PILOT Freight Services Facility Location Optimization for Last-mile Delivery

MIT Research Fest

Cambridge, May 21st 2019

Agenda

Background Information

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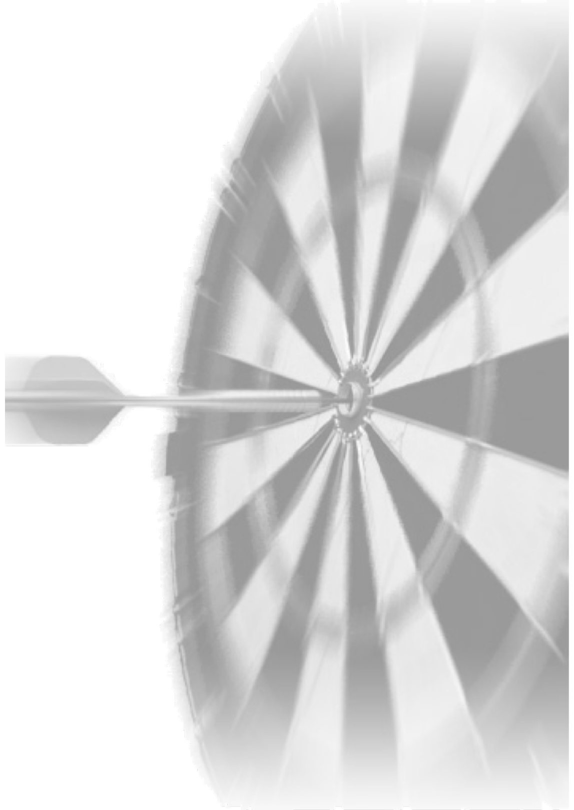
Methodology
Results & Discussion
Recommendation

Q&A



Pilot Freight Services

24/7 full-mile **Freight Forwarding** Services

Privately held; HDQ in Lima, PA

Operations in **more than 75 locations** throughout US & western Europe

Specialized for **heavy, bulky goods**

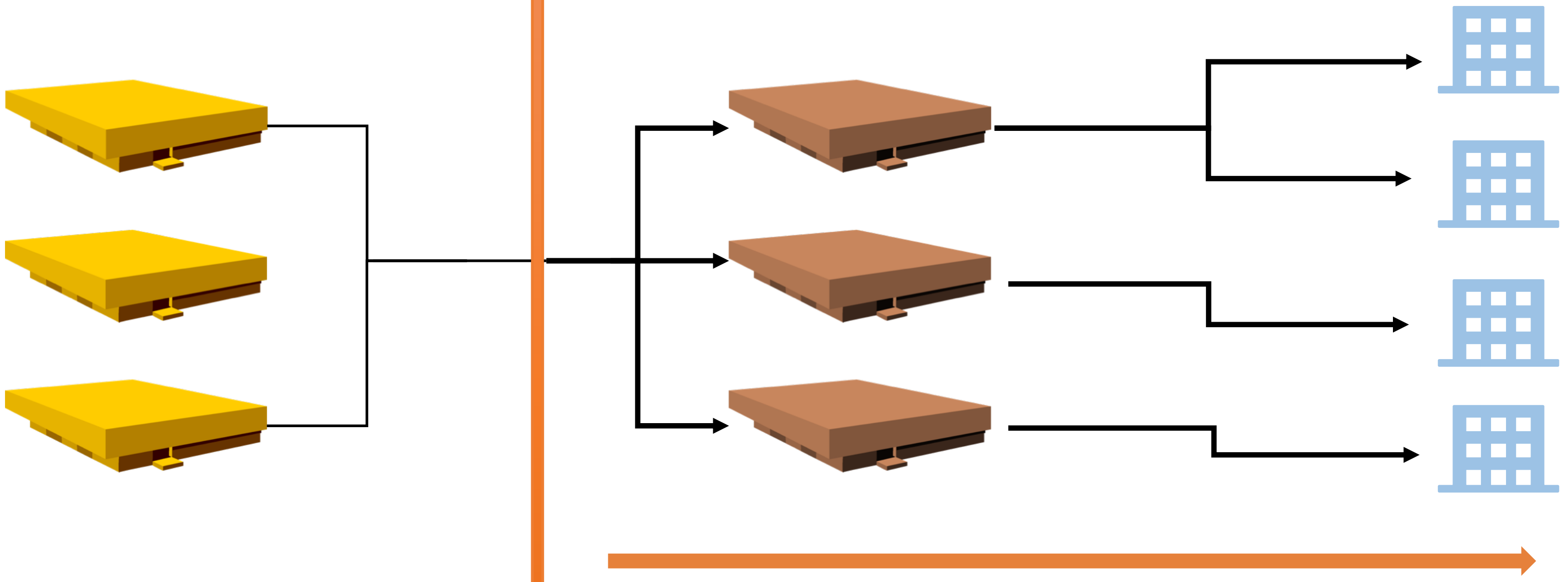
- Furniture
- Home Appliances & Electronics
- Sporting Equipment

