On the Unique Features and Benefits of On-Demand Distribution Models

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Today's Distribution Networks are Optimized for Yesterday's Customers

A wide variety of requests are made with little warning and are expected to be fulfilled quickly in small units to many dispersed locations, affordably.

Distribution fulfilled requests for Known, Fixed, & Aggregated Demand Points.

A 2017 JDA survey found only 10% of global brick-and-mortar retailers are profitably fulfilling e-commerce orders.

Users' Benefits of On-Demand Warehousing Models

1. Access to Scale
2. Reduced Capacity Granularity
3. Reduced Commitment Granularity

These benefits need to be traded off with different cost structures.

<table>
<thead>
<tr>
<th>Type</th>
<th>Capacity (K_p) (in pallets)</th>
<th>Pallet storage cost per pallet per month with β =100% utilization</th>
<th>Pallet storage cost per pallet per month with β =80% utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construct</td>
<td>30,000</td>
<td>$2.02</td>
<td>$2.53</td>
</tr>
<tr>
<td>Construct</td>
<td>70,000</td>
<td>$1.89</td>
<td>$2.36</td>
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<tr>
<td>Construct</td>
<td>160,000</td>
<td>$1.73</td>
<td>$2.16</td>
</tr>
<tr>
<td>Lease</td>
<td>10,000</td>
<td>$2.27</td>
<td>$2.84</td>
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<td>20,000</td>
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<tr>
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<td>$1.97</td>
<td>$2.46</td>
</tr>
<tr>
<td>On-demand</td>
<td></td>
<td>&lt;$7.96 - $15.63</td>
<td>&lt;$7.96 - $15.63</td>
</tr>
</tbody>
</table>

Optimization Models to Evaluate On-Demand Warehousing Strategies

- Developed a mixed integer linear programming model to determine facility location and type, as well as demand allocation over multiple periods.
- Novelty: multi-period capacitated facility location-allocation model with different commitment and capacity granularities that simultaneously considers three warehouse alternatives.

The model is used to answer the following open research questions:
1. Given user benefits, but also differences in cost structures, is there a business case for a company to use on-demand warehousing?
2. How should a company's distribution network be designed given the genesis of on-demand options (as well as existing build and lease options)?
3. What influences these decisions?

On-Demand Distribution Platforms

Operate marketplaces, in which a crowd of independent entities rent access to their resources. The platform facilitates on-demand matching of demand requests to resources (warehouse space, fulfillment services, truck space, delivery services).

Users’ Benefits of On-Demand Warehousing Models

- Test scenarios:
  - Most populated 100 counties (~43% of the US population)
  - 25 candidate locations
  - 60 monthly periods (5 years)
- US Network Preliminary Results:
  - Average 5.54% reduction in distribution center costs with on-demand alternative

Preliminary Results

- On-Going Studies & Future Research
  - Developing solution approaches (column generation based) to solve large problem instances, needed to measure access to scale.
  - Design of Experiments to quantify the value of on-demand warehousing in a wide variety of scenarios.
  - Stochastic supply capacity and stochastic demand considerations.
  - Facility logistics operational and design for an on-demand renter of space.

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