Supply Chain Management

Learning Objectives

- Understand Concepts and Issues in Supply Chain Management
  - Supply chain and supply chain management
  - Bullwhip effect
  - Vendor managed inventory
  - Inventory turnover and weeks of supply
  - The uncertainty framework for choosing right supply chain
  - Outsourcing
  - Product/process postponement

What Is Supply Chain & Supply Chain Management?

- Supply Chain
  - A network of interrelated facilities and activities that create and deliver products and services to end customers

- Supply Chain Management (SCM)
  - A total system approach to managing the entire flow of information, materials, and services from raw-material suppliers through factories and warehouses to the end customer
Supply Chain Illustration

The Supply Chain Flows

Two Perspectives on SCM

- Old (Zero-sum game)
  - Adversarial
  - I-win-you-lose approach
  - Short term is the only term
- New (Win-win game)
  - Cooperative
  - Size of the "pie" increases
  - Both short and long term is important
**Example**

**A Sunglass Supply Chain**

Zanta is an upscale sunglass maker that sells through one of its retailers, UV. Consider Zanta’s entry level sunglass for the coming season, UV purchases from Zanta for $75 each and retails for $115. Zanta’s production and shipping cost per pair is $35. At the end of the season, UV usually needs to offer deep discount ($25) to sell remaining inventory. UV believes that the demand can be represented by a normal distribution with a mean of 250 and a standard deviation of 125.

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**The Sunglass Supply Chain**

**UV’s Best Order Quantity**

Using the single period inventory model,

\[ C_u = \$115 - \$75 = \$40 \text{ and } C_o = \$75 - \$25 = \$50 \]

\[ \frac{C_u}{C_u+C_o} = \frac{40}{40+50} = 0.4444, \]

UV orders \( q = 250 + z_{0.64}(125) = 250 + (-0.15)(125) \approx 232 \)

Why is UV’s order quantity even less than average demand?

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**SC’s Best Order Quantity**

Again using the single period inventory model,

\[ C_u = \$115 - \$35 = \$80 \text{ and } C_o = \$35 - \$25 = \$10 \]

\[ \frac{C_u}{C_u+C_o} = \frac{80}{80+10} = 0.8889, \]

The whole supply chain’s best order quantity

\[ q = 250 + z_{0.89}(125) = 250 + 1.25(125) \approx 406 \]
Information Distortion in Supply Chain

The Bullwhip Effect

- Customer’s Demand to Retailers
- Retailer’s Orders to Wholesalers
- Wholesaler’s Orders to Manufacturers
- Manufacturer’s Orders to Suppliers

Bullwhip Effect: The increasing variability in demand orders from downstream customers to upstream suppliers

The Bullwhip Effect Example

The Diaper Case

- Factory
- Distributor
- Wholesaler
- Retailer
- Customer

The Bullwhip Effect Example

Campbell Soup

Bullwhip Effect due to Seasonal Sales of Soup
Bullwhip Effect

Consequences

- Inefficiency and/or irresponsiveness in the supply chain operations
  - Excessive inventory
  - Poor demand forecasts
  - Insufficient or excessive capacities
  - Poor customer services

Bullwhip Effect

General Causes

- Uncertainty at every stage of supply chain

- Lack of information sharing and coordination among supply chain members

Causes of the Bullwhip Effect:

1. Demand Forecast Updating

- Every company in a supply chain usually makes product forecasting for its production planning, inventory control etc.
- Forecasting is often done myopically based on the order history from the company’s immediate customers.
Consider a retailer that orders once a month from its supplier. The supplier faces a highly erratic stream of orders. There is a spike in demand at one time during the month, followed by no demands for the rest of the month.

**Causes of the Bullwhip Effect:**

2. **Order Batching**

![Diagram of orders received] (April 1: 1 order, May 1: 1 order, June 1: 1 order)

Suppliers may see a spike in demand at one time during the month, followed by no demands for the rest of the month.