Strategic acquisition for **e-commerce service offering**

Introduction

The company seeks to remain competitive by optimizing their network footprint and operating cost for last-mile delivery of heavy-bulky goods.

Retailer DC	Pilot Cross-dock	Customer



Anticipate e-commerce retailers will arrange mid-mile delivery to Pilot Cross-docks

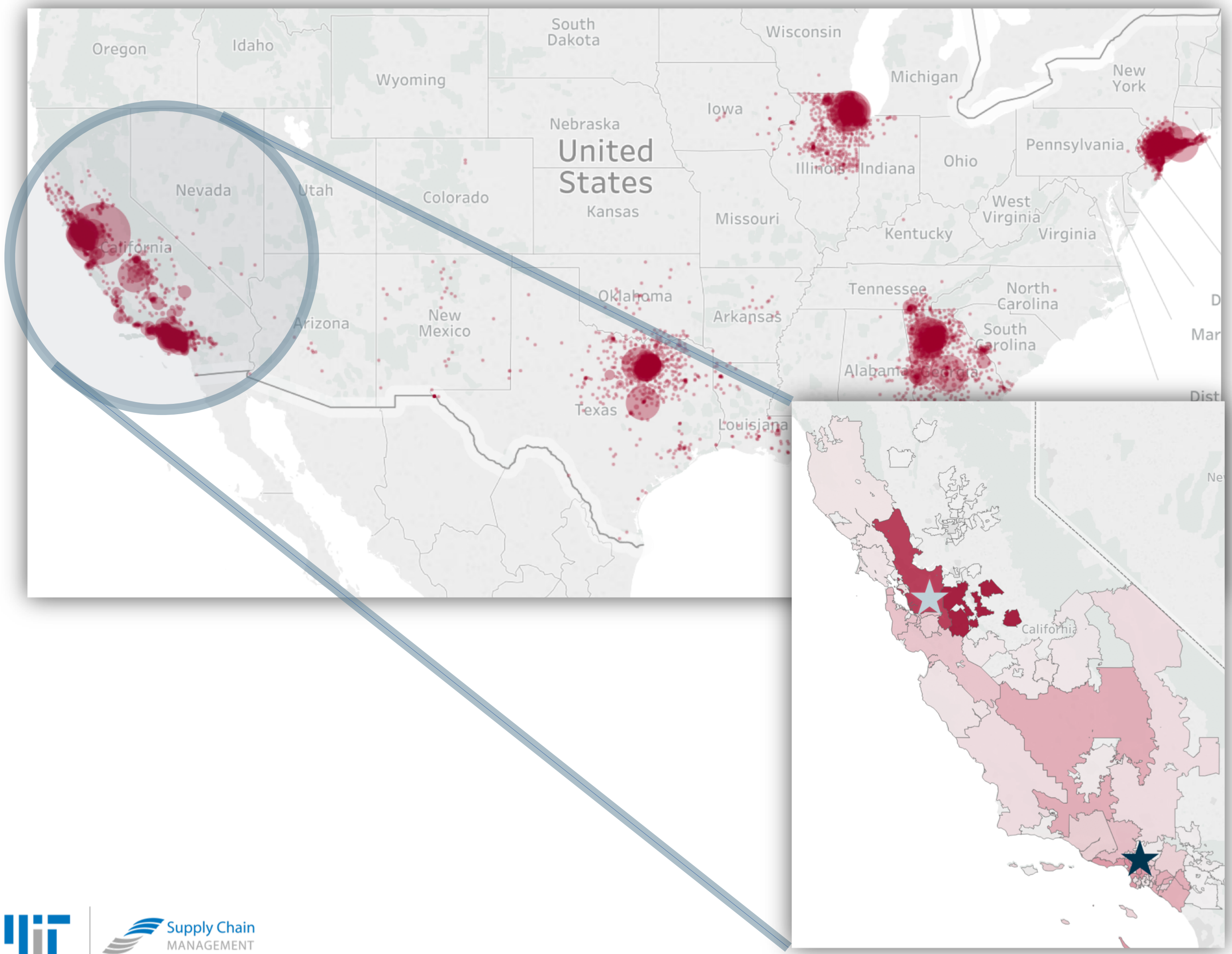
Project aims to determine the **optimal number** of local stations' **locations** in order to minimize the last-mile logistics cost

