E-commerce and the environment: Finding the optimal location for in-store pick-up

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Agenda

- Background
- Methodology
- Results
- Result Analysis
- Conclusion And Recommendation
- Q&A
Background

- An American chain of upscale department stores
- Customers in 800+ 3zip locations in the US
- More than 350 physical stores
- 26% sales of the company are online and growing

Objective: Finding the optimal location for in-store pick-up
Hypothesis

Two main hypothesis:

- It is profitable to determine some stores as pick up locations
- Having the customers pick up their orders in store reduces the environmental impact
Methodology

Demand Data analysis

Cost reduction function

More than 10 million records in 9 months

Binary integer linear programming
Optimal solution for maximizing saving

CO₂ emission function

Measured and evaluated environment impact

Results Analysis

Economic and Environmental Analysis

Cost

Service level

Green impact

Operational feasibility

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Methodology – Cost reduction model

Setup

- P: Customers’ willingness
- M: Maximum distance

Input

- C: Delivery cost
- D: Distance from store to customer
- F: Fixed cost of opening pick-up service

Output

- Cost saving
- Selected stores

\[
\text{max} \rightarrow Z = \sum_{i} \sum_{j} P \times C_{ij} \times X_{ij} - \sum_{j} F_{j} \times Y_{j}
\]

Subject to:

\[
\sum_{j} X_{ij} \leq 1, \forall i \in I, \forall j \in J
\]

\[
X_{ij} \times D_{ij} \leq M, \forall i \in I, \forall j \in J
\]

\[
X_{ij} \leq Y_{j}, \forall i \in I, \forall j \in J
\]

\[
X_{ij}, Y_{j} = \{0,1\}
\]
Methodology – CO₂ emissions model

\[ E_{\text{savings}} = E_{\text{current}} - E_{\text{proposed}} \]

Current

Proposed
Result Analysis – Cost reduction model

Optimal cost solutions in MA

Cost Savings
Stores enabled

P: WILLINGNESS TO PICK UP IN STORE

- Higher willingness leads to higher saving with more stores opening pick-up service;
- 4 stores selected as profitable candidates in MA with $77K in savings, with willingness = 20% and distance = 10 miles;
- Alternative scenario by choosing distance=6 miles and selecting stores in Boston.
Result Analysis – Cost reduction model

• CA can achieve more savings than MA as the demand is much denser;
• 15 stores would be profitable candidates in great LA area and 10 in the SF area;
• With willingness=20% and distance=10 miles, CA potentially can save $1,319K;
Result Analysis – CO₂ emissions model

<table>
<thead>
<tr>
<th>Minimum B required to have CO₂ savings</th>
<th>MA</th>
<th>CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 Packages/Route</td>
<td>95%</td>
<td>94%</td>
</tr>
<tr>
<td>100 Packages/Route</td>
<td>90%</td>
<td>86%</td>
</tr>
<tr>
<td>40 Packages/Route</td>
<td>74%</td>
<td>66%</td>
</tr>
</tbody>
</table>

- The efficiency of a route has great impact on CO₂ emission;
- The denser of demand, the lower B needed to achieve CO₂ saving;
- The more people come to store by walking, bike or public transportation, the more friendly to environment;
- In the sparse demand area, direct shipping may be more environment-friendly!
Conclusion And Recommendation

1. Cost saving highly relies on customers’ willingness to pickup the order in store;

2. Customers’ willingness to avoid driving and the efficiency of carriers’ route design highly affect environment;

3. The company should first open pick-up-in-store service in denser locations;

4. The company should incentivize and educate customers in using more environmentally-friendly transportation modes;

5. In the event that carriers’ route design is very efficient, direct shipment would be more environmentally-friendly;
Questions