Logistics and Distribution Part I

Course: Production Management and Logistic Systems [10592713]

Economia e management (Latina Campus)

AA 2024-2025 | Prof. Alessandro Pietrogiacomi

SAPIENZA
UNIVERSITÀ DI ROMA

Latina 2 March, 2025

Lesson Plan for Wednesday, April 2

Overview of the lesson, and educational objectives,

Topic: **Logistic and Distribution.**

Part I: Warehousing and Materials-Handling Transportation

Time: **14:00–17:00**

Duration**: 3 hours**

Learning Objectives

By the end of this lesson, students will be able to:

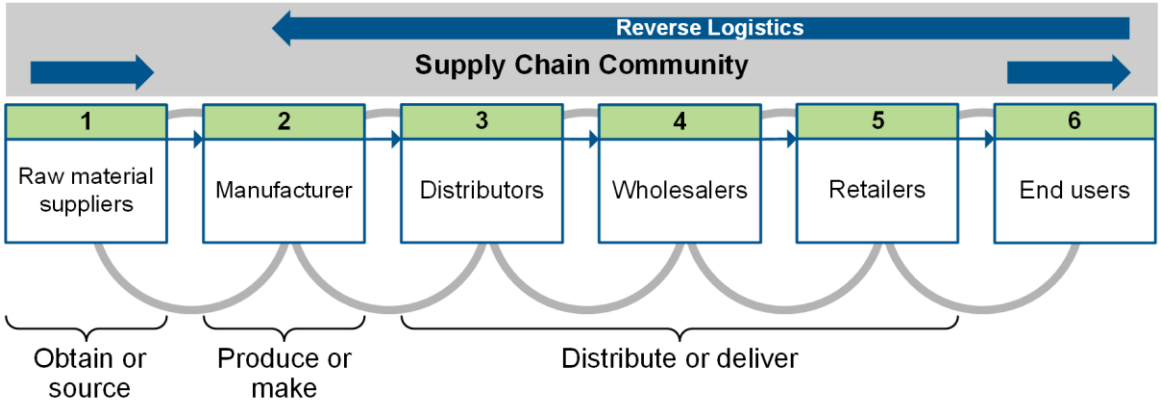
- Define the distribution network and understand the principles of logistics.
- Understand the principles of warehouse and transportation strategy.

The Role of Logistics in Supply Chain Management

Logistics

All tasks necessary to get the right product in the right quantity and right condition at the right place at the right time for the right customer at the right price

- Warehousing
- Transportation
- Import/export
- Packaging/materials handling
- Inventory management
- Logistics IS management



Logistics Trends

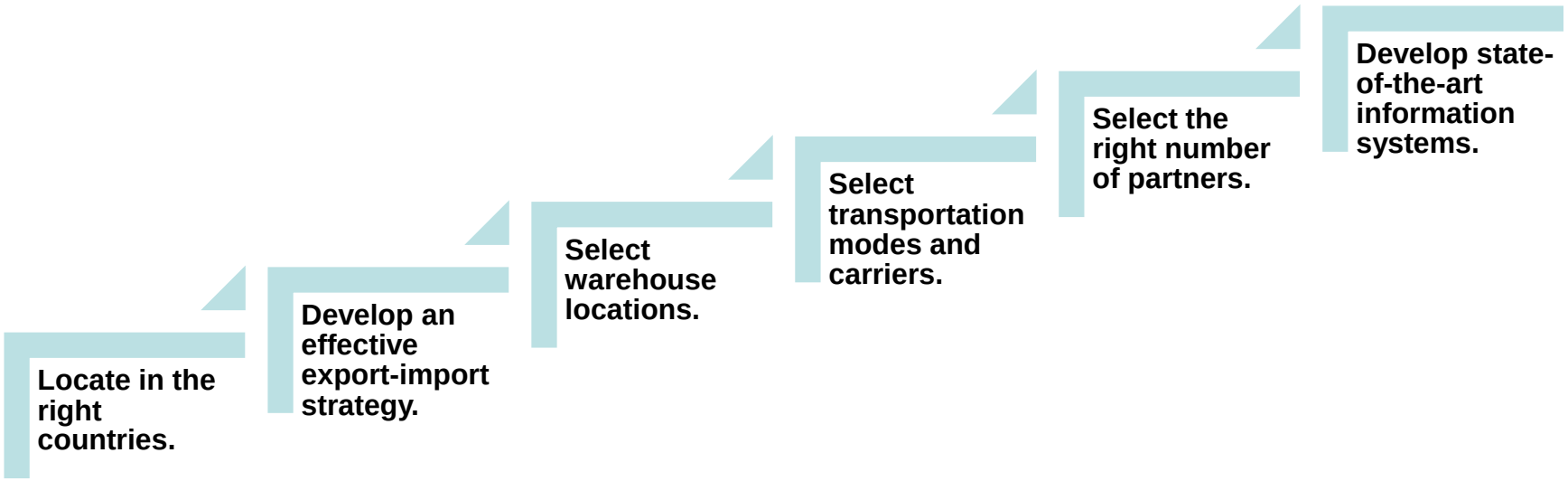
- “State of Logistics Report,” 2019, U.S. firms (billions):
  - Total logistics: US$1,630
  - Transportation costs:
    - Truck: US$680.4
    - Rail: US$83.9
    - Parcel: US$114.4
    - Water: US$47.9
    - Air: US$75.2
    - Pipeline: US$57.4
- 65% of logistics costs: transportation
- Carrying costs: +6.6% over prior year
- Trade wars; pandemic:
  - Resilience: diversification, backup capacity
  - Avoid going too far with a single-sourcing, JIT focus.

Logistics Objectives and Tactics

Logistics

Logistics Objectives	Logistics Tactics
• Rapid response capability • Minimum variance • Minimum inventory expense • Consolidated shipments • High quality • Product life cycle support	• Coordinating functions • Integrating the supply chain • Substituting information for inventory • Reducing number of partners • Pooling risks

Integrating the Supply Chain



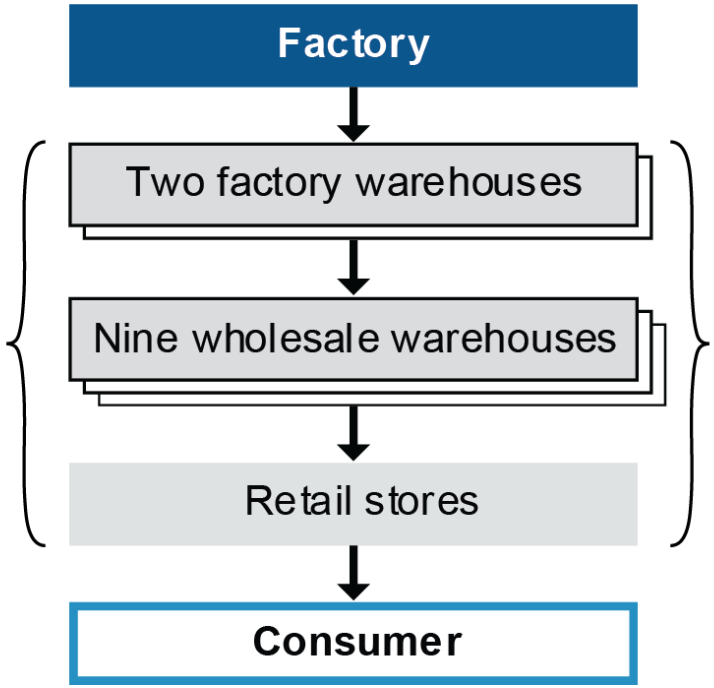
Information in Place of Inventory

- Improve communications.
- Collaborate with suppliers.
- Track inventory precisely.
- Keep inventory in transit.
- Use postponement centers.
- Mix shipments to match customer needs.
- Speed up customs.
- Make more on demand.