In Scope

San Francisco
Los Angeles
Chicago
New York
Newark
Atlanta
Dallas

Project Hypotheses

The objective is to test the hypothesis that establishing additional cross-docking facilities within metropolitan areas would reduce the mileage, and thereby the cost, of travelling from the cross-dock to final delivery.



Hypotheses

1. Pilot's cost position will improve from optimized station **locations** which reduce stem time for last-mile delivery

2. Additional stations should enhance the **capability** to meet the growth and variation of e-commerce demand

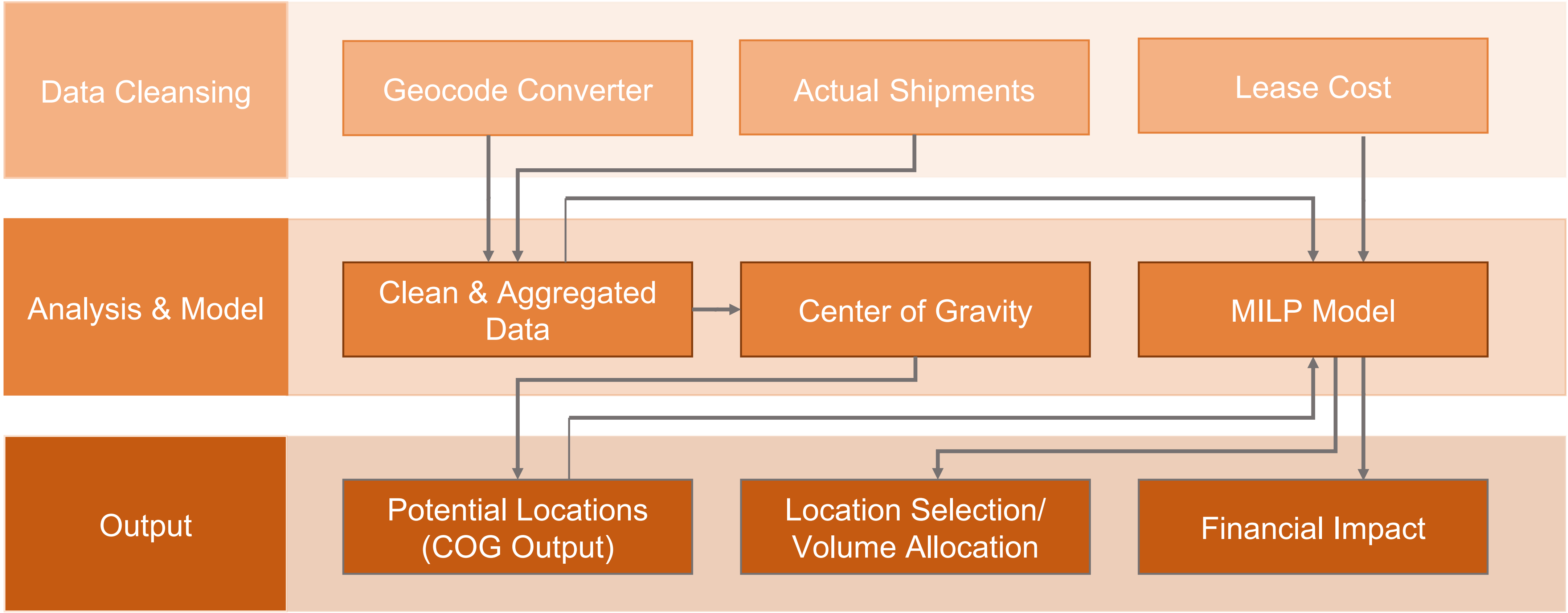
Qualitative Considerations

Feasibility of operating in urban areas

Limitations including demand uncertainty, seasonality and cost fluctuations

Data and Methodology

