Supply Chain Configurations

Penn State Cellulosic Supply Chain Short Course

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Session Objectives

- Review the basics of supply chain management
- Examine cellulosic supply chains and strategies
- Understand the roles of logistics cost tradeoffs in supply chain configuration
- Discuss examples of cellulosic supply chain configurations
Integrated Supply Chain

SCM is the art and science of integrating the flows of products, information and financials through the entire supply pipeline from the supplier’s supplier to the customer’s customer.

Supply Chain Network

Source: John J. Coyle, Center for Supply Chain Research Presentation
Demand and supply uncertainties affect how the supply chain should be devised.

Supply Chain Uncertainties

**Demand Uncertainty**

**FUNCTIONAL**
- Low demand uncertainties
- Stable, more predictable
- Long product life
- Low inventory cost
- Low profit margins
- Low product variety
- Low stockout cost
- Low obsolescence

**INNOVATIVE**
- High demand uncertainties
- Variable, difficult to forecast
- Short selling season
- High inventory cost
- High profit margins
- High product variety
- High stockout cost
- High obsolescence

**Supply Uncertainty**

**STABLE**
- Less breakdowns
- Stable & higher yields
- Less quality problems
- More supply sources
- Reliable suppliers
- Less process changes
- Less capacity constraint
- Dependable lead time

**EVOLVING**
- Vulnerable to breakdowns
- Variable & lower yields
- Potential quality problems
- Limited supply sources
- Less reliable suppliers
- More process changes
- Potential capacity constrained
- Variable lead time

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Aligning Supply Chains with Product and Supply Uncertainties

**DEMAND UNCERTAINTY**

**Low (Functional Products)**
- **EFFICIENT**
  - Examples: Grocery, basic apparel, food, oil and gas

**High (Innovative Products)**
- **RESPONSIVE**
  - Examples: Fashion apparel, computers

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**SUPPLY UNCERTAINTY**

**Low (Stable)**
- **RISK-HEDGING**
  - Examples: Hydro-electric power, some food produce

**High (Evolving)**
- **AGILE**
  - Examples: Telecom, high-end computers

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“At macro level, cellulosic supply chain is straightforward. Complexity, however, is in the supply/inbound side of the chain.”
Aligning Supply Chains with Product and Supply Uncertainties

DEMAND UNCERTAINTY
Low (Functional Products)  High (Innovative Products)

EFFICIENT  RESPONSIVE

RISK-HEDGING
Cellulosic Supply Chains

AGILE

Risk-Hedging Cellulosic Supply Chains

Risk-hedging strategies

- Inventory pools
- Lead time reduction
- Process flexibility
- Multiple supply bases
- Alternative supply resources
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Factors Affecting Logistics Costs

- Order cycle time
- Weight density
- Physical form
- Product value
- Tapering rate principle
- Susceptible to loss & damage
- Number of warehouses

Source: Coyle et al. 2008, Supply Chain Management: A Logistics Perspective
Order Cycle Time (OCT)

Order cycle time (OCT) can be defined as the time that elapses from when a customer places an order until the order is received.

OCT length and variability influence product availability and customer inventories.

Order Cycle Length & Variability

<table>
<thead>
<tr>
<th>Order cycle components</th>
<th>Supplier A</th>
<th>Supplier B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order placement</td>
<td><img src="#" alt="Graph" /></td>
<td><img src="#" alt="Graph" /></td>
</tr>
<tr>
<td>Order processing</td>
<td><img src="#" alt="Graph" /></td>
<td><img src="#" alt="Graph" /></td>
</tr>
<tr>
<td>Order preparation</td>
<td><img src="#" alt="Graph" /></td>
<td><img src="#" alt="Graph" /></td>
</tr>
<tr>
<td>Order shipment</td>
<td><img src="#" alt="Graph" /></td>
<td><img src="#" alt="Graph" /></td>
</tr>
<tr>
<td>Total order cycle</td>
<td>Average: 13 days, Range: 4 to 22 days</td>
<td>Average: 11 days, Range: 6 to 16 days</td>
</tr>
</tbody>
</table>

Source: Coyle et al. 2008, Supply Chain Management: A Logistics Perspective
OCT as a Competitive Factor

- The longer OCT usually requires higher customer inventories.
- Variability of OCT affects customer safety stock inventory levels and stockout costs.