**Causes of the Bullwhip Effect:**

3. **Price Fluctuation**

**What Happens:**
- Supplier offers a sales promotion (temporary discount)
- Buyers purchase more than they need
- Buyer’s inventory goes up, supplier may get backlogged
- Supplier ends promotion
- Buyer orders less because they have larger inventory

**Causes of the Bullwhip Effect:**

3. **Price Fluctuation (cont.)**

- It was estimated that 80 percent of the transactions between distributors and manufacturers in the grocery industry are made in a *forward buy* arrangement
  - A forward buy is one in which items are bought in advance of requirements, usually because of a manufacturer’s attractive price offer
  - With price fluctuations, customers buy in quantities that do not reflect their immediate needs:
    - They buy in larger quantities and stock up when price is low
    - They postpone purchases when price is regular or high
Causes of The Bullwhip Effect:

4. Rationing & Shortage Gaming

- When a product's anticipated demand exceeds supply, manufacturer may ration its products and retailers tend to order more just in case that they may not be able to get enough later on

- Consider the following example:
  1. Normally you order 100 cases of soda per week, but on Memorial Day you order 200. Due to shortage, the wholesaler only ships you 150.
  2. You want to get 200 cases for July 4 weekend. How many do you order?
  3. How do you respond when the excess finally arrives?

Reading:

Veggies Tales

1. What are the major challenges facing a food supply chain? What are differences between a food supply chain and a fashion supply chain?
2. Facing challenges in the food supply chain, what current practices do you know or ideas do you have that can help improve its performances?
3. Managing inventory is critical in supply chain management. How does the location and amount of inventory affect costs in a supply chain?

Counteract the Bullwhip Effect

<table>
<thead>
<tr>
<th>Cause of Bullwhip</th>
<th>Approaches</th>
</tr>
</thead>
</table>
| 1. Demand Forecasts Updating | - Use of point-of-sale (POS) data  
- Electronic data interchange (EDI)  
- Vendor-managed inventory  
- Collaborative forecasting (CPFR)  |
| 2. Order Batching | - Use of EDI (to reduce ordering costs)  
- Logistics outsourcing  |
| 3. Price Fluctuations | - Every day low price (EDLP)  |
| 4. Shortage Gaming | - Sharing sales and inventory data  
- Allocation based on past sales  |
Improve Supply Chain Performance

- Information and knowledge Sharing
- Coordination and Integration
- Right Supply Chain Choice
- Outsourcing
- Product/Process Postponement

Information Sharing

- Importance of Sharing Information
  - Critical to supply chain success
  - The key to reduce/eliminate the bullwhip effect
  - The enabler for supply chain integration and coordination
- Share information intensively but selectively
  - Use rigid formats for sharing information
  - Share formation in a structured fashion
  - Insist on accurate data collection
  - Sales, forecasts, capacity, inventory, and planning data are typically shared

Effective Information Sharing

- From paper-based to paperless
  - e-mail
  - Bar codes
  - RFID
  - Shared database
  - Internet and WWW
  - Electronic data interchange (EDI)
Coordination and Integration

- Trust
- Communication
- Shared performance measures
- Risk and reward sharing

Example: Vendor Managed Inventory (VMI)

Vendor Managed Inventory

- Other names
  - Continuous replenishment Planning (CRP)
  - Supplier Managed Inventory (SMI)
- The supplier is responsible for maintaining the customer’s inventory management. The supplier has access to the customer’s inventory data and is responsible for determining order amounts and timing

VMI Examples

In Factory

At retail store
**VMI - Advantages**

- better forecasts (POS)
- lower inventory
- less errors in orders placed
- leveling of production capacity
- Full truck load
- Efficient route planning
- less stock-out
- lower inventory
- better service level
- lower planning & ordering costs

**Supply Chain Performance Measures**

<table>
<thead>
<tr>
<th>Costs</th>
<th>Total supply chain costs</th>
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</thead>
<tbody>
<tr>
<td>Customer satisfaction / Service Quality</td>
<td>Perfect order fulfillment, Customer satisfaction, Product quality</td>
</tr>
<tr>
<td>Time</td>
<td>Order fulfillment lead time, Supply chain response time, Source/make cycle time</td>
</tr>
<tr>
<td>Profitability/Assets Usage</td>
<td>Return on total supply chain assets, Net operating profit after tax, Cash-to-cash cycle time, Inventory turnover/Days of supply, Capacity utilization</td>
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</tbody>
</table>

**Inventory Related Measures**

- **Inventory Turnover**
  \[ \text{Inventory Turnover} = \frac{\text{Cost of goods sold}}{\text{Average aggregate inventory value}} \]

- **Weeks of Supply**
  \[ \text{Weeks of Supply} = \frac{\text{Average aggregate inventory value}}{\text{Cost of goods sold}} \times 52 \]
Inventory Turnover Example

Suppose a company's new annual report claims their costs of goods sold for the year is $160 million and their total average inventory (production materials + work-in-process) is worth $35 million. This company normally has an inventory turn ratio of 10. What is this year's inventory turnover ratio? What does it mean?