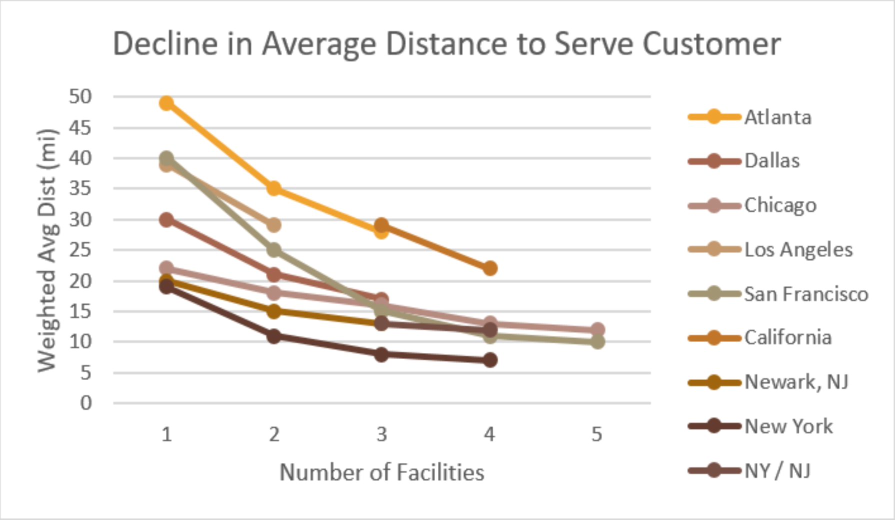
Arriving at a recommendation requires collecting data and understanding the baseline, designing two models, and finally analyzing the results.



Results: Center of Gravity (COG) Analysis

The COG approach aims to select the location of a facility to minimize the weighted-average distance to all the demand points.

	Weighted Average Distance (mi)			% Customers >50mi		
	Baseline	Two Sites (COG)	Reduction (mi)	Baseline	Two Sites (COG)	Reduction (points)
Atlanta	51	35	-16	33.6%	21.4%	-12.2%
Dallas	31	21	-10	14.6%	6.6%	-8.0%
Chicago	22	18	-4	8.0%	7.3%	-0.7%
Los Angeles	41	29	-12	19.2%	16.1%	-3.1%
San Francisco	43	25	-18	13.5%	13.1%	-0.4%
Newark, NJ	21	15	-6	3.6%	1.3%	-2.3%
New York	22	11	-11	4.3%	1.7%	-2.6%
Total WA	**35**	**23**	**-12**	**14.9%**	**10.8%**	**-4.1%**

