Logistics and Distribution Part II

Course: Production Management and Logistic Systems [10592713]

Economia e management (Latina Campus)

AA 2024-2025 | Prof. Alessandro Pietrogiacomi

SAPIENZA
UNIVERSITÀ DI ROMA

Latina 8 April, 2025

Lesson Plan for Tuesday, March 25

Overview of the lesson, and educational objectives,

Topic: **Logistics and Distribution.**

Part II– Inventory, Replenishment Strategies, Traceability, Accuracy, and Disposition and import export regulations

Time: **14:00–17:00**

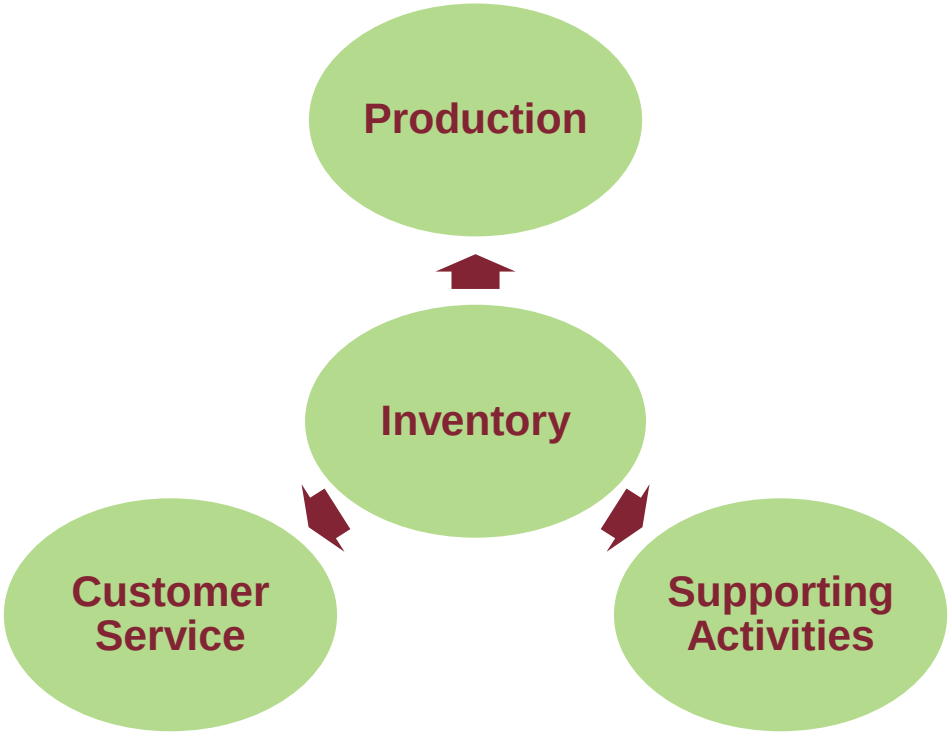
Duration**: 3 hours**

Learning Objectives

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

- Understand how to align inventory requirements with demand.
- Unerstadn product traceability and chain of custody.
- Define and execute physical inventory and cycle counting.
- Understand product disposition and obsolescence.

The Need for Inventory



- Production
  - Raw materials
  - Work-in-process items
- Customer service
  - Finished goods
  - Spare parts
- Supporting activities
  - Maintenance
  - Repair
  - Operating supplies

Types of Inventory

1) Raw materials

2) Work-in-process (WIP)

3) Finished goods (FG

Raw materials supplier → Component supplier → Manufacturer → Distributor → End customer

4) MRO

5) In-transit

Inventory

Why Have Inventory?

