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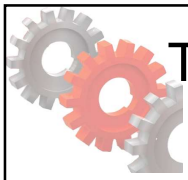
Transportation in a Supply Chain

PowerPoint presentation to accompany
Chopra and Meindl Supply Chain Management, 5e

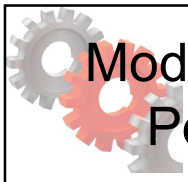
Learning Objectives

1. Understand the role of transportation in a supply chain
2. Evaluate the strengths and weaknesses of different modes of transportation
3. Discuss the role of infrastructure and policies in transportation
4. Identify the relative strengths and weaknesses of various transportation network design options
5. Identify trade-offs that shippers need to consider when designing a transportation network



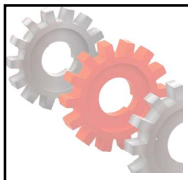
The Role of Transportation in a Supply Chain

- Movement of product from one location to another
- Products rarely produced and consumed in the same location
- Significant cost component
- Shipper requires the movement of the product
- Carrier moves or transports the product



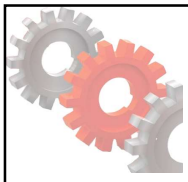
Modes of Transportation and their Performance Characteristics

- Air
- Package carriers
- Truck
- Rail
- Water
- Pipeline
- Intermodal



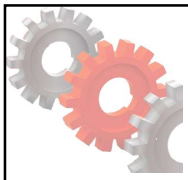
Air

- Cost components
  - Fixed infrastructure and equipment
  - Labor and fuel
  - Variable – passenger/cargo
- Key issues
  - Location/number of hubs
  - Fleet assignment
  - Maintenance schedules
  - Crew scheduling
  - Prices and availability



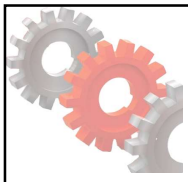
Package Carriers

- Small packages up to about 70 kg
- Expensive
- Rapid and reliable delivery
- Small and time-sensitive shipments
- Provide other value-added services
- Consolidation of shipments a key factor



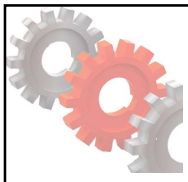
Truck

- Significant fraction of the goods moved
- Truckload (TL)
  - Low fixed cost
  - Imbalance between flows
- Less than truckload (LTL)
  - Small lots
  - Hub and spoke system
  - May take longer than TL



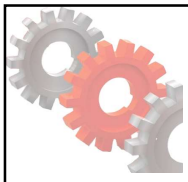
Rail

- Move commodities over large distances
- High fixed costs in equipment and facilities
- Scheduled to maximize utilization
- Transportation time can be long
  - Trains ‘built’ not scheduled



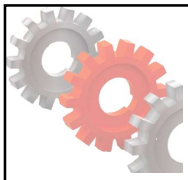
Water

- Limited to certain geographic areas
- Ocean, inland waterway system, coastal waters
- Very large loads at very low cost
- Slowest
- Dominant in global trade
- Containers



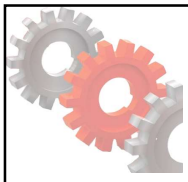
Pipeline

- High fixed cost
- Primarily for crude petroleum, refined petroleum products, natural gas
- Best for large and stable flows
- Pricing structure encourages use for predictable component of demand



Intermodal

- Use of more than one mode of transportation to move a shipment
- Grown considerably with increased use of containers
- May be the only option for global trade
- More convenient for shippers – one entity
- Key issue – exchange of information to facilitate transfer between different modes



Design Options for a Transportation Network

- When designing a transportation network
  1. Should transportation be direct or through an intermediate site?
  2. Should the intermediate site stock product or only serve as a cross-docking location?
  3. Should each delivery route supply a single destination or multiple destinations (milk run)?

