Chapter 4

Designing the Distribution Network in a Supply Chain

After this discussion, you should be able to understand:

- The role of distribution in a supply chain
- The key factors influencing distribution network design
- The design options for a distribution network
- Assessment of the value, the strengths and weaknesses of various distribution options
- Distribution networks in practice
- Summary thinking questions

GM case:

- In 1994, General Motors was planning to test a program in Florida to reduce the amount of time Cadillac buyers must wait for new cars

- Under the program, which begins in mid-September, about 1,500 Cadillacs will be parked at a regional distribution center in Orlando, Fla, to await delivery to dealers statewide within 24 hours. …GM hopes improving customer service will boost sales of Cadillacs…Research shows we lose 10% to 11% of sales because the car is not available… GM says the test program will increase Cadillac sales by 10%.

**GM - Cadillac Distribution Systems**

- **What is GM trying to achieve?**
  - Centralized distribution system performs better than a decentralized system
  - For the same inventory level, centralized system provides higher service level, and hence higher sales
  - The Risk Pooling Concept

- **Is the centralized system a better system?**
  - Better for the manufacturer?
  - Better for the retailers/dealers?

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**The Role of Distribution in the Supply Chain**

- **Distribution:** the steps taken to move and store a product from the supplier stage to the customer stage in a supply chain
  - Distribution related costs form about 10.5% of the US economy, and about 20% of manufacturing cost
  - Directly affects cost and the customer experience and therefore drives profitability
  - Long term effect to the company
  - Choice of distribution network can achieve supply chain objectives from low cost to high responsiveness

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**Questions:**

- What the role of distribution networks?
- What are the optional networks?
- How to evaluate a network?
- Value of each system?

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**Factors Influencing Distribution Network Design**

- Distribution network performance evaluated along two dimensions at the highest level:
  - Customer needs that are met
  - Cost of meeting customer needs

- Distribution network design options must therefore be compared according to their impact on customer service and the cost to provide this level of service

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- Compaq computer estimates it lost $500 million to $1 billion in sales in 1995 because its laptops and desktops were not available when and where customers were ready to buy them.

- Boeing Aircraft, one of America’s leading capital goods producers, was forced to announce writedowns of $2.6 billion in October 1997.
  The reason? “Raw material shortages, internal and supplier parts shortages...”. (Wall Street Journal, Oct. 23, 1997)
Factors Influencing Distribution Network Design

- Key customer needs or the elements of customer service influenced by network structure:
  - Response time
  - Product variety
  - Product availability
  - Customer experience
  - Order visibility
  - Returnability …

- Supply chain costs affected by network structure:
  - Inventories
  - Transportation
  - Facilities and handling
  - Information …

Service Time and Number of Facilities

A decrease in the response time customers desire increases the number of facilities required in the network.

Where inventory needs to be for a one week order

Where inventory needs to be for a 5 day order

response time - typical results --> 2 DCs
Where inventory needs to be for a 3 day order response time - typical results -> 5 DCs

Where inventory needs to be for a next day order response time - typical results -> 13 DCs

Where inventory needs to be for a same day / next day order response time - typical results -> 26 DCs

The Cost-Response Time Frontier

SC responsiveness vs. SC efficiency
Critical decision: How to optimize the distribution network to achieve a satisfactory customer service standard with the minimum possible cost?

Design Options for a Distribution Network
- Manufacturer Storage with Direct Shipping
- Manufacturer Storage with Direct Shipping and In-Transit Merge
- Distributor Storage with Carrier Delivery
- Distributor Storage with Last Mile Delivery
- Manufacturer or Distributor Storage with Consumer Pickup
- Retail Storage with Consumer Pickup
- Selecting a Distribution Network Design
- …

Manufacturer Storage with Direct Shipping (Fig. 4.6)
- Retailers carry no inventories. The ownership of inventories is at manufacturers
- Example networks: eBags, Gateway, Nordstrom.com (for slow moving items) and W.W.Grainger
- Advantages:
  - Aggregate demand and centralized inventory, which is good for high-value, low demand items with unpredictable demand.
  - Manufacturer can postpone the customization till the order is placed
- Response time is large. Transportation (outbound) cost is high. And so is for information infrastructure.
Giordano (Hong Kong)

- Distribution strategy to its Japan market changes.
- Old strategy: Products sent from China to Tokyo warehouse, then distributed to retailing stores.
- New strategy: Send products from China to retailing stores directly through cross-docking at Narita airport, using airplane.
- Tradeoff between warehouse cost and transportation cost. (about the same)
  - Distribution time and sales increased (due to the most updated information)

Cross-dock DC

In-Transit Merge Network (Fig. 4.7)
Combines pieces of the order from different locations so the customer gets a single delivery

<table>
<thead>
<tr>
<th>Distribution Storage with Carrier Delivery (Fig. 4.8)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product Flow</strong></td>
</tr>
<tr>
<td><strong>Information Flow</strong></td>
</tr>
</tbody>
</table>

Distributor Storage with Last Mile Delivery (Fig. 4.9)

**TABLE 4.3 Performance Characteristics of Distributor Storage with Carrier Delivery**

<table>
<thead>
<tr>
<th>Cost Factor</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventory</td>
<td>Higher than manufacturer storage. Difference is not large for faster moving items.</td>
</tr>
<tr>
<td>Transportation</td>
<td>Lower than manufacturer storage. Reduction is highest for faster moving items.</td>
</tr>
<tr>
<td>Facilities and handling</td>
<td>Somewhat higher than manufacturer storage. The difference can be large for faster moving items.</td>
</tr>
<tr>
<td>Information</td>
<td>Simpler information compared to manufacturer storage.</td>
</tr>
<tr>
<td>Response time</td>
<td>Faster than manufacturer storage.</td>
</tr>
<tr>
<td>Product variety</td>
<td>Lower than manufacturer storage.</td>
</tr>
<tr>
<td>Product availability</td>
<td>Higher cost to provide the same level of availability as manufacturer storage.</td>
</tr>
<tr>
<td>Customer experience</td>
<td>Better than manufacturer storage with drop-shipping.</td>
</tr>
<tr>
<td>Order visibility</td>
<td>Faster than manufacturer storage.</td>
</tr>
<tr>
<td>Returnability</td>
<td>Faster than manufacturer storage.</td>
</tr>
</tbody>
</table>