Inventory Functions	Cycle stock/lot size inventory
	Anticipation inventory
	Buffer inventory
	Safety stock
	Hedge inventory
	Decoupling

Inventory Costs

- Acquisition costs: order quantity × unit cost
- Landed costs: product cost plus logistics costs
- Carrying (holding) costs: storage, capital, and risk costs

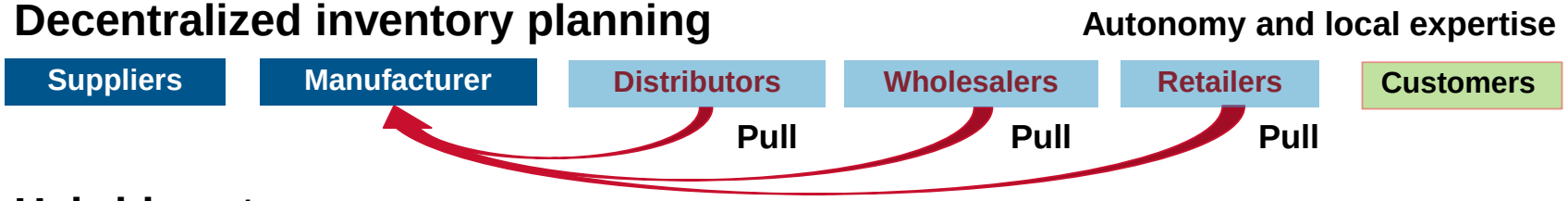
- Storage costs
  - Rent, equipment leases, depreciation
  - Operating costs, material-handling expenses, power
  - Taxes
- Capital costs
  - Interest, financing, payments to creditors and investors
- Risk costs
  - Insurance, inventory value reductions, write-offs