Direct Shipment Network to Single Destination

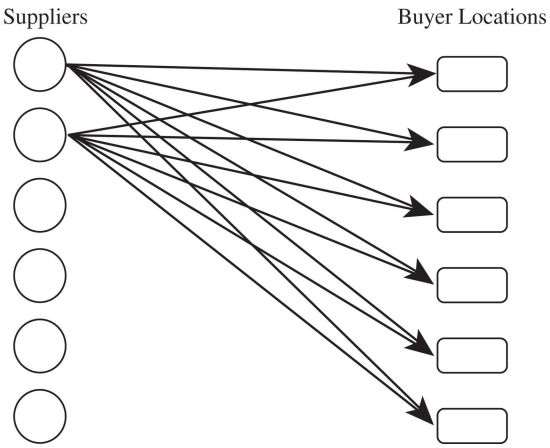


Figure 14-2

Direct Shipping with Milk Runs

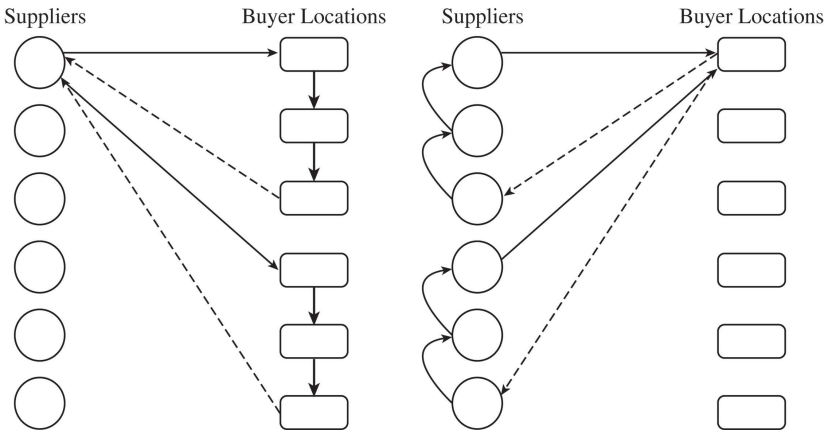


Figure 14-3

All Shipments via Intermediate Distribution Center with Storage

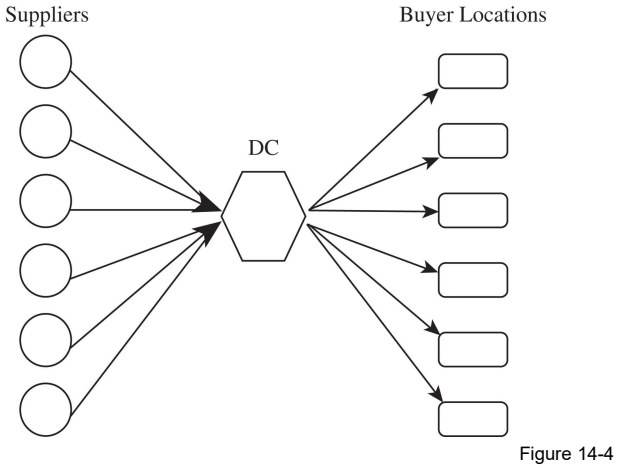


Figure 14-4

All Shipments via Intermediate Transit Point with Cross-Docking

- Suppliers send their shipments to an intermediate transit point
- They are cross-docked and sent to buyer locations without storing them

Shipping via DC Using Milk Runs

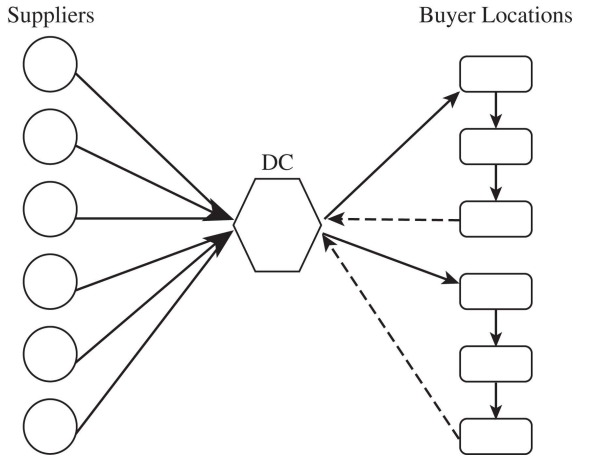


Figure 14-5

Tailored Network

Network Structure	Pros	Cons
Direct shipping	No intermediate warehouse Simple to coordinate	High inventories (due to large lot size) Significant receiving expense
Direct shipping with milk runs	Lower transportation costs for small lots Lower inventories	Increased coordination complexity
All shipments via central DC with inventory storage	Lower inbound transportation cost through consolidation	Increased inventory cost Increased handling at DC
All shipments via central DC with cross-dock	Low inventory requirement Lower transportation cost through consolidation	Increased coordination complexity
Shipping via DC using milk runs	Lower outbound transportation cost for small lots	Further increase in coordination complexity
Tailored network	Transportation choice best matches needs of individual product and store	Highest coordination complexity

Table 14-2

Selecting a Transportation Network

- Eight stores, four supply sources
- Truck capacity = 40,000 units
- Cost $1,000 per load, $100 per delivery
- Holding cost = $0.20/year

Selecting a Transportation Network

Annual sales = 960,000/store Direct shipping

Batch size shipped from each supplier to each store = 40,000 units

Number of shipments/yr from each supplier to each store = 960,000/40,000 = 24

Annual trucking cost for direct network = 24 x 1,100 x 4 x 8 = $844,800

Average inventory at each store for each product = 40,000/2 = 20,000 units

Annual inventory cost for direct network = 20,000 x 0.2 x 4 x 8 = $128,000

Total annual cost of direct network = $844,800 + $128,000 = $972,800

Selecting a Transportation Network

Annual sales = 960,000/store Milk runs

Batch size shipped from each supplier to each store	= 40,000/2 = 20,000 units
Number of shipments/yr from each supplier to each store	= 960,000/20,000 = 48
Transportation cost per shipment per store (two stores/truck)	= 1,000/2 + 100 = $600
Annual trucking cost for direct network	= 48 x 600 x 4 x 8 = $921,600
Average inventory at each store for each product	= 20,000/2 = 10,000 units
Annual inventory cost for direct network	= 10,000 x 0.2 x 4 x 8 = $64,000
Total annual cost of direct network	= $921,600 + $64,000 = $985,600