Reducing SC Partners to an Effective Number

This is a supply chain with three echelons between the factory and the consumers:

- Two factory warehouses
- Nine wholesale warehouses
- 350 retail stores

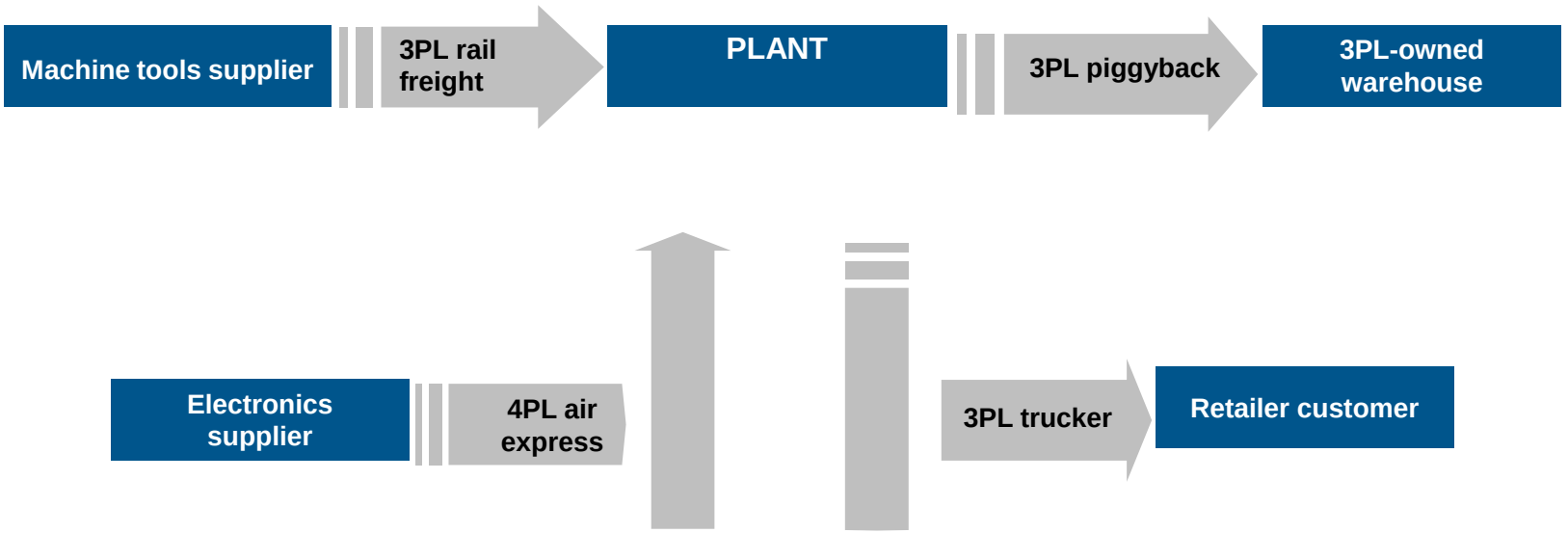


Nodes—Each of these nodes represents an echelon in the supply chain network.

Echelons:

- Add to operating expenses.
- Hold inventory.
- Add to cycle time.
- Expect to make a profit.

How 3PLs and 4PLs Are Related



- **3PL** arrangement: The third party takes over some or all logistics functions and performs them itself.
- **4PL** arrangement: A logistics specialist takes over the entire logistics operation and subcontracts some or all specific functions.

3PL and 4PL Tradeoffs

	Potential Benefits	Risks
3PL	• More focus on areas of competence • More current technology; more technological flexibility • More efficient warehousing (economies of scale) • Improved customer service • More workforce flexibility	• Less control over some aspects of logistics, including overall strategy • Potential for inefficiency
4PL	• Improved focus on areas of competence • Higher-quality logistics, reduced costs, or both • Greater business flexibility	• Less control over all aspects of logistics, including strategy • Potential loss of effectiveness or higher cost if 4PL deals with favored providers

Outsourcing Considerations

Logistics

Current Costs?

- How much will it save?
- Is it worth the risks?
- Are the benefits worth paying more?

Customer Skills?

- Evaluate the bidders' customer skills.
- Are the bidders reliable?
- Are their references credible?

Special Strengths?

- How did the company (especially if a 4PL) get started?
- What does it do best?
- Is there a match between its strengths and your needs?

Subcontracting Ability?

- Will the contractor subcontract effectively and honestly to get competent service?
- Are they biased toward their own divisions or toward certain firms that lack competence or over-charge?

Outsourcing and Contract Considerations

Contract Considerations

- Mutually beneficial
- Specify what each part will do to ensure success
- Commitment of time and energy
- Shared risks and rewards
- Carefully select performance metrics that address performance and customer service

Specific Rules and Clauses

- Confidentiality
- Subcontractor
- Remedies (correcting variances from performance targets)
- Use of arbitration
- Escape

Warehousing Objectives

Objective	Warehousing Contribution
Rapid response	Strategic placement, optimal numbers facilitate response to markets and order changes.
Minimize variances	Technology and automation aid efficient handling to promote predictable service.
Minimize inventory	Determine most efficient number of warehouses to reduce inventory, prevent stockouts.
Consolidation of movement	Warehouse placement, transportation interface, efficient materials handling all required for effective consolidation of shipments.
High quality	Subject all aspects of warehousing to continuous improvement.
Life cycle support	Place warehouses for returns, repairs, etc., as well as to support product movement during growth, development, and maturity.

Warehousing and Materials-Handling Strategy

Owned versus Leased Warehouses

Private warehouses owned by firm	• Control and flexibility to suit to products/SC • No markup • Market presence • Fixed cost, depreciates
Public warehouses available for hire	• Flexibility to scale • Potential cost savings from economies of scale (multiple clients)
Contract warehouses	• Potential cost savings with equal or better service • Tailored services • Flexibility • Expanded geographic market

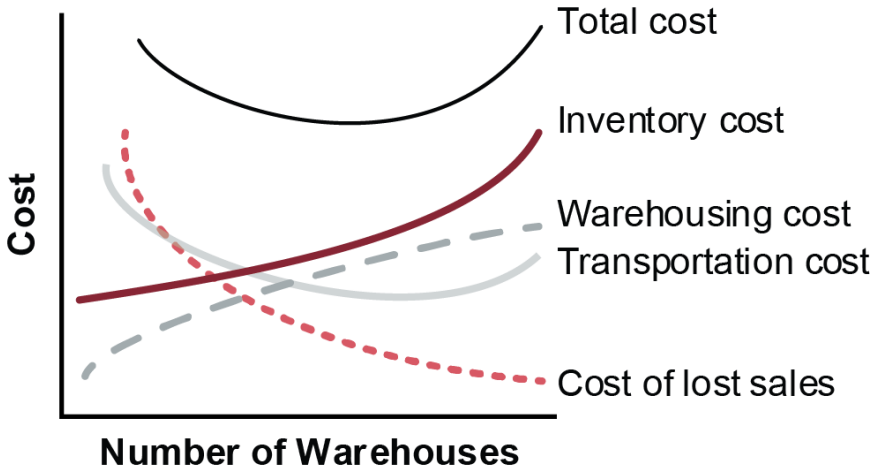
Warehousing and Materials-Handling Strategy

Effects of Adding Warehouses

- Customer service improves.
- Transportation costs decline with shorter distances to travel.
- Rapid delivery may improve competitive position.
- Decentralized system allows better service to small customers.