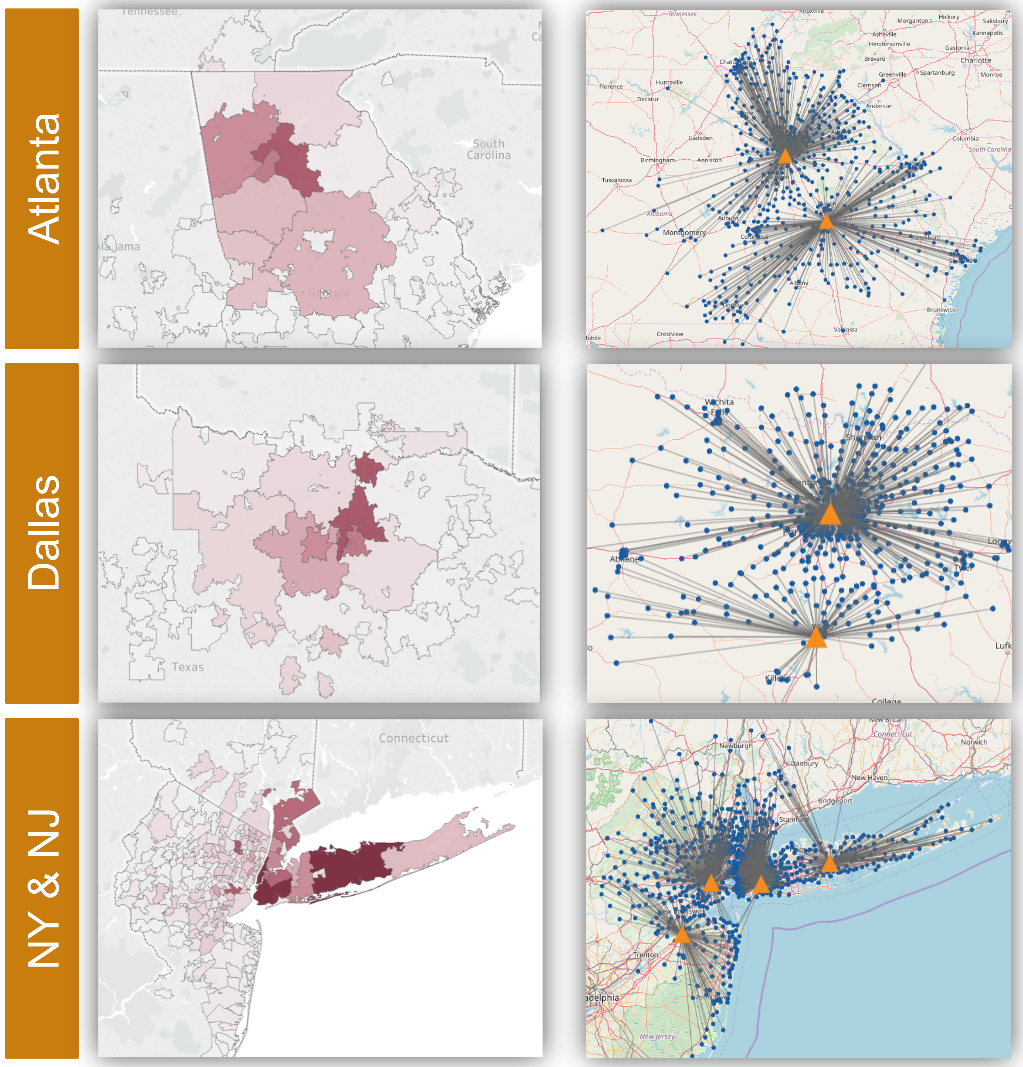


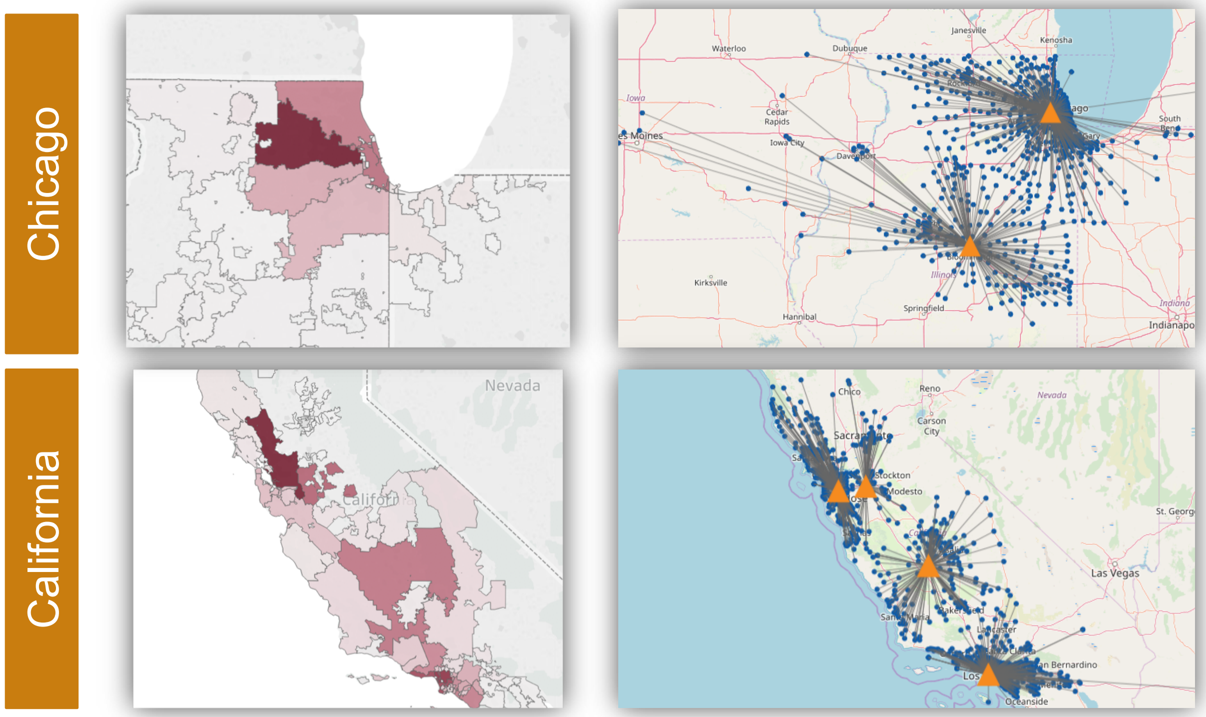
Facility Constraint

- The greatest reduction in miles occurs when the first incremental facility is added in a market. Additional facilities were at **diminishing returns**.
- **COG provided valuable information** to seed the next major stage of our research - the MILP model.
- In Atlanta, Dallas and Chicago, a **two-station solution** is proposed. For