7.1 Introduction

- Focus on the distribution function.
- Various possible distribution strategies, and the opportunities and challenges associated with these strategies.
- Two fundamental distribution strategies:
  - Items can be directly shipped from the supplier or manufacturer to the retail stores or end customer
  - Use intermediate inventory storage points (typically warehouses and/or distribution centers).
- Issues with warehouses
  - Manufacturing strategy (make-to-stock vs. make-to-order)
  - Number of warehouses
  - Inventory policy
  - Inventory turn over ratio
  - Internal warehouses vs. outside distributor
  - Owned by a single firm or by a variety of firms
7.2 Direct Shipment Distribution Strategies

● Advantages:
  ● The retailer avoids the expenses of operating a distribution center
  ● Lead times are reduced.

● Disadvantages:
  ● Risk-pooling effects are negated
  ● Manufacturer and distributor transportation costs increase

● Commonly used scenarios:
  ● Retail store requires fully loaded trucks
  ● Often mandated by powerful retailers
  ● Lead time is critical.
  ● Manufacturer may be reluctant but may have no choice
  ● Prevalent in the grocery industry
    ● lead times are critical because of perishable goods.
7.3. Intermediate Inventory Storage Point Strategies

- Variety of characteristics distinguish different strategies.
  - Length of time inventory is stored at warehouses and distribution centers.

Strategies:

- Traditional warehousing strategy
  - distribution centers and warehouses hold stock inventory
  - provide their downstream customers with inventory as needed.

- Cross-docking strategy
  - warehouses and distribution centers serve as transfer points for inventory
  - no inventory is held at these transfer points.

- Centralized pooling and transshipment strategies
  - may be useful when there is a large variety of different products
Traditional Warehousing

- Inventory management and risk pooling key factors
- Other factors also play a significant role
  - Centralized vs Decentralized Management
  - Central vs Local Facilities
Centralized vs Decentralized Management

- **Decentralized system**
  - Each facility identifies its most effective strategy without considering the impact on the other facilities in the supply chain.
  - Leads to local optimization.

- **Centralized system**
  - Decisions are made at a central location for the entire supply network.
  - Typical objective: minimize the total cost of the system subject to satisfying some service-level requirements.
  - Centralized control leads to global optimization.
  - At least as effective as the decentralized system.
  - Allow use of coordinated strategies

- If system cannot be centralized
  - Often helpful to form partnerships to approach the advantages of a centralized system.
Central vs. Local Facilities

- Centralized facilities
  - Employ both fewer warehouses and distribution centers
  - Facilities are located further from customers.

- Other factors:
  - **Safety stock.** Lower safety stock levels with centralized facilities
  - **Overhead.** Lower total overhead cost with centralized facilities
  - **Economies of scale.** Greater economies of scale with centralized facilities
  - **Lead time.** Lead time to market reduced with local facilities
  - **Service.**
    - Utilization of risk pooling better with centralized
    - Shipping times better with local
  - **Transportation costs.**
    - Costs between production facilities and warehouses higher with local
    - Costs from warehouses to retailers lesser with local
A Hybrid Decision

- Some products use centralized strategy while others use local strategy.
- Not an either or decision.
- Varying degrees of centralization and localization due to the varying levels of advantages and disadvantages.
Cross-Docking

- Popularized by Wal-Mart
- Warehouses function as inventory coordination points rather than as inventory storage points.
- Goods arriving at warehouses from the manufacturer:
  - are transferred to vehicles serving the retailers
  - are delivered to the retailers as rapidly as possible.
- Goods spend very little time in storage at the warehouse
  - Often less than 12 hours
  - Limits inventory costs and decreases lead times
Issues with Cross-Docking

- Require a significant start-up investment and are very difficult to manage
- Supply chain partners must be linked with advanced information systems for coordination
- A fast and responsive transportation system is necessary
- Forecasts are critical, necessitating the sharing of information.
- Effective only for large distribution systems
  - Sufficient volume every day to allow shipments of fully loaded trucks from the suppliers to the warehouses.
  - Sufficient demand at retail outlets to receive full truckload quantities
Inventory Pooling – GM Example

- 1,500 Cadillacs parked at a regional distribution center in Orlando
- Await delivery to dealers statewide within 24 hours
- 10% to 11% sales loss because a car is not available…
- Test program expected to:
  - improve customer service
  - boost sales of Cadillacs by 10%
Centralized Pooled Systems Perform Better

- For the same inventory level, a centralized system provides:
  - higher service level
  - higher sales
- Push-pull supply chain
  - Moving from a push supply chain
    - Dealers have to order before demand is realized
  - To a push-pull supply chain
    - Dealers pull from regional distribution centers.
- Implications:
  - End consumers will see better customer service
  - More cars are available to them.
Other Factors

- Will GM sell more cars to GM dealers?
  - Total number of cars ordered by dealers will not necessarily increase, even as customer service increases.

- What about the dealers?
  - Dealers have access to more inventory
    - Potentially can sell more.
  - Levels out the playing field between dealers.
    - Small dealers would favor such a system Competitive advantage of large dealers wiped out
Example of Inventory Pooling

- Two retailers face random demand for a single product.
- No differences between the retailers
- Compare two systems
  - centralized pooled system,
    - retailers together operate a joint inventory facility
    - take items out of the pooled inventory to meet demand.
  - decentralized system
    - each retailer individually orders from the manufacturer to meet demand.
- In both systems, inventory is owned by the retailers
The Two Systems

FIGURE 7-9: The centralized and decentralized systems

FIGURE 7-10: Probabilistic demand faced by each retailer
Other Data

- Wholesale price = $80 per unit
- Selling price = $125 per unit
- Salvage value = $20 per unit
- Production cost = $35 per unit
Costs and Profits in the Two Systems

- Decentralized system
  - Each dealer orders 12,000 units
  - Expected profit per dealer = $470,000, Total = $940,000
  - Expected sales = 11,340 units, Total = 22,680 units
  - Manufacturer profit = $1,080,000

- Centralized system
  - Two dealers together will order 26,000 units
  - Total expected profit = $1,009,392
  - Joint expected sales = 24,470 units
  - Manufacturer profit = $1,170,000
Customer Search

- If the customer arrives at a dealer and does not find the item
  - Switches to another dealer
  - Helps the manufacturer sell more products
- Which system is better under customer search?
  - No impact on the centralized system
Impact on Decentralized System

- If a dealer knows that its competitors do not keep enough inventory
  - this dealer should raise the inventory level to satisfy:
    - its own demand
    - demand of customers who initially approach other dealers with limited inventory.