But note that:

- Inventory costs rise with redundant functions, safety stock.
- Setup and overhead costs go up.

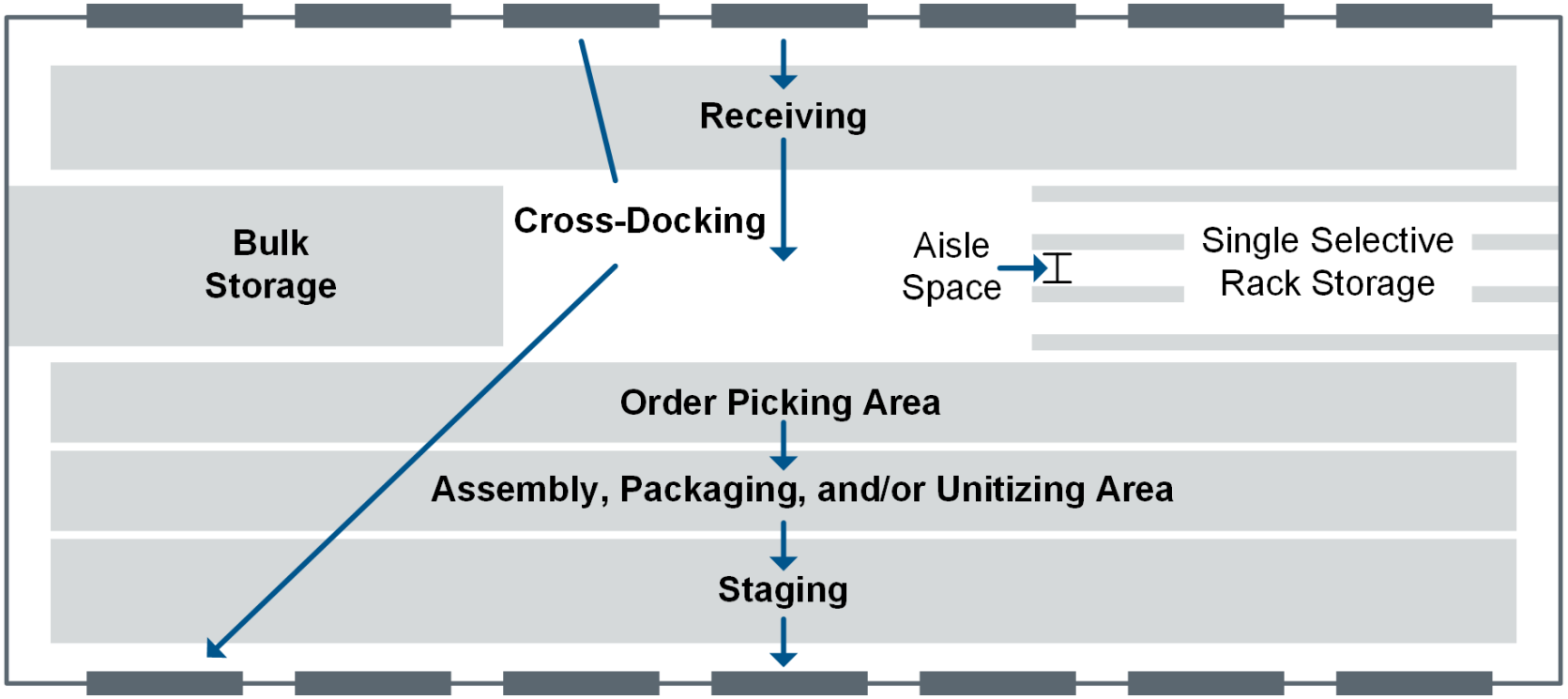


Where Should Warehouses Be Located?

Services	Availability of services is most important factor.
Neighborhood	Consider available space, soil support, nearness to market; not restricted to warehouse districts.
Costs	Services, location (urban costs more), taxes, insurance, transportation (tradeoff with cheaper land).
Community inducements	Tax incentives, infrastructure support, trained and available workforce.
Regulations	Environmental impact statements can slow construction, inflate costs.

Warehousing and Materials-Handling Strategy

Organization of Storage Locations



Warehousing and Materials-Handling Strategy

Stock Location

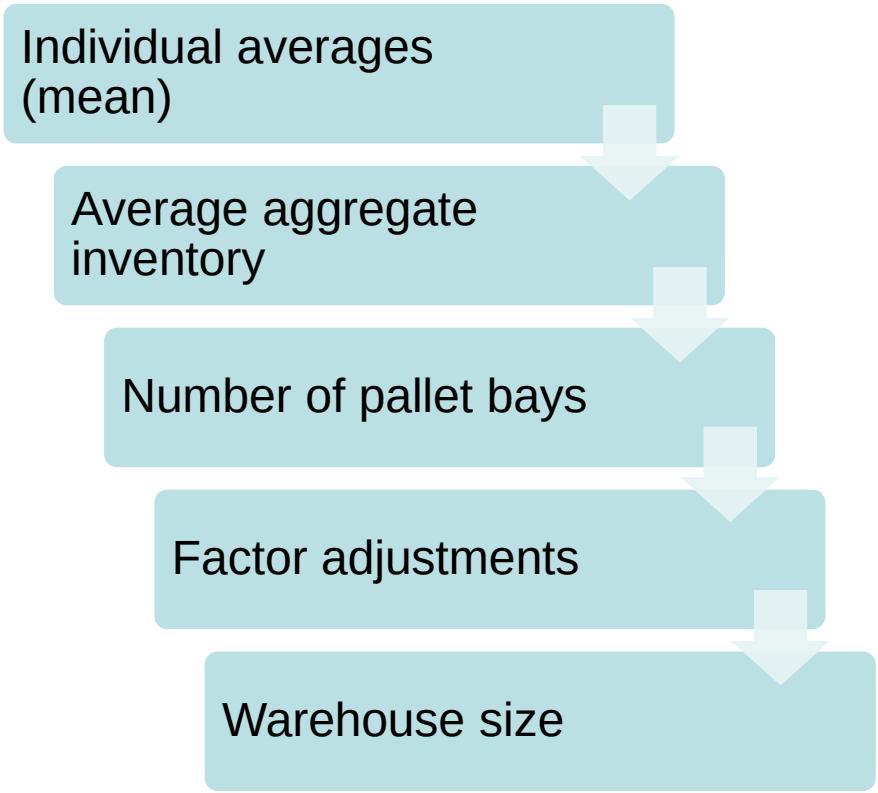
Random location	Maximizes cube utilization but need locator file
Fixed location	Need more space, but learn fixed locations
ABC	Good for secure/fast-moving requirements
By function	Good for modular units, assists assembly
By velocity	Fast-moving items placed near docks
By physical similarity	Frozen or refrigerated items, bulky items
Separate reserve stock	Bulk storage items (or defective/obsolete) out of way, replenishes working stock

Warehousing and Materials-Handling Strategy

Warehouse Capacity Forecasting and Planning

Factor adjustments:

- Partial pallets
- Space around inventory, for movement, assembly, etc.
- Levels of vertical storage
- Target utilization of warehouse
- Bulk storage calculated separately



Warehousing and Materials-Handling Strategy

Materials-Handling Options

Goals of warehousing	Limitations of equipment and automation
• Cost-effective • Efficient use of: – Warehouse space – Human labor – Equipment – Software, automation, IT	• May add cost without increasing value • Must blend with space, labor skills, layout, etc. • May require expert advice and software to select

Warehousing and Materials-Handling Strategy

Mechanized Systems

Forklifts

Conveyors

Bridge/ wagon cranes

Towlines

Other mechanized systems

- Carousels
- Pick-to-light
- Tow tractors with trailers

Automated Systems

Type	Features and Uses
AGVS	• Riderless; moves along floor on tape or wire with preset stops. • Similar in use to forklift and tow tractors. • Available with tines or platforms.
Sorting systems	• Generally used with conveyors. • Automate direction of items into shipments. • Programmable for different speeds to fit shipment requirements.
Robotics	• Used to build and break down unit loads. • Recognizes product stacking patterns. • Transfers to/from conveyor belt.
Live racks	• Gravity roller conveyors. • When item is taken from front, rest move down.
AS/RS	• Automate both storage and retrieval. • Machine moves both horizontally and vertically and can have high racks. • Pickup and dropoff programmed at end-of-aisle stations.