California, New York & New Jersey, a **four-station** is proposed.

Results: Mixed Integer Linear Programming (MILP)

MILP model identifies the optimal combination of locations that leads to the minimum total costs.





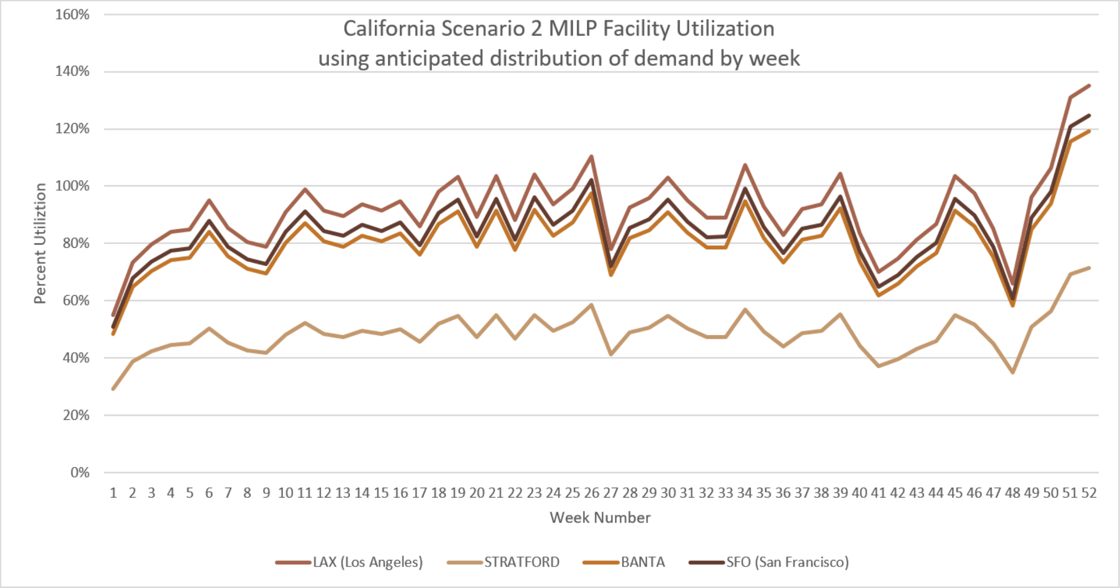
Summary

- Concentration of demand is indicated by heat maps
- Recommended sites and flows in each of the five markets is displayed. Existing facilities are included

