Inventory Optimization in a Retail Multi-Echelon Environment

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Agenda

- Introduction to RetailCo’s Supply Chain
- Research Questions
- Inventory model development
- Optimal result and sensitivity analysis
RetailCo Supply Chain Network

- This study focuses on 3 echelons: SupplierCo’s warehouse, RetailCo’s DC, and RetailCo’s stores
- All echelons’ use periodic, order-up-to-level (OUTL) policies
- Review periods are based on fixed schedule basis

![Diagram of supply chain network]

(R,S) Daily review, Order-up-to-level with case pack quantity
(R,S) Weekly review, Order-up-to-level with case pack quantity
(R,S) Period review (Every 3 days or 7 days), Order-up-to-level
Current Situation

Single-echelon approach is used to set up an echelon’s inventory policies

What’re the problems?

- Suboptimal inventory allocation
- Customer service failure
Research Questions

“How should inventory be distributed to optimize the total network carrying cost while still achieving the store target service level?”

Additional Questions:

- How does an echelon’s inventory policy impact the other echelons?
- How does store target service level impact inventory distribution and the other echelons’ service levels?
- How does supplier’s service disruption impact the echelons’ service levels?
Inventory Model Development

100 Stores are segmented into 12 Store-segments

Store Service Level = Number of Day In-Stock
Supplier and DC Service Level = Fulfilled Demand
Objective Function, Constraints, and Variables

- **Objective Function:**
  
  MIN (Network Carrying Cost)

- **Constraints:**
  
  Stores’ Service Level \( \geq \) Target Service Level
  
  Stores’ OUTL \( \geq \) Minimum OUTL
  
  (Minimum OUTL = Minimum Presentation Quantity)

- **Variables:**
  
  Echelons’ OUTLs
Finding Optimal Result

2-Year Random Daily Store Demand (Poisson)

Varying Stores’ OUTLs

Varying DC’s and Supplier’s OUTL

RetailCo’s DC

Orders

Orders

Delivered Quantity

Delivered Quantity

SupplierCo’s Warehouse
Optimal Inventory Distribution

Optimal inventory carrying cost can be achieved by having low inventory at the DC.

Service Level

<table>
<thead>
<tr>
<th>Sales Unit Volume</th>
<th>Supplier</th>
<th>DC</th>
<th>Stores</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>100.0%</td>
<td>97.0%</td>
<td>98.8%</td>
</tr>
<tr>
<td>Medium</td>
<td>99.0%</td>
<td>86.8%</td>
<td>99.0%</td>
</tr>
<tr>
<td>Low</td>
<td>91.2%</td>
<td>75.6%</td>
<td>99.1%</td>
</tr>
</tbody>
</table>
How an echelon’s inventory policy affects other echelons?

Inventory decreases as the DC decreases OUTL

Inventory increases as the DC increases OUTL BUT only at the DC!!

DC’s service level plummets as well as Store’s service level as DC’s OUTL drops

ONLY DC’s service level increases as DC increases OUTL!!

Inventory decreases as the DC decreases OUTL
How store target SL impacts inventory distribution and echelons’ SLs?

Stores and DC needs to have more inventory.

Stores and DC needs higher service level BUT Supplier can relax its service level!!
How supplier’s service disruption impacts echelons’ SLs?

Supplier’s service disruption has significant impact on the downstream echelon, especially at DC.

1% Service disruption causes store’s SL to drop below target SL
Conclusion

- The optimal carrying cost can be achieved by keeping low inventory and service level at the DC.
- This study shows INTERRELATIONs among the echelons in a multi-echelon network.
- This relationship should be considered when setting up the echelon inventory policy
  - Eliminate excess safety stock
  - Reduce service failure
- Higher store target service level = Higher inventory at the downstream echelon
- Service failure can have significant impact on the network service levels
Question