Transportation Strategy

Transportation Objectives

Movement of Materials Through Network

- Time issues
- Cost issues
- Environmental issues

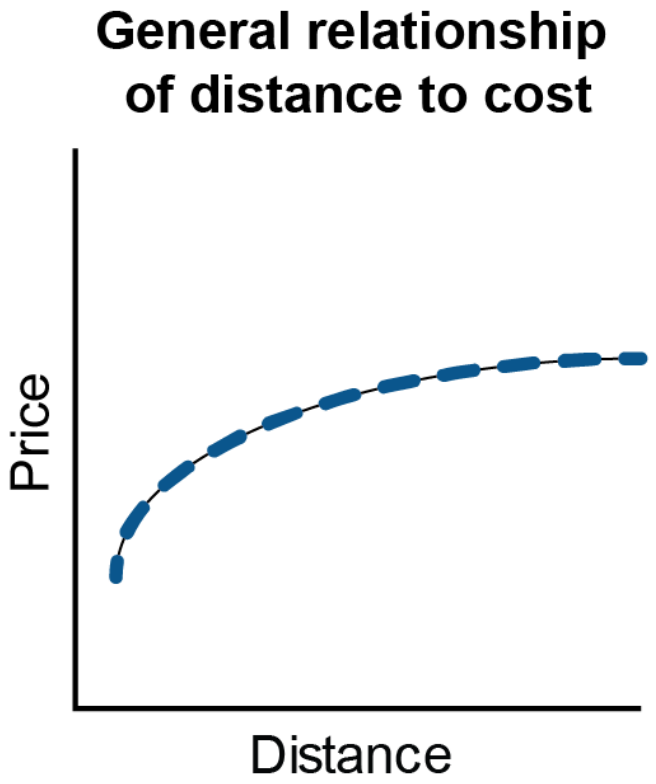
Temporary Storage

- Park without unloading for short-term storage.
- Take early, slow route from crowded facility (if same cost).
- Divert in mid-course due to order or demand changes or warehouse capacity.

Transportation Strategy

Capacity Constraints: Distance

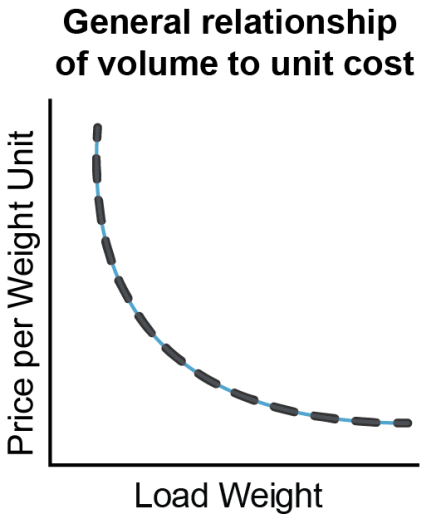
- More distance means higher cost but not uniformly.
- Longer trips allow:
  - Fewer starts and stops
  - More cruising
  - Nonurban miles (trucking).

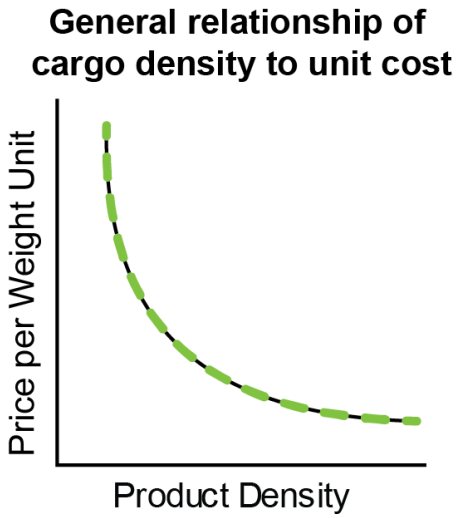


Transportation Strategy

Capacity Constraints: Volume and Density

- Volume adds to cost, but full loads earn discounts.
- Higher volume may qualify for full-load pricing; spreads cost over more weight units.
- Denser loads may cost more in total but less per weight unit.
- Higher density packing spreads cost over more units—good unless weight limit precludes full load.





Transportation Strategy

Capacity Constraints: Stowability, Handling, and Liability

Stowability and Handling

- Shape storage efficiency?
- Difficult loading and unloading?
- Specialized handling equipment?
- Packaging and grouping for handling?

Economics of Liability

- Susceptibility to damage
- Perishability
- Susceptibility to theft
- Value per pound

Transportation Strategy

Capacity Constraints: Conflicts of Interest

Optimize tradeoffs.		
Manufacturers: Large lot sizes for lower unit setup costs	⟷	Logistics: Reduction in inventories and improved system responsiveness
Per-item transportation costs reduced by full truckload (TL)	⟷	Inventory holding costs reduced by less-than-truckload (LTL)
Lead time reduced if goods are transported as they are made	⟷	Transportation costs reduced if orders wait until ship via TL
High product variety	⟷	High transportation and storage cost

Module 5, Section B

Section B Introduction

Section B Key Processes:

- Provide distribution services.
  - Receive, put away, and store product.
  - Pick, pack, and ship product.
  - Provide value-added services.
  - Select mode and transport providers.

Section B Topics:

- Distribution Services and Delivery Patterns
- Transportation Mode and Carrier Selection