cross-docking facility *customer node (5-digit zip code)*

Results: Volume Allocation

Capacity utilization estimation reveals how recommended cross-docking facilities handle seasonal demand.

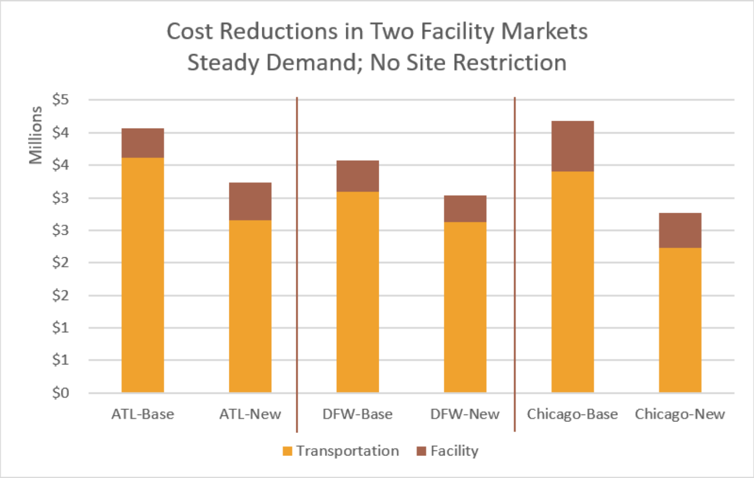


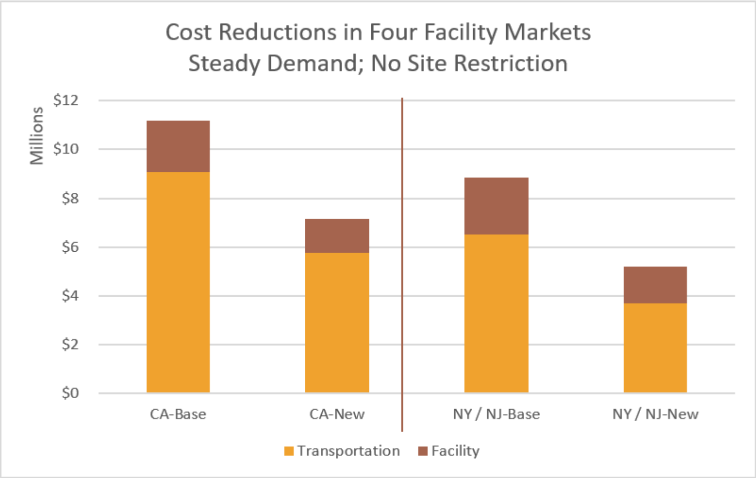
Summary

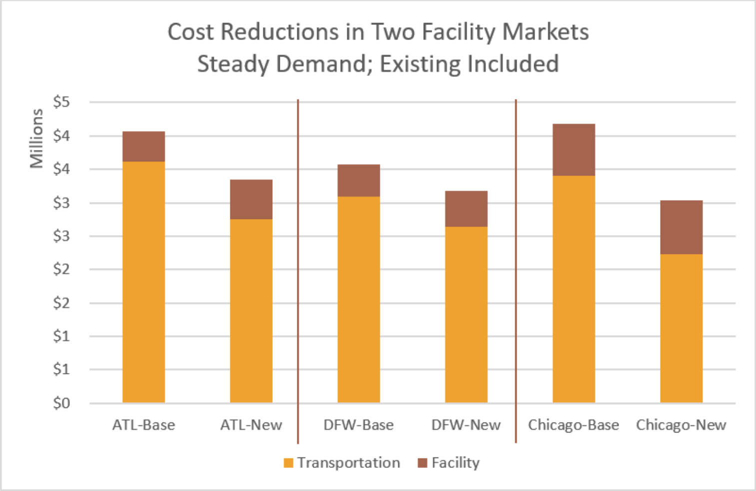
- Graph depicts the four total facilities in California, including the existing facilities
- **Average utilization is ~82%** for the three facilities carrying the most demand
- During the holiday peak, utilization rate **exceeds 100%; outsource or offload** to another facility
- Stratford facility is underutilized. The company could look for a smaller space, or it may be a good location to **shift demand** during times like the peak season

