920</td>
<td>7.3%</td>
<td>763</td>
<td>12.6%</td>
<td>110.3</td>
</tr>
<tr>
<td>Construction</td>
<td>4,170</td>
<td>4.4%</td>
<td>300</td>
<td>5.0%</td>
<td>71.9</td>
</tr>
<tr>
<td>For hire carriage</td>
<td>2,361</td>
<td>2.5%</td>
<td>59</td>
<td>1.0%</td>
<td>25.0</td>
</tr>
<tr>
<td>Services</td>
<td>21,665</td>
<td>23.0%</td>
<td>695</td>
<td>11.5%</td>
<td>32.1</td>
</tr>
<tr>
<td>Utilities/communication</td>
<td>183</td>
<td>0.2%</td>
<td>7</td>
<td>0.1%</td>
<td>38.3</td>
</tr>
<tr>
<td>Public administration</td>
<td>12</td>
<td>0.0%</td>
<td>3</td>
<td>0.0%</td>
<td>250.0</td>
</tr>
<tr>
<td>Large freight generator</td>
<td>4,364</td>
<td>4.60%</td>
<td>1,577</td>
<td>26.0%</td>
<td>361.4</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0</td>
<td>0.0%</td>
<td>0</td>
<td>0.0%</td>
<td>0.0</td>
</tr>
<tr>
<td>Mining</td>
<td>1,528</td>
<td>1.6%</td>
<td>109</td>
<td>1.8%</td>
<td>71.3</td>
</tr>
<tr>
<td>Unclassified</td>
<td>94,000 trips per day generated</td>
<td>0.2%</td>
<td>More than 6,000 tons transported between small establishments</td>
<td>198.7</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>94,184</td>
<td>100.0%</td>
<td>6,060</td>
<td>100.0%</td>
<td>64.3</td>
</tr>
</tbody>
</table>

- Retail and Manufacturing → Large amounts of trips and tons
- Services → Relatively large number of trips with small portion of tons
- Large Generators → Relatively few trips with large portion of tons
Establishment Survey Statistics

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Trip Attraction (trips/day)</th>
<th>Trip Production (trips/day)</th>
<th>Freight Attraction (Kg/day)</th>
<th>Freight Production (Kg/day)</th>
<th>Area (m²)</th>
<th>Employees (full and part time)</th>
<th>Vendors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.99</td>
<td>1.05</td>
<td>90.6</td>
<td>34.3</td>
<td>157.4</td>
<td>9.1</td>
<td>3.6</td>
</tr>
<tr>
<td>Std.Dev</td>
<td>9.12</td>
<td>18.79</td>
<td>520.3</td>
<td>283.5</td>
<td>743.2</td>
<td>80.5</td>
<td>6.4</td>
</tr>
<tr>
<td>Min-Max</td>
<td>0-461.5</td>
<td>0-923.1</td>
<td>0-13,882.3</td>
<td>0-8,538.5</td>
<td>1-30,000</td>
<td>0.9-4,200</td>
<td>1-170</td>
</tr>
</tbody>
</table>

Notes:
1. Trip production excludes zero values;
2. Employment is calculated as full-time employees + 0.45 part-time employees
3. Sample size: 2,947 establishments

Total amount of cargo per person-day:
- In the MMA: 25 kg/person-day
- In New York City: 50 kg/person-day

Tons/day - Freight Related Establishments

Fuel/Lubricants Distributor
- Recycle stores
- Wholesale
- Medium Manufacturing
- Light Manufacturing
- Repair stores
- Accomodations and food
- Retail
- Construction
- Mining
- Transport/Warehouse
- Heavy Manufacturing
- Machine renting

- Freight Attraction (Kg/day)
- Freight Production (Kg/day)
Other findings

- 71% of the establishments do not have a storage room → they need frequent deliveries
- 45% of the establishments open between 7:00-8:00 a.m., and 40% close between 5:00 and 6:00 p.m.
- 70% of trucks park in the street to load/unload cargo
- Average time to load/unload is 18.5 min

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>% Trips</th>
<th>% Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trucks</td>
<td>64.4</td>
<td>72.7</td>
</tr>
<tr>
<td>Pick-ups and vans</td>
<td>11.5</td>
<td>11.3</td>
</tr>
<tr>
<td>Cars</td>
<td>8.1</td>
<td>9.6</td>
</tr>
<tr>
<td>Motorcycles</td>
<td>10.4</td>
<td>4.7</td>
</tr>
<tr>
<td>Bikes</td>
<td>3.3</td>
<td>0.8</td>
</tr>
<tr>
<td>Others</td>
<td>2.3</td>
<td>0.9</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Not conventional freight vehicles: 24.1% of trips 16% of tons
Conclusions

- To obtain a complete depiction of the freight patterns it is necessary to combine different freight surveys: cordon, establishments, carriers, etc.
- External-Internal and Internal-External flows move a lot of cargo with a relatively small number of trips.
- Internal-Internal flows move small amounts of cargo with large number of trips due to small shipment sizes.
- Trip attraction – 0.99 trips/establishment/day (90.6Kg).
- Trip production – 30% of the establishments produce 1.05 trips/day (34.3kg). 70% do not produce trips.
- The analysis of the data should be performed for freight related and service-oriented sectors separately.
Acknowledgments

- Rensselaer Polytechnic Institute – VREF Center of Excellence for Sustainable Urban Freight Systems
  - Many thanks to Prof. José Holguín-Veras and his team for the help and advise in the design and analyses of the freight surveys
- Metropolitan Area of Aburra Valley and the Municipality of Medellin
  - Thanks for funding the freight study

Thanks! Questions?

Gitakrishnan Ramadurai  
Indian Institute of Technology Madras  
gitakrishnan@iitm.ac.in

Ivan Sarmiento Ordosgoitia,  
Universidad Nacional - Medellin  
irsarmie@unal.edu.co
References


7. Área Metropolitana del Valle de Aburrá, Municipio de Medellín, and Universidad Nacional de Colombia Sede Medellín. Encuesta Origen Destino de Hogares y de Carga para el Valle de Aburrá. Área Metropolitana del Valle de Aburrá, Medellín. 2012.