Distribution Services and Delivery Patterns

Warehouse Capabilities

Warehousing activities

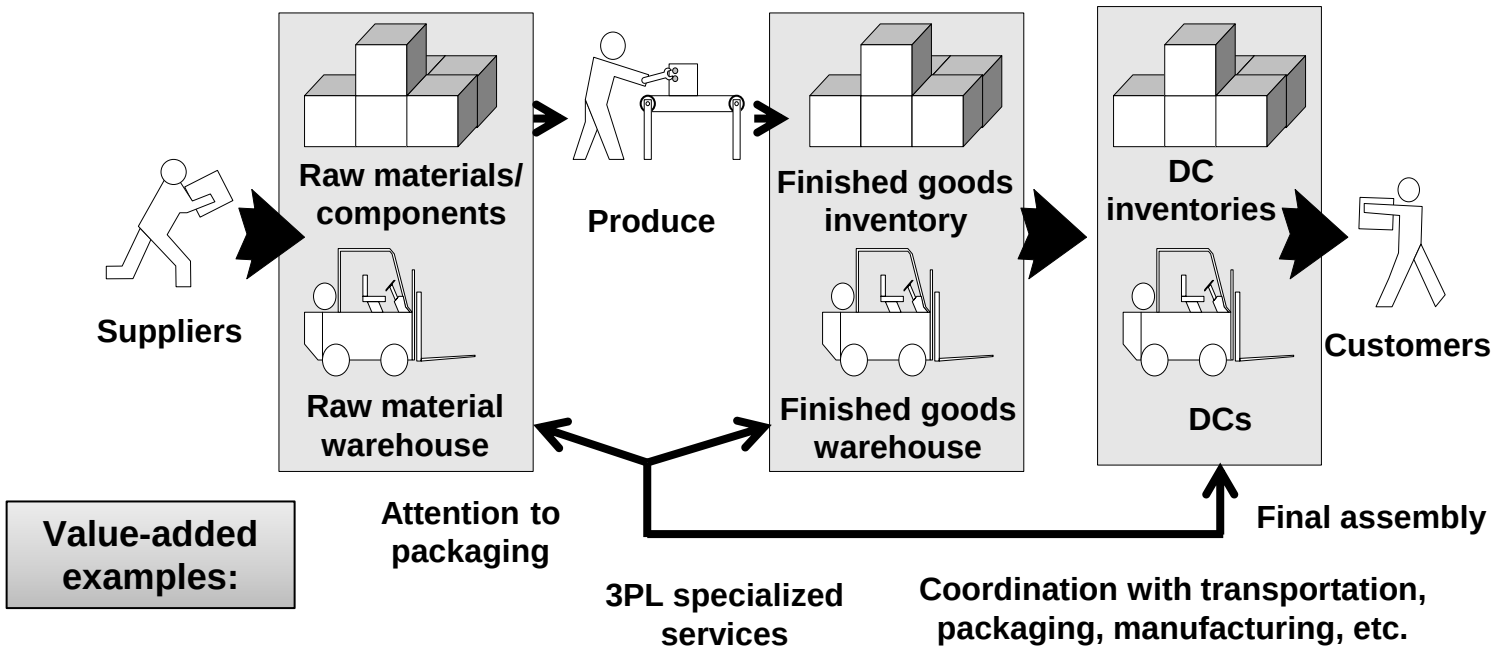
- Consolidation
- Break-bulk and cross-dock
- Postponement and processing
- Stockpiling seasonal inventory
- Spot stocking advance shipments
- Assortment
- Mixing

Warehouse functions

- Receiving
- Prepackaging
- Put-away
- Storing
- Order picking
- Moving
- Shipping
- Packaging
- Packing and marking
- Cycle counting

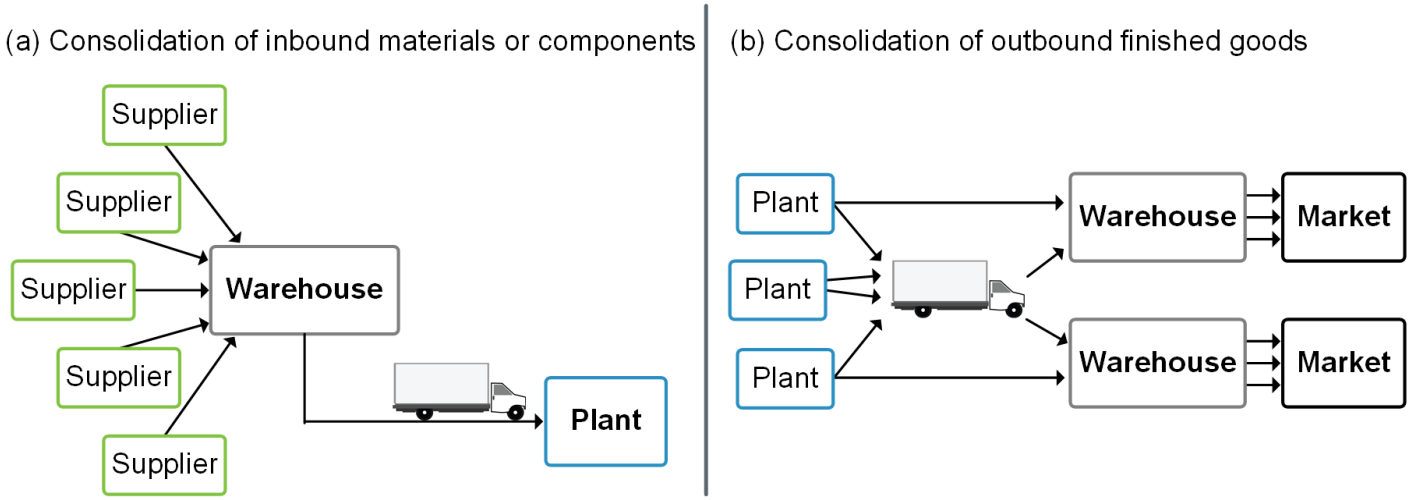
Distribution Services and Delivery Patterns

Value-Added Warehousing



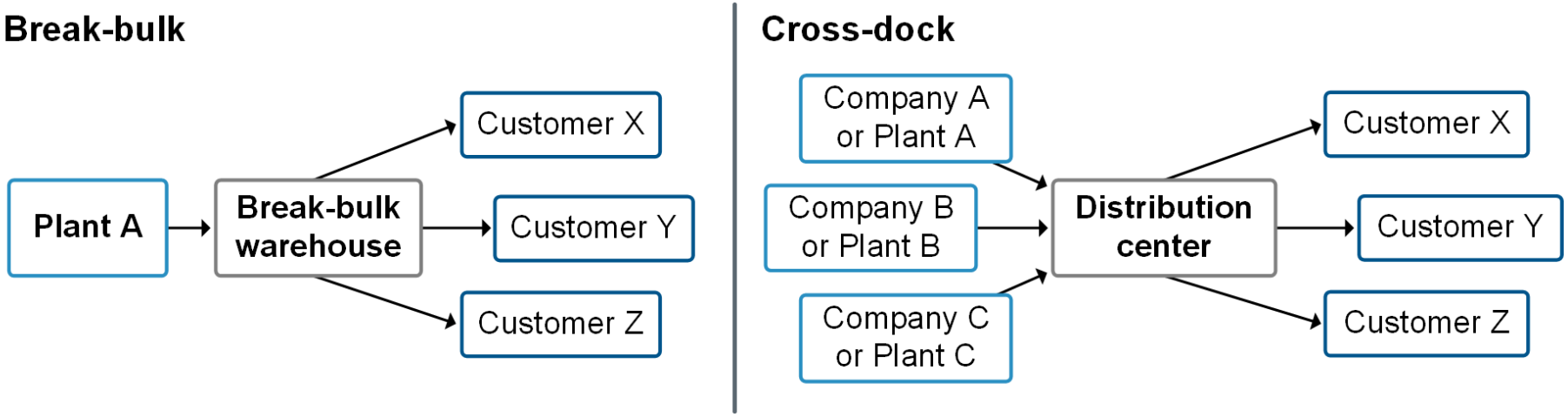
Consolidation

- Combining inbound or outbound shipments for economies of scale to reduce logistics costs
- Reduced congestion at receiving dock



