FUTURE FREIGHT SURVEYS – TRACKING SHIPMENTS

Lynette Cheah, Monique Stinson, Ziyue Chen, Vittorio Marzano, Fang Zhao, Moshe Ben-Akiva
7th METTRANS International Urban Freight Conference (I-NUF),
Long Beach, California, October 17-20, 2017
The importance of commodity flow surveys (CFS)

• **What is a CFS?**
  • An establishment survey for understanding freight flows generated by economic activities: what is moving, where, how much, what is it worth, how is it transported?

• **Examples**
  • Tokyo Metropolitan Region Freight Survey, every 10 years since 1972
  • U.S. CFS, every 5 years since 1990s

• **Uses**
  • Evaluate freight transport trends
  • Data applied in freight models: to simulate current situation and forecast future freight demand → decision support for freight planning and policies
Key CFS feature: Shipment log / diary

<table>
<thead>
<tr>
<th>Line No.</th>
<th>Your Shipment ID Number</th>
<th>Shipment Date</th>
<th>Shipment value (excluding freight charges and excise taxes) in whole dollars. Estimates acceptable.</th>
<th>Net Shipment Weight in pounds. Estimates acceptable.</th>
<th>SCTG commodity code from accompanying booklet¹</th>
<th>Commodity Description¹</th>
<th>Is item in col (G) a hazardous material? Enter &quot;UN&quot; or &quot;NA&quot;, number (H)</th>
<th>Is item in col (G) Temperature controlled? (YN) (I)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex.1</td>
<td>123-5</td>
<td>4 26</td>
<td>224,235</td>
<td>4,840</td>
<td>34520</td>
<td>Mechanical machinery</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Ex.2</td>
<td>402H</td>
<td>4 26</td>
<td>1,375</td>
<td>50,125</td>
<td>20222</td>
<td>Sulfuric acid</td>
<td>N</td>
<td>1830</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CFS challenges and project approach

- Manual-entry process – completing a shipment log is burdensome
- Shipment data lacking in details
  - Routes, intermediate stops, transshipment activity, visibility issues (e.g., due to multiple carriers)

Idea: Leverage sensing technologies to track shipments within a commodity flow survey, to enhance data collected and reduce survey burden

Objective: develop an integrated approach to gather data for shippers, carriers and shipments
Proposed integrated data collection approach

1. Registration & Pre-survey
   - Receiver questionnaire
   - Shipper questionnaire*
   - Carrier questionnaire
   - Driver pre-survey

* Traditional commodity flow survey

2. Tracking
   - Track shipments
   - Track vehicles

3. Verification
   - Shipment timeline
   - Driver timeline
Using the Future Mobility Sensing (FMS) survey platform: Vehicle survey example

MOBILE APP/TRACKING DEVICES

RAW DATA

MACHINE LEARNING BACKEND

PROCESSED DATA

VERIFIED DATA

MOBILE / WEB INTERFACE

Sensing Technologies, e.g.

- GPS
- GSM
- WiFi
- Bluetooth
- Accelerometer
- RFID
- OBD

Context Info

- Road network
- Points of Interest
- Land Use
- Events
- Establishment/vehicle/driver Info
- Carrier data
- …

Driver/Handler Timeline

- Activities
- Commodity
- Parking
- Helpers
- Special loads
- Alteration in plan
Proposed shipment tracking process within a CFS

- Shipment log options
  - Manual entry
  - Upload shipment records
- Tracking options
  - Share shipment tracking numbers, if already tracked by carrier
  - Agree to track shipments using GPS device
Approaches, technologies evaluated

Approaches: crowdsourcing using Bluetooth devices, QR code labels
  • Tested for response

Technologies: **GPS**, AGPS, GSM, WiFi localization
  • Tested for location accuracy, battery life in different environments

REPORT ME: Scan this QR code or SMS/WhatsApp “Tag 12345 is at <postal code of current location>” to 9999-9999. If you are the first to report where this package stopped, you will receive $5!
Selected GPS device