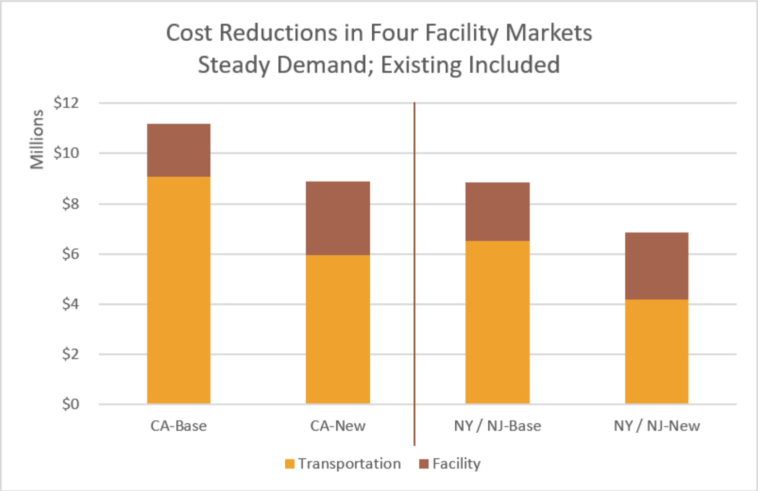
Results: Financial Impact

Compared to the baseline, the unconstrained MILP resulted in a 34% cost reduction, while including existing facilities led to a 23% cost reduction, when doubling the total facilities in the network.









Summary

- The **second scenario** reflects a more **realistic** operating footprint because existing facilities remain operational.
- This financial analysis is **simplified;** only transportation and leasing costs are included.
- Cost reduction estimates indicate **directional accuracy**. New facilities offer operational efficiency and **cost savings**.
- More inclusive cost analysis should be done as next step before finalizing network modeling decision.

Results: Break-even Analysis

Estimated transportation savings were calculated as the reduced mileage times the cost per mile. If the market transportation rate increased, the calculated savings would be greater with same distance reduction.

$/SqFt/Yr	Baseline	Scenario 1		Scenario 2	
	Actual	Average	Breakeven	Average	Breakeven
Atlanta	$5.94	$6.00	$9.67	$5.97	$8.65
Dallas	$6.54	$4.40	$5.47	$5.17	$5.20
Chicago	$10.29	$5.05	$13.71	$6.95	$13.83
California	$14.09	$7.86	$18.76	$10.79	$13.87
NY / NJ	$23.57	$9.81	$25.67	$16.29	$15.47

Summary

- MILP model allocates facilities **nearest** to dense demand to reduce the distance to service the customer
- The **higher the transportation cost rates**, the **greater the incentive** to invest in additional facilities.
- The break-even unit cost for stations is the **benchmark** for the commercial buildings sourcing. Any unit cost lower than the ceiling would lead to an overall logistics cost (transportation and facility operation cost) savings.

Limitations and Suggestions to Further the Study

Limitations

- Other operational costs are not included in this study
- The nature of dynamic, market-based leasing rates is not captured in the model
- Demand is in a fast growing stage; the most recent peak period is not captured

Suggestions

1. Capacity planning based on most recent peak-season shipment data
2. Form cross-functional team to discuss strategic network decision: comprehensive real-estate study, network complexity, IT systems changes, retail partners willingness to change

Thank you