Selecting a Transportation Network

Annual sales = 120,000/store Direct shipping

Batch size shipped from each supplier to each store	= 40,000 units
Number of shipments/yr from each supplier to each store	= 120,000/40,000 = 3
Annual trucking cost for direct network	= 3 x 1,100 x 4 x 8 = $105,600
Average inventory at each store for each product	= 40,000/2 = 20,000 units
Annual inventory cost for direct network	= 20,000 x 0.2 x 4 x 8 = $128,000
Total annual cost of direct network	= $105,600 + $128,000 = $233,600

Selecting a Transportation Network

	Annual sales = 120,000/store Milk runs
Batch size shipped from each supplier to each store	= 40,000/4 = 10,000 units
Number of shipments/yr from each supplier to each store	= 120,000/10,000 = 12
Transportation cost per shipment per store (two stores/truck)	= 1,000/4 + 100 = $350
Annual trucking cost for direct network	= 12 x 350 x 4 x 8 = $134,400
Average inventory at each store for each product	= 10,000/2 = 5,000 units
Annual inventory cost for direct network	= 5,000 x 0.2 x 4 x 8 = $32,000
Total annual cost of direct network	= $134,400 + $32,000 = $166,400

Trade-offs in Transportation Design

- Transportation and inventory cost trade-off
  - Choice of transportation mode
  - Inventory aggregation
- Transportation cost and responsiveness trade-off

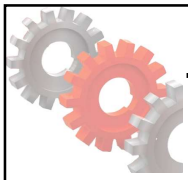
Trade-offs in Transportation Design

Mode	Cycle Inventory	Safety Inventory	In-Transit Cost	Transportation Time	Transportation Cost
Rail	5	5	5	2	5
TL	4	4	4	3	3
LTL	3	3	3	4	4
Package	1	1	1	6	1
Air	2	2	2	5	2
Water	6	6	6	1	6

Table 14-3

Tailored Transportation

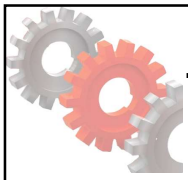
- The use of different transportation networks and modes based on customer and product characteristics
- Factors affecting tailoring
  - Customer density and distance
  - Customer size
  - Product demand and value



Tailored Transportation

	Short Distance	Medium Distance	Long Distance
High density	Private fleet with milk runs	Cross-dock with milk runs	Cross-dock with milk runs
Medium density	Third-party milk runs	LTL carrier	LTL or package carrier
Low density	Third-party milk runs or LTL carrier	LTL or package carrier	Package carrier

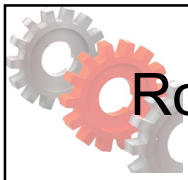
Table 14-10



Tailored Transportation

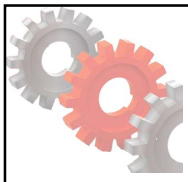
Product Type	High Value	Low Value
High demand	Disaggregate cycle inventory. Aggregate safety inventory. Inexpensive mode of transportation for replenishing cycle inventory and fast mode when using safety inventory.	Disaggregate all inventories and use inexpensive mode of transportation for replenishment.
Low demand	Aggregate all inventories. If needed, use fast mode of transportation for filling customer orders.	Aggregate only safety inventory. Use inexpensive mode of transportation for replenishing cycle inventory.

Table 14-11



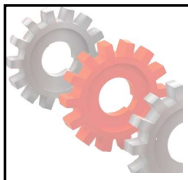
Role of IT in Transportation

- The complexity of transportation decisions demands use of IT systems
- IT software can assist in:
  - Identification of optimal routes by minimizing costs subject to delivery constraints
  - Optimal fleet utilization
  - GPS applications



Risk Management in Transportation

- Three main risks to be considered in transportation are
  1. Risk that the shipment is delayed
  2. Risk of disruptions
  3. Risk of hazardous material
- Risk mitigation strategies
  - Decrease the probability of disruptions
  - Alternative routings
  - In case of hazardous materials the use of modified containers, low-risk transportation models, modification of physical and chemical properties can prove to be effective



Making Transportation Decisions in Practice

1. Align transportation strategy with competitive strategy
2. Consider both in-house and outsourced transportation
3. Use technology to improve transportation performance
4. Design flexibility into the transportation network