Solution: Inventory Turnover = Cost of goods sold/ Avg inventory value

= $160/35

= 4.57

Since the company's normal inventory turnover ratio is 10, a drop to 4.57 means that the inventory is not turning over as quickly as it had in the past. Without knowing the industry average of turns for this company it is not possible to comment on how they are competitively doing in the industry, but they now have more inventory relative to their cost of goods sold than before.

Choosing the Right Supply Chain Strategy

Demand and Supply Uncertainty Characteristics

<table>
<thead>
<tr>
<th>Demand Characteristics</th>
<th>Supply Characteristics</th>
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</thead>
<tbody>
<tr>
<td>Functional</td>
<td>Innovative</td>
</tr>
<tr>
<td>Low demand uncertainty</td>
<td>High demand uncertainty</td>
</tr>
<tr>
<td>Non-predictable demand</td>
<td>Difficult to forecast</td>
</tr>
<tr>
<td>Long product life</td>
<td>Short selling season</td>
</tr>
<tr>
<td>Low inventory cost</td>
<td>High inventory cost</td>
</tr>
<tr>
<td>Low profit margin</td>
<td>High profit margin</td>
</tr>
<tr>
<td>High product variety</td>
<td>High product variety</td>
</tr>
<tr>
<td>High volume</td>
<td>Low volume</td>
</tr>
<tr>
<td>Low stockout cost</td>
<td>High stockout cost</td>
</tr>
<tr>
<td>Low obsolescence</td>
<td>High obsolescence</td>
</tr>
<tr>
<td>Stable</td>
<td>Evolving</td>
</tr>
<tr>
<td>Low demand uncertainty</td>
<td>High demand uncertainty</td>
</tr>
<tr>
<td>Stable and higher yields</td>
<td>Instable and lower yields</td>
</tr>
<tr>
<td>Fewer quality problems</td>
<td>Potential quality problems</td>
</tr>
<tr>
<td>Most supply sources</td>
<td>Limited supply sources</td>
</tr>
<tr>
<td>Reliable suppliers</td>
<td>Unreliable suppliers</td>
</tr>
<tr>
<td>Predictable changes</td>
<td>Unpredictable changes</td>
</tr>
<tr>
<td>Lower capacity constraint</td>
<td>Potential capacity maintained</td>
</tr>
<tr>
<td>Easier to change over</td>
<td>Difficult to change over</td>
</tr>
<tr>
<td>Dependable lead times</td>
<td>Variable lead time</td>
</tr>
</tbody>
</table>

Choosing the Right Supply Chain Strategy

The Uncertainty Framework

<table>
<thead>
<tr>
<th>Demand Uncertainty</th>
<th>Supply Uncertainty</th>
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<tbody>
<tr>
<td>Low (Functional Products)</td>
<td>Low (Stable Process)</td>
</tr>
<tr>
<td>Efficient Supply Chains (Ex. Basic food, apparel, oil and gas)</td>
<td></td>
</tr>
<tr>
<td>Responsive Supply Chains (Ex. Fashion apparel, computer, pop music)</td>
<td></td>
</tr>
<tr>
<td>High (Innovative Products)</td>
<td>High (Evolving Process)</td>
</tr>
<tr>
<td>Risk-Hedging Supply Chains (Ex. Hydroelectric power)</td>
<td></td>
</tr>
<tr>
<td>Agile Supply Chains (Ex. Telecom, high-end computer, semiconductor)</td>
<td></td>
</tr>
</tbody>
</table>
Choosing the Right Supply Chain Strategy