“Shorter and more consistent OCT could be as important as a reduction in prices of biomass feedstock itself.”

Weight Density & Logistics Costs

Source: Coyle et al. 2008, Supply Chain Management: A Logistics Perspective
Product Value & Logistics Cost

Dollar Value of Product

- Transportation cost
- Inventory cost
- Packaging cost

Transportation rates increase with, but not in direct proportion to, distance.

Source: Coyle et al. 2008, Supply Chain Management: A Logistics Perspective
Transport Mode & Logistics Costs: Truck vs. Rail Example

Shifting the mode of transportation from rail to motor results in:

- Fast and more reliable transit times
- Better accessibility
- Lower inventory costs
- Higher motor carrier prices

In this case, the lower inventory costs and faster and more reliable transit times more than offset the higher transportation price of the motor carrier.

<table>
<thead>
<tr>
<th>Logistics Cost Centers</th>
<th>Rail ($ per unit)</th>
<th>Motor ($ per unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation</td>
<td>3.00</td>
<td>4.30</td>
</tr>
<tr>
<td>Inventory</td>
<td>5.00</td>
<td>3.75</td>
</tr>
<tr>
<td>Packaging</td>
<td>3.50</td>
<td>3.20</td>
</tr>
<tr>
<td>Warehousing</td>
<td>1.50</td>
<td>0.75</td>
</tr>
<tr>
<td>Cost of lost sales</td>
<td>2.00</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Total logistics cost</strong></td>
<td><strong>15.00</strong></td>
<td><strong>13.00</strong></td>
</tr>
</tbody>
</table>

*Source: Coyle et al. 2008, Supply Chain Management: A Logistics Perspective*
Number of Warehouses & Logistics Cost

Source: Coyle et al. 2008, Supply Chain Management: A Logistics Perspective

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Discuss examples of cellulosic supply chain configurations
Advanced-uniform feedstock supply system uses Deployable Process Development Unit (PDU) for on-farm physical processing.

PDU is a modular and reconfigurable biomass feedstock preprocessing system, consisting of decomposition, grinding, drying, and densification modules.

Modules are portable, allowing for deployment in any location with adequate space and available utilities.

Deployable Process Development Unit (PDU) approximates one replicable biomass depot.
Regional Biomass Preprocessing Centers (Carolan et al. 2007)

Regional biomass preprocessing centers (RBPC) are conceptualized as:

- Relatively large, intermediate, geographically distributed facilities
- Involve both physical transformation and chemical pre-treatment
- Capable of pre-treating and converting a variety of biomass into appropriate feedstocks for a variety of final products such as fuels, chemicals, electricity, and animal feeds
Wood processors such as pulp and paper manufacturers are in a position to provide supplies of wood chips and wood waste that a cellulosic ethanol plant may need:

- Local access to abundant untapped sources of wood waste that could be used to produce cellulosic biofuels
- Infrastructure needed for on site preprocessing, storage, and handling of wood waste
Supply Chain Configuration Consideration Factors

- **Supply risk hedging potentials**
  - Inventory pooling
  - Multiple supply bases

- **Supply flexibilities**
  - Feedstock transshipment
  - Lead time

- **Resource sharing potentials**
  - Costs of storage
  - Costs of pre-processing

- **Total logistics costs**
  - Economies of scale and scope
  - Biomass contract transaction cost

Key Takeaways

- Logistics is a critical part of supply chain management.
- Logistics systems are frequently analyzed from a system approach, emphasizing total cost and tradeoffs.
- The cost of logistics systems can be affected by a number of major factors, including competition in the market, the spatial relationship, and product characteristics.
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