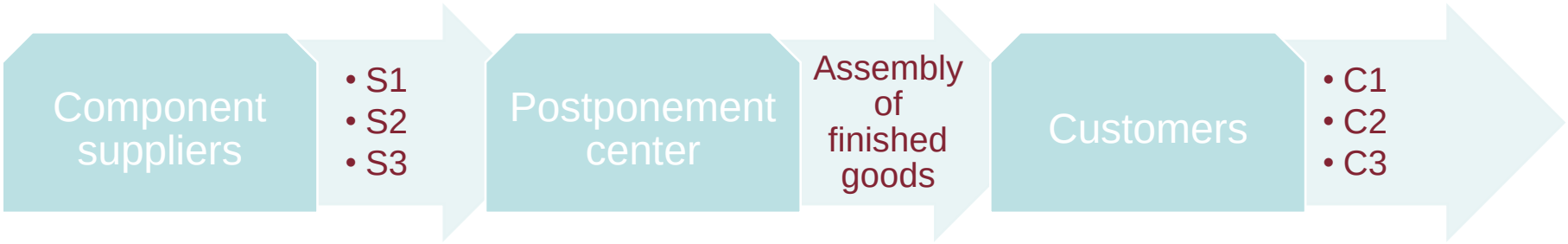
Break-Bulk and Cross-Dock

- Combining inbound or outbound shipments for economies of scale to reduce logistics costs
- Reduced handling costs (no storage)



Distribution Services and Delivery Patterns

Postponement



Benefits:

- More efficient storage
- More accurate forecasting
- Less safety stock required
- Mass customization

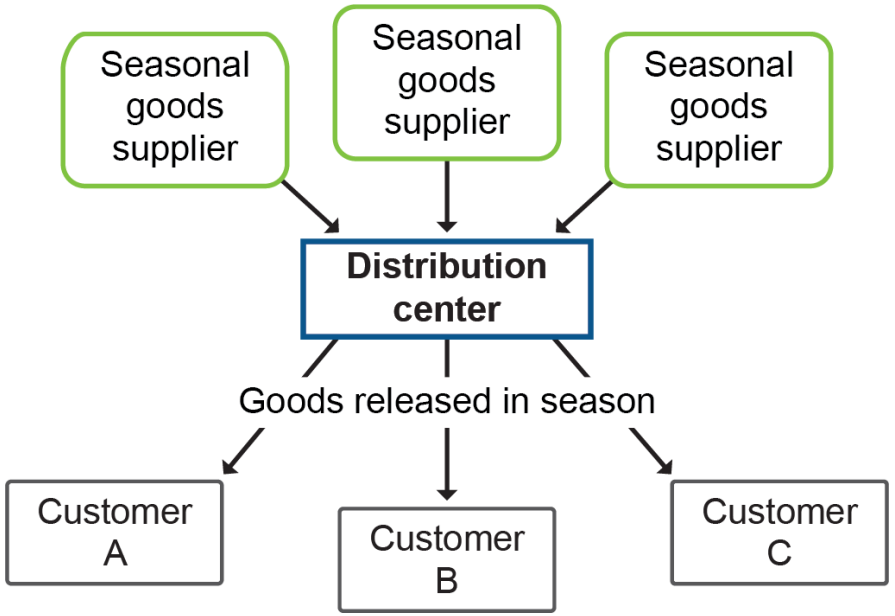
Drawback:

- Increased costs for hiring, training, and (possibly) finishing

Distribution Services and Delivery Patterns

Anticipation (Stockpiling)

- Benefits:
- Efficient use of production by eliminating seasonal increase and decrease in capacity
- Reduced chance of seasonal stockouts
- Drawback:
- More warehouse capacity than required for JIT delivery

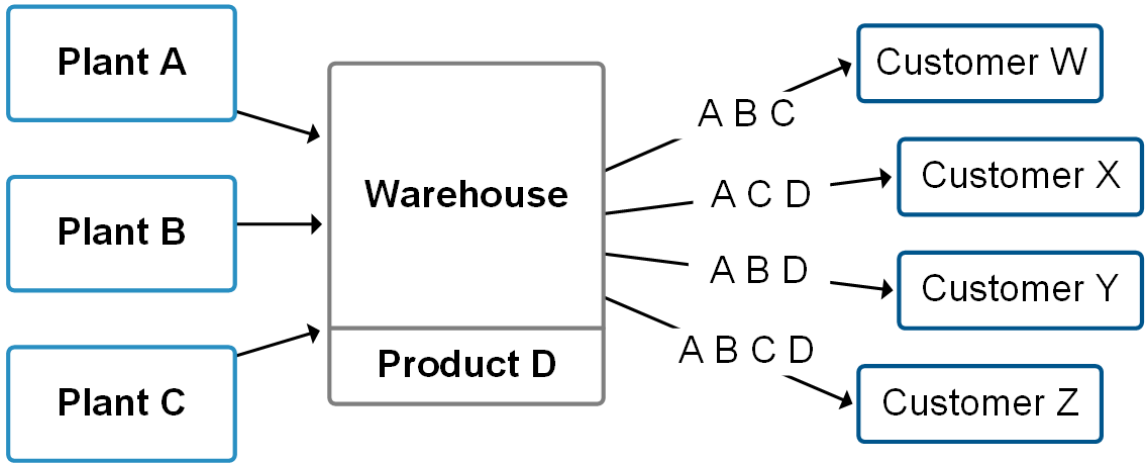


Distribution Services and Delivery Patterns

Mixing

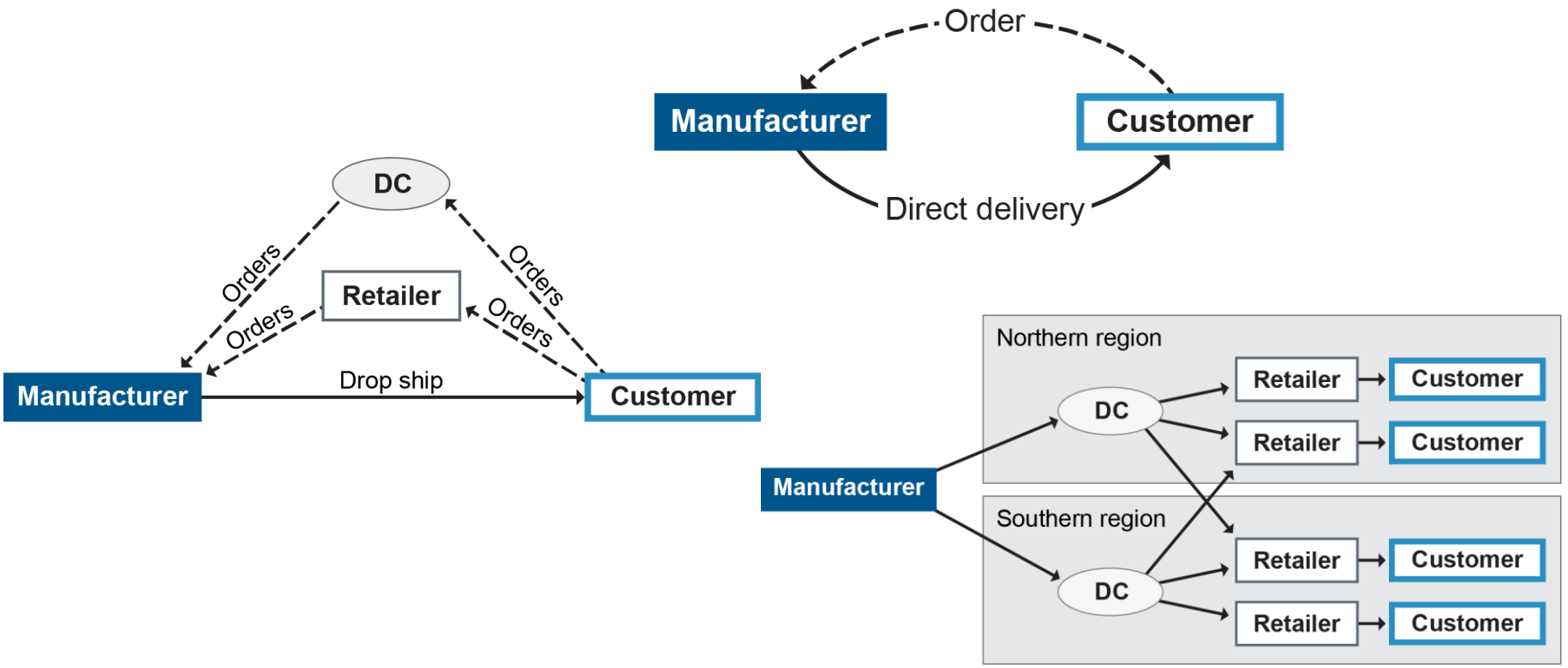
Benefits:

- Serves customers by reducing their costs for handling, storage, etc.
- Increases efficient use of warehouse space



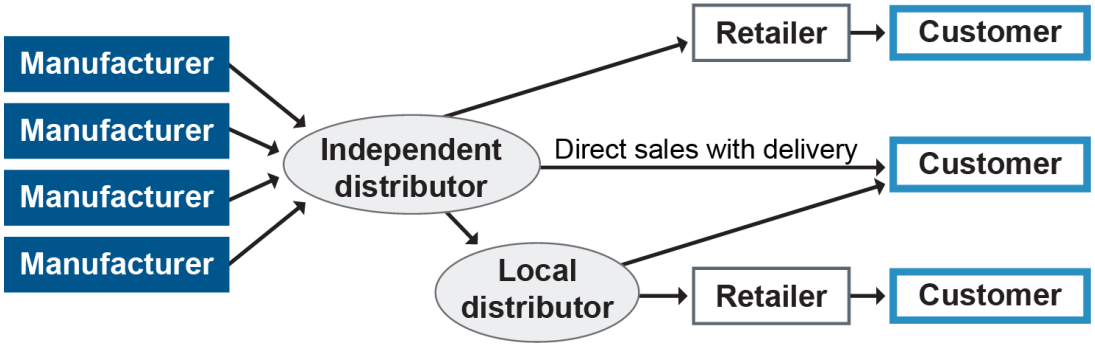
Distribution Services and Delivery Patterns

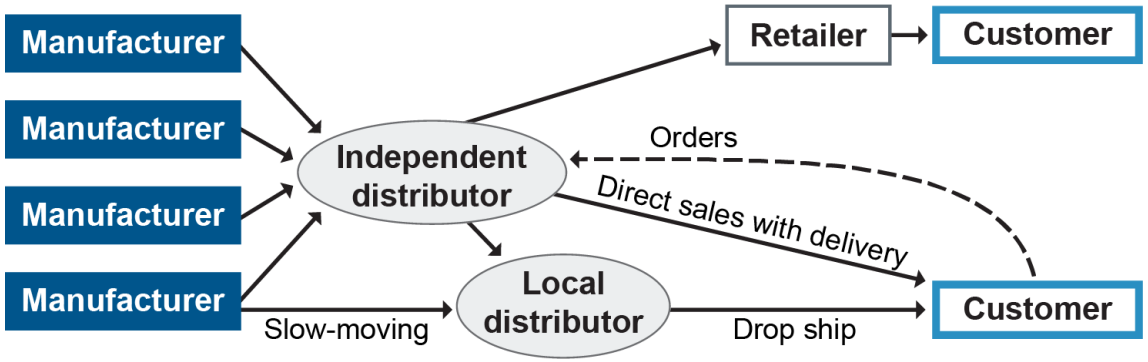
Delivery Patterns



Distribution Services and Delivery Patterns

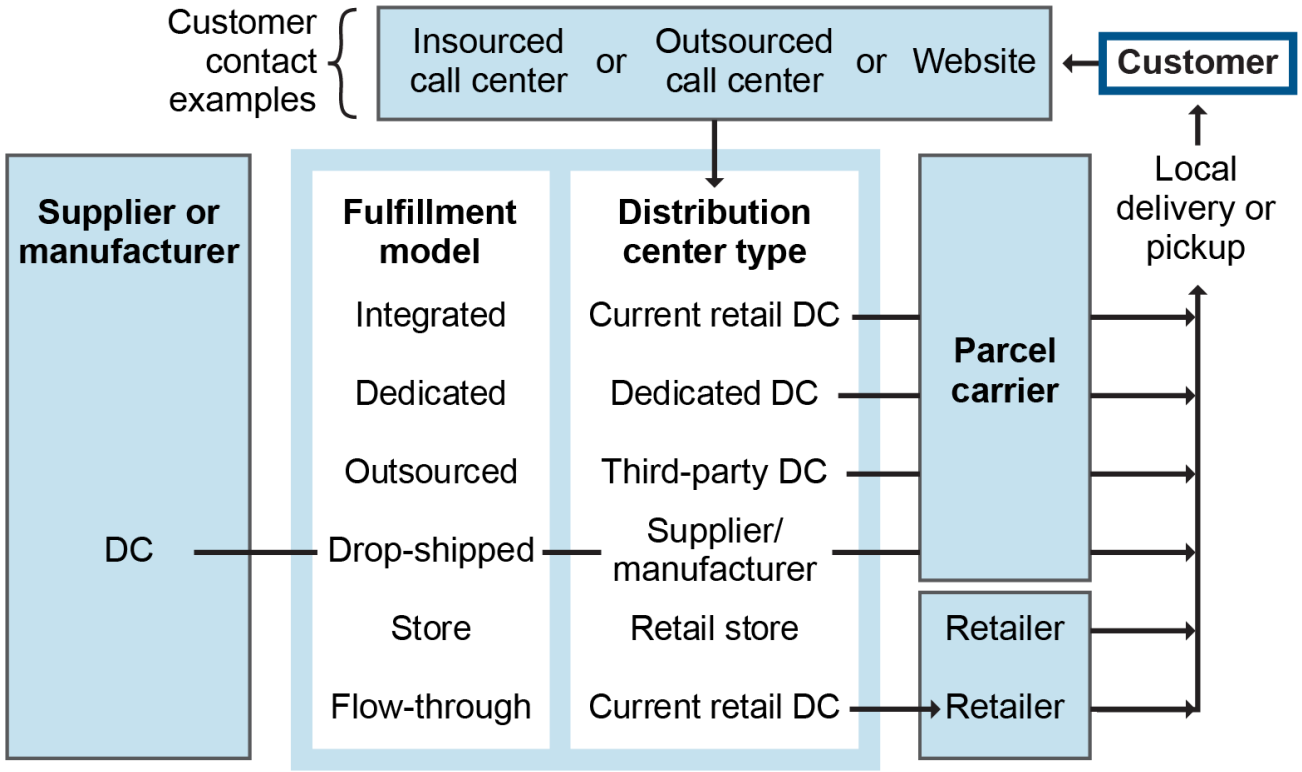
Delivery Patterns (continued)