Inventory

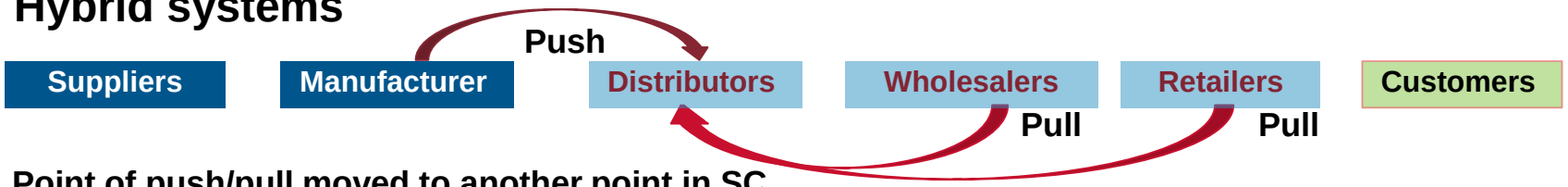
Inventory Planning

Centralized inventory planning

Decentralized inventory planning

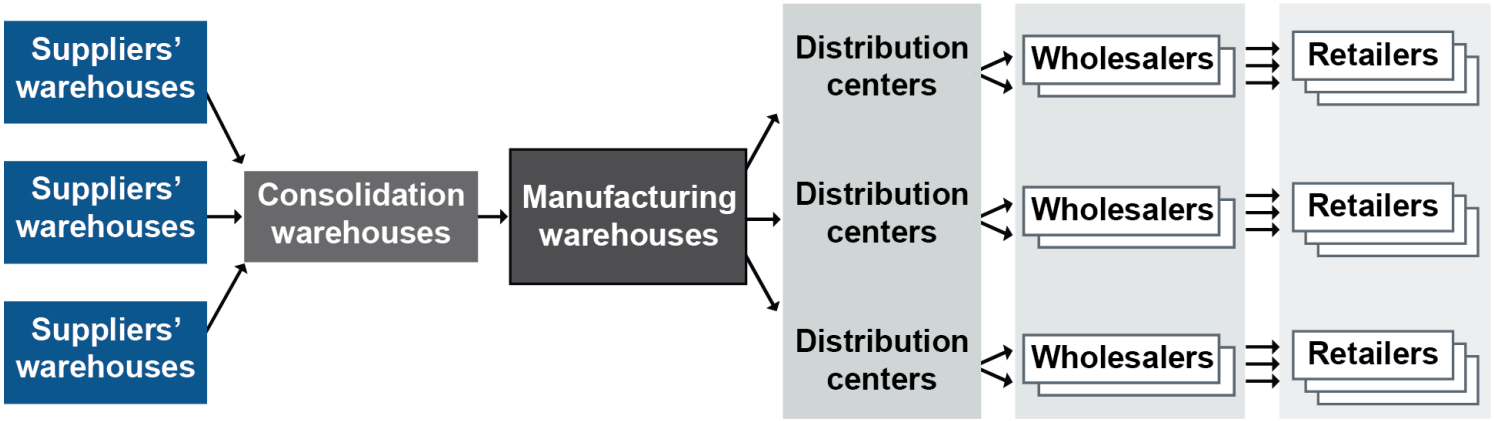


Hybrid systems



Point of push/pull moved to another point in SC

Echelons and Echelon Inventory



- Echelons
  - Add costs.
  - Are a buffer for later echelons.
  - May provide consolidation or break-bulk to reduce total inventory/costs.
- Echelon inventory aggregates demand for more accurate order calculation.
  - Inventory at a node = all inventory at that echelon + all inventory at later SC points + in transit

Inventory

Inventory Management Roles

Purchasing and materials management: adequate raw materials at low inventory cost

Manufacturing and finance: efficient and low-cost production balanced against low inventory cost

Sales and marketing: sufficient inventory to meet customer delivery requests and service levels

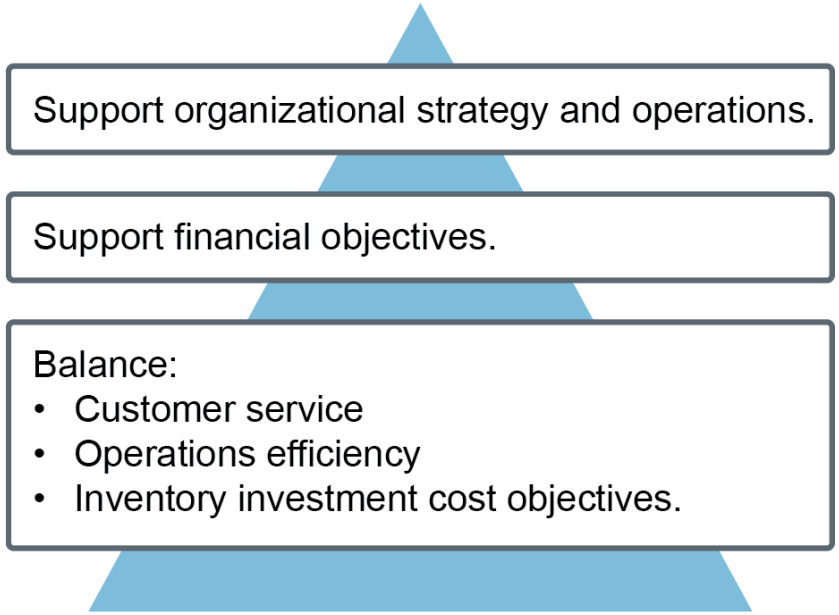
Inventory

Factors Influencing Inventory Policies

Customer demand	Planning horizon	Replenishment lead time
Product variety	Inventory costs	Customer service requirements