• Low-cost (<US$45) GPS devices tested suffered quality and/or battery life issues
• Selected device: CarCorp CCTR-800G
  • Battery life: ~10-12 days @30 min polling frequency
  • Weight: 250g
  • Dimensions: 70 x 55 x 32 mm (approx. 3” x 2.5” x 2”)
  • Price: US$60
  • Able to comply with FMS communications protocols
  • Relatively large, but device size is expected to decrease over time
FMS-Freight interfaces
Verification (1)

Shipment Tracking Verification

6/6/17 - 6/6/17
Shipment ID: 001

6/6/2017

6:25: ORIGIN
123 Main St. 1 ✔

9:07
315 Harbor Ave. 2

23:08: DESTINATION
100 Park Rd. 3 ✔

Click pencil to edit reported origin or checkmark to confirm

Click + to add stop

Click dustbin to delete stop
Verification (2)

Shipment Tracking Verification

6/6/17 - 6/6/17

Shipment ID: 001

6/6/2017

6:25: ORIGIN
123 Main St.

9:07
315 Harbor Ave.

23:08: DESTINATION
100 Park Rd.

Click the pencil to edit the activity

Arrival: 6/6/17, 9:07
Departure: 6/6/17, 10:25

What activities were conducted at this stop?
- Cross-docking
- Transloading
- Consolidation
- Deconsolidation
- Storage
- Value-added activities
- Other _____
- Don’t know
Verification (3)

Shipment Tracking Verification

6/6/17 - 6/6/17

Shipment ID: 001

6/6/2017

6:25: ORIGIN
123 Main St.

1

9:07
315 Harbor Ave.

2

23:08: DESTINATION
100 Park Rd.

3

Click the pencil to edit mode

Please select the mode used on this leg:

- Rail-container
- Rail carload
- Truck
- Airplane
- OTHER ___
- DON’T KNOW
This is a Package Tracking Experiment by researchers. If you are a driver / courier delivering this package, or the end recipient, you are eligible for a $5 reward!

1. At point of delivery, tear off this sealed, prepaid envelope.
2. Scan the QR code, or visit the website below to enter delivery and contact details.
3. Drop the sealed envelope at any mailbox within 7 days of item delivery.
4. Your S$5.00 reward will be sent to you!

Shipment ID code: 0001
*Visit https://freight-sg.fmsensing.com
Recruitment option 1: shipper-receiver pair

- Permission sought from shipper and receiver
  - Device placed in package
  - Verification by shipper and receiver
- Advantages:
  - Ensure tracking to final destination
- Disadvantages:
  - Receivers may have privacy concerns
  - Potential lack of visibility in multi-leg trips
Recruitment option 2: shipper and carrier

- Permission sought from shipper
  - Device attached to package
  - Verification by shipper and carrier
- Advantages
  - Engages carrier, who possesses more information about the shipment
- Disadvantages
  - Risk of lost devices
  - Still possible to miss some legs
Pilot shipment tracking surveys

- Objectives
  - Demonstrate viability of tracking shipments
  - Evaluate scalability
  - Investigate feasibility of collecting “big data” – uploading of shipment records
  - Offer informational incentive
- Convenience sample of establishments (shippers)
- Both pilots are to be launched by end-2017

<table>
<thead>
<tr>
<th>U.S. pilot</th>
<th>Singapore pilot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recruit shipper-receiver</td>
<td>Recruit shipper-carrier</td>
</tr>
<tr>
<td>n=200 shipments</td>
<td>n=50 shipments</td>
</tr>
</tbody>
</table>
Risks and limitations

• GPS tracking devices cannot be deployed for all shipment types, e.g. bulk goods
• Loss of tracking devices (not returned)
Summary

• The traditional CFS is burdensome and lacks key details

• We aim to track shipments using GPS devices and have shipping agents verify data collected

• Data is collected and processed using a web-based Future Mobility Sensing (FMS) survey platform

• Pilot shipment tracking surveys are being planned for end-2017
Acknowledgements

• Federal Highway Administration (FHWA) Exploratory Advanced Research Program, Contract No. DTFHG115C00033

• Singapore Ministry of National Development and National Research Foundation, L2 NIC Award No. L2NICTDF1-2016-1
THANK YOU

Contact: Monique Stinson, mstinson@mit.edu