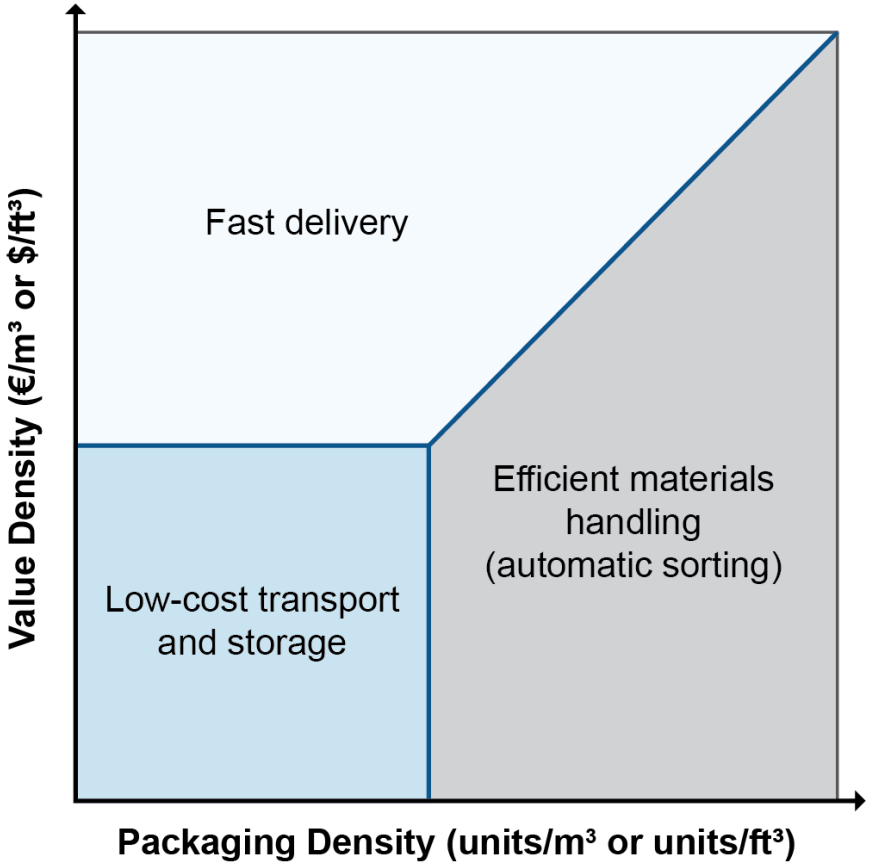
Distribution Services and Delivery Patterns

Direct-to-Consumer Model



Transportation Mode and Carrier Selection

Value Density vs. Packaging Density

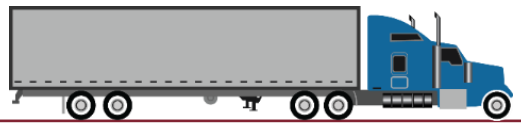


Transportation Mode and Carrier Selection

Modes of Transportation: Rail

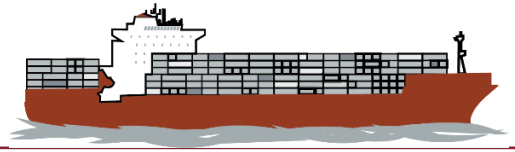
Capabilities	Market	Limitations
Fuel-efficient Heavy loads (equal to water) Any load (with bulk restrictions) Low-value cargo Relatively low rates Low variable costs	Low variable costs, high fixed costs Few carriers (U.S.), mostly consolidated Growth in China still possible, little elsewhere Intermodal options growing 	Restricted destina-tions, little chance to expand Slow if stops, gauge or crew switches Rough ride

Modes of Transportation: Motor Carriers

Capabilities	Market	Tradeoffs
Small shipments; high-value items; short to medium hauls Greatest accessibility for pickup and direct delivery Speedy delivery	Low fixed costs with tax-funded infrastructure High variable costs: wages, equipment, etc. Easy entry, many carriers available; TL, LTL, specialty Some regulatory limits on type of cargo 	Labor-intensive with rising rates Intense competition with resulting bankruptcies Less hazardous than rail or water for high-value goods

Transportation Mode and Carrier Selection

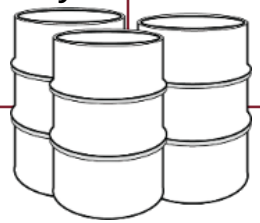
Modes of Transportation: Water Transport

Capabilities	Market	Tradeoffs
Huge, heavy loads hauled for distances Low-value, high-density cargo such as coal, crude oil, or grain Very low per-mile cost and fuel-efficient	Used in U.S. Great Lakes, rivers; EU rivers; China and SE Asia and elsewhere Waterways maintained by taxpayers Low fixed costs for ease of entry, private fleets 	Limited accessibility, other transport required to/from port Slow travel (trains faster but higher cost) Harmful to environment

Transportation Mode and Carrier Selection

Modes of Transportation: Pipeline Transport

Capabilities	Challenges
Special adaptation for crude oil, petroleum products	Cargo limited to liquids, slurry
No packaging required	Costly construction
Storage and transport combined	Monopolies (most are common carriers)
Usable 24/365 in all weather	Limited access
Fixed costs similar to rail; low operating cost (no driver required)	Political barriers at borders
New types of cargo being developed in slurry form	Vulnerable to terrorism



Transportation Mode and Carrier Selection

Modes of Transportation: Air Transport

Capabilities	Market	Tradeoffs
Speed—may eliminate safety stock Smooth ride for valuable and perish-able cargoes—or any cargo Lower packaging expense	Low fixed cost, high variable cost Tends to be run by government or heavily regulated Competes for transoceanic carriage Tiny percentage of overall cargo market	Cargo secondary to passenger service (except FedEx, etc.) Very high delivery costs per ton/mile Limited access (some help from intermodal) Reliability problems

Transportation Mode and Carrier Selection

Hybrids: Package Delivery Services

Capabilities	Market	Limitation
Speed—up to same-day service Accessibility and flexible hours for pickup, delivery Perfect for perishable and high-value goods, e.g., food and drugs	Compatible with JIT and lean Large employer and logistics provider globally 	High price—traditionally limited to small, high-value items (package delivery)

Transportation Mode and Carrier Selection

Hybrids: Intermodal Transport

Piggyback service	Trailer or container on rail flatcar
Trainship or containership service	Truck trailer, railcar (trainship), or container (containership) on ship or barge; land bridge
Truck-plane services	Air transport plus surface transit to/from terminal
Freight truck on railroad car	Truck loaded on flatbed railcar in EU so driver can sleep

Benefits

- Flexibility
- Efficiency
- Lower cost

Transportation Mode and Carrier Selection

Types of Carriers

Type of Carrier	Description	Benefits	Drawbacks
Common (public)	Perform bulk of shipping; required to serve commercial shippers.	• Availability, rates supported by regulations • Carrier assumes risk	• Most economic regulations to consider • Must publish reasonable rates
Private	Shipper's own fleet of vehicles for carrying own goods (and possibly some other goods).	• Control of vehicles • Possible cross-licensing since deregulation for backhaul loads	• Maintenance cost • Problems when business slows • Core competence? • Empty backhauls

Transportation Mode and Carrier Selection

Types of Carriers (continued)

Type of Carrier	Description	Benefits	Drawbacks
Contract	Work on contract with specific clients; not required to serve all shippers; negotiable (not regulated) rates.	• Low rates • Custom services	• Not required to provide service
Exempt	Free from most federal regulation (state-licensed in U.S.); restricted to specific markets—mostly agriculture.	• Low rates (no regulation) • Adapted to special niches	• Limited availability for most products • Limited range of operation

Recap, Q&A and Homework Assignment

Recap of Key Points

- Logistics ensures the right product reaches the right place at the right time.
- Warehousing, transportation, and network design are critical for efficiency.

Homework Assignment

- As discussed in class