Impact of Freight Consolidation on Logistics Cost and Emissions
SCM Master students - 2019

Ajay Mohan
Sik (Lance) So
Dr. Josue C. Velazquez-Martinez
SLI Director
Dr. Karla M. Gámez Pérez
Postdoctoral Researcher
Sayda Benitez
Visiting Student
Research Questions

• Our research partner is a big Mexican retailer with omnichannel network

• If a customer is willing to wait, are there opportunities to consolidate shipments and improve route utilization?

• Impact of consolidation on Carbon Dioxide (CO$_2$) emissions and logistics costs for omnichannel home delivery?

• Are there any other upstream savings opportunities because of additional lead time that retailers can benefit from e.g. inventory pooling / warehouse transfers?
METHODOLOGY

Baseline

Orders / truck
Volume / Truck
Seasonality
Leadtime

Delivery Clustering for 6 selected DC: Culiacan; Leon, Hermosillo, Laguna, Monterrey, Tecamac

Model consolidation for high density and low density

Constraint: \[
\frac{K_{esp(l)}}{S_{esp(l)}} * \sqrt{A_n + T_d(l)} * n \leq T_k
\]

Using Trips as proxy and convert to fuel saving

Convert to Emission & Dollar saving

Truck density data

OSMNX Road network
GeoCoding API
Google
Convert between addresses and geographic coordinates.

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Conclusion 1: Current vehicle utilization is low for volume and weight. Operation time is the main constraint

Conclusion 2: Volume has seasonality during Nov-Dec and 60% of volume is delivered within 2 days
DELIVERY ZONE ANALYSIS

Monterrey - High, Medium and Low volume zones (by Orders per truck)

Monterrey have many medium utilization truck

Tecamac (Mexico City) - High, Medium and Low volume zones
Remove Low Utilization by Policy Enhancement

- Not dispatching trucks with low utilization.
  - Delay routes
  - Merge routes
  - Estimate saving 6% of truck move.
- In our example there are 94 orders carry by low utilization truck from TECAMAC in one week.
Increase time per truck with less frequent deliveries

Medium Density Zone
- Orders per truck between 7 and 17
- With customer willing to wait. Rationalize the frequency of delivery - 13 to 19% saving

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High Density Zone
- By Increasing time spend on last mile
  - Less truck is required to handle all delivery
  - Estimate 12-26% saving

High Density Zone
- Orders per truck >= 18
- Less truck is required to handle all delivery
- Estimate 12-26% saving

3 Delivers / week
- 3 hrs
4 Delivers / week
- 4 hrs
RECOMMENDATIONS

• Operational
  ▪ Improve low utilized routes through consolidation.
  ▪ Reduce delivery frequency given longer lead-times.
  ▪ Increase route length for last mile delivery

• Future Opportunities
  ▪ Work on improving geocode data quality
  ▪ Up-stream DC inventory analysis with longer lead-time
Saving Opportunity

Maximum: 32% trips reduced (combining options)

2.35 Million USD

2.14 Million Liters Diesel

5.76 Million Kg
Thanks!

Questions?

Name
email@mit.edu

http://sustainablelogistics.mit.edu
Backup: Additional study on upstream inventory

- Coppel have intra DC traffic from each DC to all other DC. The top 6 DC shipping out are:
  - Culiacan
  - Leon
  - Hermosillo
  - Laguna
  - Monterrey
  - Guadalajara

- We recommend holding inventory in centralized locations and pull by regional DC to reduce inter DC traffic.

- 15% potential saving on inter DC traffic.
Back-up Limitations

• Only 60% of record could get accurate Geocode from Google API.

• Could not run all Geocode due to Google API limitation, we only run 6 DC for 1 week, roughly 30K records.

• Currently there is no logical grouping other than City name in the data for demand analysis or automated consolidation

• The benefit is base on the weekly data we analysis