**TABLE 4.4 Performance Characteristics of Distributor Storage with Last Mile Delivery**

<table>
<thead>
<tr>
<th>Cost Factor</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventory</td>
<td>Higher than distributor storage with package carrier delivery.</td>
</tr>
<tr>
<td>Transportation</td>
<td>Very high cost gives minimal scale economies. Higher than any other distribution option.</td>
</tr>
<tr>
<td>Facilities and handling</td>
<td>Facility costs higher than manufacturer storage or distributor storage with package carrier delivery, but lower than a chain of retail stores.</td>
</tr>
<tr>
<td>Information</td>
<td>Similar to distributor storage with package carrier delivery.</td>
</tr>
<tr>
<td>Service Factor</td>
<td>Performance</td>
</tr>
<tr>
<td>Response time</td>
<td>Very quick. Some day to next day delivery.</td>
</tr>
<tr>
<td>Product variety</td>
<td>Somewhat less than distributor storage with package carrier delivery, but larger than retail stores.</td>
</tr>
<tr>
<td>Product availability</td>
<td>More expensive to provide availability than any other option except retail stores.</td>
</tr>
<tr>
<td>Customer experience</td>
<td>Very good, particularly for bulky items.</td>
</tr>
<tr>
<td>Order traceability</td>
<td>Less of an issue and easier to implement than manufacturer storage or distributor storage with package carrier delivery.</td>
</tr>
<tr>
<td>Returnability</td>
<td>Faster to implement than other options. Faster and more expensive than a retail network.</td>
</tr>
</tbody>
</table>
What accounts for Wal-Mart’s remarkable success?

- In 1979, Kmart was the king of the retail industry with 1891 stores and average revenues per store of $7.25 million.
- At that time Wal-Mart was a small niche retailer in the South with only 229 stores and average revenues about half of those Kmart stores.
- Ten years later, Wal-Mart transformed itself; it has the highest sales per square foot, inventory turnover and operating profit of any discount retailer. Today Wal-Mart is the largest and highest performing retailer in the world.

The starting point was a relentless focus on suppliers and stores to guarantee that any order is processed and executed in a matter of hours, for Kmart.

Store trigger orders for products.

- Customer Flow
- Product Flow
- Information Flow

Characteristics of Cross-Docking:
- Goods spend at most 48 hours in the warehouse, avoiding inventory and handling costs.
- Wal-Mart delivers about 85% of its goods through its warehouse system, compared to about 50% for Kmart.
- Stores trigger orders for products.
- Very difficult to manage.
- Requires linking Wal-Mart’s distribution centers, suppliers and stores to guarantee that any order is processed and executed in a matter of hours.
- Wal-Mart operates a private satellite-communications system that sends point-of-sale data to all its vendors allowing them to have a clear vision of sales at the stores.
- Need a fast and responsive transportation system.
- Wal-Mart has a dedicated fleet of 2000 truck that serve their 19 warehouses.
- This allows them to replenish stores twice a week on average.

Questions to be answered:
- How many and where are the cross-docking points needed?
- Is cross-docking strategies better than traditional strategy?
- How should it be implemented?

Comparative Performance of Delivery Network Designs (Table 4.7)

<table>
<thead>
<tr>
<th>Retail Storage with Customer Pickup</th>
<th>Manufacturer Storage with Direct Shipping</th>
<th>Manufacturer Storage with In-Transit Storage</th>
<th>Distributor Storage with Package Carrier Delivery</th>
<th>Manufacturer Storage with Pick-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response Time</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Product Variety</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Product Availability</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Customer Experience</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Order Visibility</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Returnability</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Inventory</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Transportation</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Facility &amp; Handling</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Information</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

Linking Product Characteristics and Customer Preferences to Network Design

- Retail Storage with Customer Pickup
- Manufacturer Storage with Direct Shipping
- Manufacturer Storage with In-Transit Storage
- Distributor Storage with Package Carrier Delivery
- Manufacturer Storage with Pick-up

- High demand product
- Medium demand product
- Low demand product
- Very low demand product
- Many product sources
- High product value
- Quick demand response
- High product variety
- Low customer effort

- +2 +2 +2 +2 +2
- -2 -2 -2 -2 -2
- +1 +1 +1 +1 +1
- -1 -1 -1 -1 -1
- +0 +0 +0 +0 +0
- -3 -3 -3 -3 -3
- +4 +4 +4 +4 +4
- -2 -2 -2 -2 -2
Distribution Networks in Practice

- The key factors to be considered when designing the distribution network: customer needs to be met, and the cost of meeting these needs
- **The ownership structure** of the distribution network can have as big an impact as the type of physical flows in distribution network
- The choice of a distribution network has very long-term consequences
- Consider whether an exclusive distribution strategy is advantageous. A hybrid distribution network is often the optimal choice
- Product, price, commoditization, and criticality have an impact on the type of distribution system preferred by customers

Think Questions:

- What roles do distribution play in the supply chain?
- What are the key factors to be considered when designing the distribution network?
- What are the strengths and weaknesses of various distribution options?
- What types of distribution networks are typically best suited for commodity items? Why?
- What types of networks are best suited to highly differentiated products?
- What are some examples of very effective distribution networks?