Four Supply Chain Strategies

- **Efficient supply chains**: utilize strategies aimed at creating the highest cost efficiency
- **Risk-hedging supply chains**: utilize strategies aimed at pooling and sharing resources in a supply chain to share risk
- **Responsive supply chains**: utilize strategies aimed at being responsive and flexible
- **Agile supply chains**: utilize strategies aimed at being responsive and flexible to customer needs

Outsourcing for Risk Sharing

- **Outsourcing**: the act of moving some of a firm’s internal activities and decision responsibility to outside providers
- It allows companies to focus on their core competencies while reducing cost and risk

Outsourcing Factors to Consider

- Core competency
- Cost
- Capacity
- Quality
- Speed
- Reliability
- Expertise
Postponement for Mass Customization

- **Postponement**: postponing the point of product differentiation in a supply chain until some actual order information is gathered
- The goal of postponement is to enable highly flexible response to changes in product mix by developing configurable (or generic) products that can be differentiated quickly and inexpensively
- Requires fast information transfer and reaction

Case: Pepe Jeans

- Discuss the pros and cons of Pepe Jean’s current business practice of not carrying inventory in UK and the six-month order lead time?
- As the manager of Pepe Jean, how do you respond to the recent independent retailers’ complaints?
- The case lists two possible alternatives to reduce lead time, i.e., (1) to work with the Hong Kong sourcing agent and (2) to build a finishing operation in UK. Which one is better? Why?

Pepe Jeans

- High quality and priced jeans
- Use independent retailers in the UK
- Six month lead-time – sourced from Hong Kong
- By postponing the finishing of the jeans they can reduce the lead time to six weeks
- It would require an increase in investment both in inventory and equipment
An Introduction to Radio Frequency IDentification (RFID)

Bar Codes

- The machine-readable representation of the Universal Product Code (UPC)
- UPC is a unique 12-digit number assigned to retail merchandise that identifies both the product and the vendor that sells the product
- The first six digits identifies the vendor. The next five digits are the product’s unique reference number. The last number is called the check digit that is used to verify that the UPC for that specific product is correct

RFID

A major technology for tracking goods and assets around the world --- from the point of manufacturing through to the retail point-of-sale.
Some Applications

- Manufacturing, logistics and material handling (e.g., Pharmaceutical companies can use RFID to ensure medicines are put into correctly labored packages.)
- Inventory tracking and management
- Safety and security
- Cashless payment
- Customer service

Passports
The new U.S. e-Passport is easier to scan and tougher to forge

Pets
Implanted chips help keep track of stray animals

Humans
In people, RFID chips could be used to store medical records

Containers
RFID monitors the movement of shipping containers

Books
Librarians use RFID to locate lost and misplaced volumes

Tires
Embedding RFID tags in tires allows makers to find them in case of recalls

Credit cards
You can buy without swiping—but there are security risks

How Does RFID Work?

- An RFID tag is a microchip combined with an antenna which holds an electronic product code (EPC) number that points to additional data detailing the contents of the package.
- RFID uses low-power radio signals to exchange data wirelessly between chips and readers/encoders.
- RFID is fast, reliable, and does not require physical sight or contact between reader/scanner and the tagged item
How Does RFID Work?

- **RFID tags**
  - **Active**
    - Tag transmits radio signal
    - Battery powered memory, radio & circuitry
    - High Read Range (300 feet)
  - **Passive**
    - Tag reflects radio signal from reader
    - Reader powered
    - Short Read Range (4 inches - 15 feet)

- **RFID reader**
  - Handheld terminals
  - Fixed and positioned at strategic points

How Does RFID Work?

**Transmitting ePC Codes**

- Soda Can - Transmits ePC code from embedded “smart tag” on side of can
- Reader - Could be found in shelving, appliances, etc
- Internet - Translates ePC code into useful information

Benefits of RFID-Consumers

- Convenience
Benefits of RFID-Retailers

- Efficiency in Inventory
- Eliminate Overstocking

Benefits of RFID-Supply Chain Automation

- Computers will be able to 'see' physical objects, increasing the visibility of the supply chain and allowing manufacturers and retailers to be able to track and trace items automatically throughout the SC. This technology will revolutionize the way that products are manufactured, transported, stored, and purchased.