- If a dealer knows that its competitors has significant inventory
  - this dealer will reduce the inventory level
  - It is not likely to see customers who switch

- Dealer’s strategy depends on its competitor’s strategy.

- Dealers may/may not know their competitor strategy
  - not clear how they decide on their inventory level.
  - not clear about the impact of search on the manufacturer
Nash Equilibrium (Game Theory)

- If two competitors are making decisions, they have reached Nash equilibrium if they have both made a decision
  - Both have decided on an amount to order
  - Neither can improve their expected profit by changing the order amount if the other dealer doesn’t change his order amount.
Example

- $\alpha =$ percentage of customers that search the system
- Each retailer can determine what their effective demand will be if the other retailer orders a specific amount.
- Based on this information, they can calculate how much they should order given any order by their competitors.
  - Best response
Best Response with $\alpha=90\%$

FIGURE 7-11 Retailers’ best response.

FIGURE 7-11: Retailers’ best response
Nash Equilibrium of the System

- Retailer one orders about 20,000 units, retailer two will respond by ordering about 12,000 units.
- If this is the case, then retailer one should modify its strategy and reduce the order quantity.
- No retailer has an incentive to modify its strategy.
- They order amounts associated with the intersection of the two curves.
- Optimal order quantity for each retailer = 13,900 units.
- Total expected profit for each retailer = $489,460.
- Total expected profit = $978,920.
- Total expected sales = 25,208.
- Total amount ordered from the manufacturer = 27,800.
- Manufacturer’s profit = $1,251,000.
Decentralized and Centralized Systems for Search Level of 90%

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Retailers</th>
<th>Manufacturer</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decentralized</td>
<td>978,920</td>
<td>1,251,000</td>
<td>2,229,920</td>
</tr>
<tr>
<td>Centralized</td>
<td>1,009,392</td>
<td>1,170,000</td>
<td>2,179,392</td>
</tr>
</tbody>
</table>

- Centralized system does not dominate the decentralized system.
- Retailers prefer the centralized system.
- Manufacturer’s profit is higher in the decentralized system.
As $\alpha$ Increases

- Each retailer’s order quantity and profit increases.
- Retailers’ total expected profit will be higher in the centralized pooling system than in the decentralized system.
As $\alpha$ Increases

- With larger $\alpha$
  - retailers will order more in a decentralized system
  - manufacturer will prefer a decentralized system
  - retailers will prefer a centralized system

- With smaller $\alpha$
  - manufacturer will order less in a decentralized system
  - both the retailers and the manufacturer will prefer a centralized pooling system.
Effect of $\alpha$ on Amounts Ordered

FIGURE 7-12: Amount ordered by dealers as a function of the search level
Critical Search Level

- Presence of a critical search level
  - manufacturer prefers the centralized system below the level
  - otherwise, manufacturer prefers the decentralized system.
- Manufacturer always prefers a higher search level
How Can the Search Level Be Increased?

- Increase brand loyalty
  - customers will more likely search for a particular brand at another retailer if their first choice does not have the product in inventory.

- Information technology initiatives to increase communication between retailers
  - increases the ease with which customers can search in the system
  - higher likelihood that customers will search in the system
Transshipment

- Shipment of items between different facilities *at the same level in the supply chain* to meet some immediate need
- Occurs mostly at the retail level
- Can be achieved:
  - with advanced information systems
  - Shipping costs are reasonable
  - Retailers have same owner
Retailers with Different Owners

- May not want to do transshipments
- Distributor Integration strategies may be adopted
- Not clear regarding inventory levels
  - A retailer’s strategy depends on competitors’ strategies
Which Strategy to Adopt?

- Different approaches for different products
- Factors:
  - Customer demand and location
  - Service level
  - Costs => transportation & inventory costs
  - Demand Variability
## Summary of the Distribution Strategies

<table>
<thead>
<tr>
<th>Strategy → Attribute ↓</th>
<th>Direct shipment</th>
<th>Cross-docking</th>
<th>Inventory at warehouses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk pooling</td>
<td></td>
<td></td>
<td>Take advantage</td>
</tr>
<tr>
<td>Transportation costs</td>
<td></td>
<td>Reduced inbound costs</td>
<td>Reduced inbound costs</td>
</tr>
<tr>
<td>Holding costs</td>
<td>No warehouse cost</td>
<td>No holding costs</td>
<td></td>
</tr>
<tr>
<td>Allocation</td>
<td></td>
<td>Delayed</td>
<td>Delayed</td>
</tr>
</tbody>
</table>
Summary

- Critical to implement effective distribution strategies regardless of the total level of supply chain integration.

- Strategies:
  - direct shipping
  - warehouses or distribution centers

- Related decisions
  - Should there be many or only a few warehouses or DC’s?
  - Should inventory be held at these locations, or transshipped?
  - As a retailer, does it make sense to participate in a centralized inventory pooling system?
  - What about a transshipment system?