Order-picking methods: Improving order-picking efficiency

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ORDER-PICKING - process of retrieving items from storage locations in response to specific customer request

- most laborious in a typical warehouse
- up to 55% of warehouse operating cost
- direct influence on order accuracy and delivery time

- 50% of the total order-picking time spent on unproductive traveling

\[
\text{Source: Tompkins et al. Facilities Planning, Wiley, 1996}
\]

**REDUCTION OF TRAVEL DISTANCES \(\rightarrow\) IMPROVING EFFICIENCY**
**Routing methods (policies)**
- determine the sequences and routes of picking

**Storage methods (policies)**
- assign items to storage locations based on some rule

**Orderbatching methods (algorithms)**
- group two or more customer orders in one picking order

**Performances:**
- the size and layout of a warehouse
- the size and characteristics of orders
- picker’s capacity
- combination of methods !!!
THE ANALYSIS OF ORDER-PICKING METHODS

- by simulation
- restricted to conventional warehouses with basic layout

[Diagram of a warehouse layout with main aisles and depot]
THE ANALYSIS OF ROUTING METHODS

S-shape

Return

Midpoint

Largest Gap

Composite/Combined

Optimal
THE ANALYSIS OF ROUTING METHODS

- 48 different situations examined
  (6 pick list’s sizes, 2 warehouse’s sizes, 4 layouts)
- random storage

Small # of picks → appropriate heuristics are only 5-10% over the optimal algorithm
Large # of picks → difference between appropriate heuristics and optimal algorithm is neglected
THE ANALYSIS OF STORAGE METHODS

*Volume-based storage*

- most frequently accessed items in the locations “nearest” to the depot
- different types (patterns) of volume-based storage

![Diagram of storage methods](image)

- a) diagonal type
- b) within aisle type
- c) along front aisle type
- d) along front and rear aisle type
THE ANALYSIS OF STORAGE METHODS

- 48 different situations examined
  (6 pick list’s sizes, 2 warehouse’s sizes, 4 layouts)

- 4 types of storage, 4 volume-based ABC curves
  in combinations with routing methods

<table>
<thead>
<tr>
<th>Routing method</th>
<th>Region</th>
<th># of picks</th>
<th>ABC curve</th>
<th>Preferred type of storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-Shape</td>
<td>all</td>
<td>all</td>
<td>all</td>
<td>within aisle</td>
</tr>
<tr>
<td>Return</td>
<td>large</td>
<td>less skewed</td>
<td>across aisle</td>
<td></td>
</tr>
<tr>
<td></td>
<td>small</td>
<td>more skewed</td>
<td>diagonal</td>
<td></td>
</tr>
<tr>
<td>Largest Gap</td>
<td>all</td>
<td>all</td>
<td></td>
<td>within aisle</td>
</tr>
<tr>
<td>Combined</td>
<td>larger</td>
<td>all</td>
<td></td>
<td>within aisle</td>
</tr>
<tr>
<td></td>
<td>few</td>
<td>all</td>
<td>diagonal</td>
<td></td>
</tr>
<tr>
<td>Optimal</td>
<td>larger</td>
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<td></td>
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<td>more skewed</td>
<td>diagonal</td>
<td></td>
</tr>
</tbody>
</table>

The preferred types of storage for particular routing method
THE ANALYSIS OF STORAGE METHODS

- all volume-based storage types provide travel savings over random storage
  45-55% (small # of picks, more skewed ABC curve)
  few-15% (large # of picks, less skewed ABC curve)

- the performances of routing methods with volume-based storage changed

Right selected routing heuristics with preferred type of storage result in travel distances only few percents over the optimal.
THE ANALYSIS OF ORDERBATCHING METHODS

- simple algorithms (FCFS)
- seed algorithms
- savings algorithms

based on calculated travel distance
(interactions with routing and storage methods)

- simulation
  - 13 orderbatching algorithms (9 seed, 3 savings, FCFS)
  - 16 different situations (warehouse’s size and layout, orderpicker capacity, order size)

- 4 routing methods
- random storage, preferred type of volume-based storage
THE ANALYSIS OF ORDERBATCHING METHODS

-the best OB algorithm is modified Clarke & Wright savings algorithm
  outperforming seed algorithms 2.5%
  outperforming FCFS 4-21%

-relative performances of routing methods stay the same as for single OP
  with large orders. The difference between heuristic routing methods and
  optimal algorithm decreased (few percents).
THE ANALYSIS OF ORDERBATCHING METHODS

- potential savings using OB methods in comparison with single OP depend on the # of customer orders per group (OP’s capacity / avg. order size), 40-70%.

- savings by OB methods and volume-based storage in comparison to single order-picking with random storage are cumulative

Optimal routing algorithm – within-aisle volume-based storage – mod C&W algorithm
CONCLUSIONS

- great potential of OP methods in reducing travel distances

- orderbatching on average showed the greatest potential in reducing order-picking travel distances (small orders) ADDITIONAL SORTING ?

- volume-based storage requires significantly less travel than random storage. (Without OB more than 30% with more skewed ABC curves) within aisle type - CONGESTION ?

- complex routing methods offer reduction (insignificant with other methods implemented)
THANK YOU