On the Unique Features and Benefits of On-Demand Distribution Models
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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_i^n) (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>$3.02</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>
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<tr>
<td>Lease</td>
<td>10,000</td>
<td>$2.27</td>
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<tr>
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<td>$1.97</td>
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<tr>
<td>On-demand</td>
<td></td>
<td>$7.96</td>
<td>$7.96</td>
</tr>
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</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?

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

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.

Preliminary Results

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

With On-demand alternative
Without On-demand alternative

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.

Acknowledgements:
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