Aggregate Inventory Management

Aggregate Inventory Management Objectives



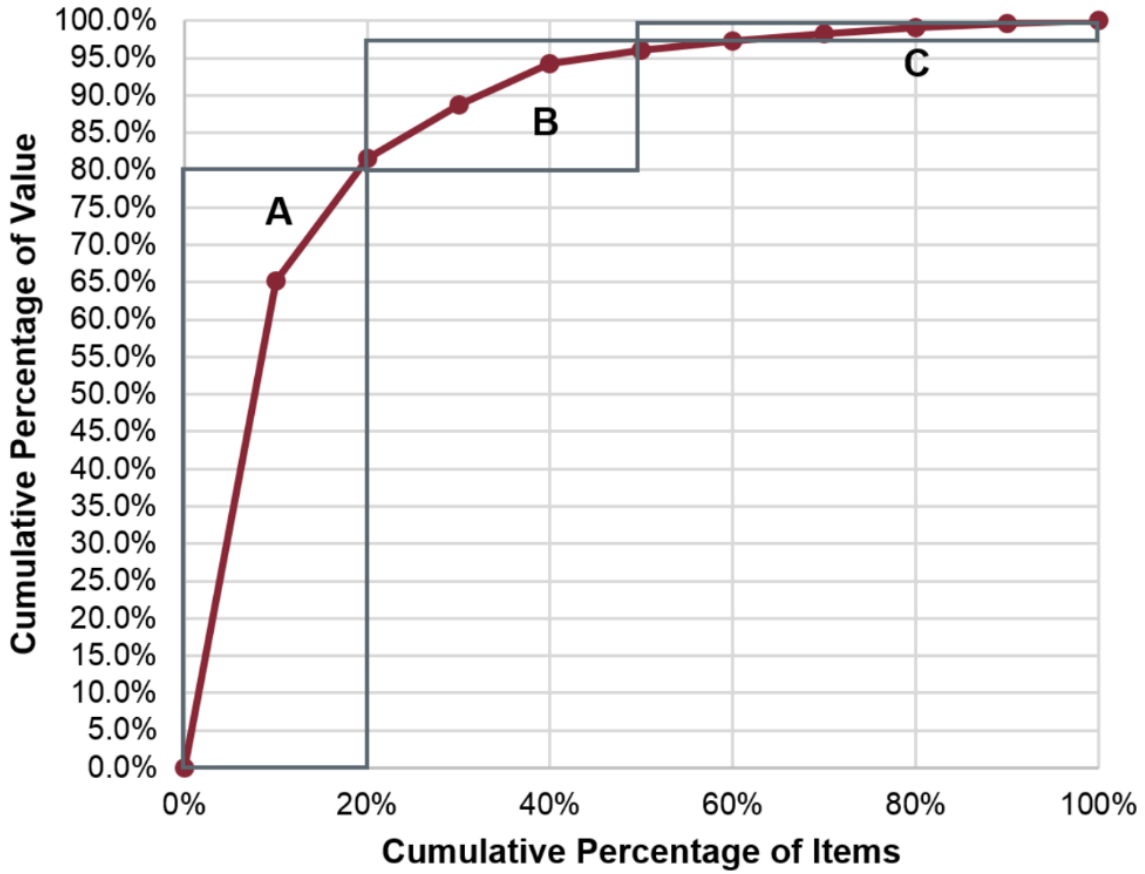
Ways to Aggregate Inventory

- Demand pattern
- Production process
- Stage of production flow
- Relative value to organization
- Product or SKU family or type
- Distribution pattern

Inventory

ABC Inventory Classification: Pareto Analysis

- A: Better treatment, tighter controls
- B: Moderate treatment and control
- C: Looser controls, may not get safety stock



Item Inventory Management

- Goal is to enable planners to translate strategic inventory goals into measurable results (proper production and distribution of each SKU).
- Inventory rules
  - When to order inventory
  - How to determine order size per order
  - Relative importance of each inventory item
  - Inventory control procedures for individual items

Inventory

Effects of Inventory on Financial Statements

Balance Sheet	Income Statement	Cash Flows
• Unsold inventory is current asset. • Only profit margin portion contributes to net income when sold. • Can determine average inventory from balance sheet.	• COGS: Product expenses booked when units sold. • Operating expenses: Period expenses booked when incurred. • Reducing costs is more effective than increasing sales volume.	• Decrease in inventory increases cash position. • Inventory write-offs reduce owners' equity and may require reducing debts to maintain covenants.

Inventory

Balance Sheet for Two Years (Assets)

What the organization owns

Assets expected to be converted to cash within one year

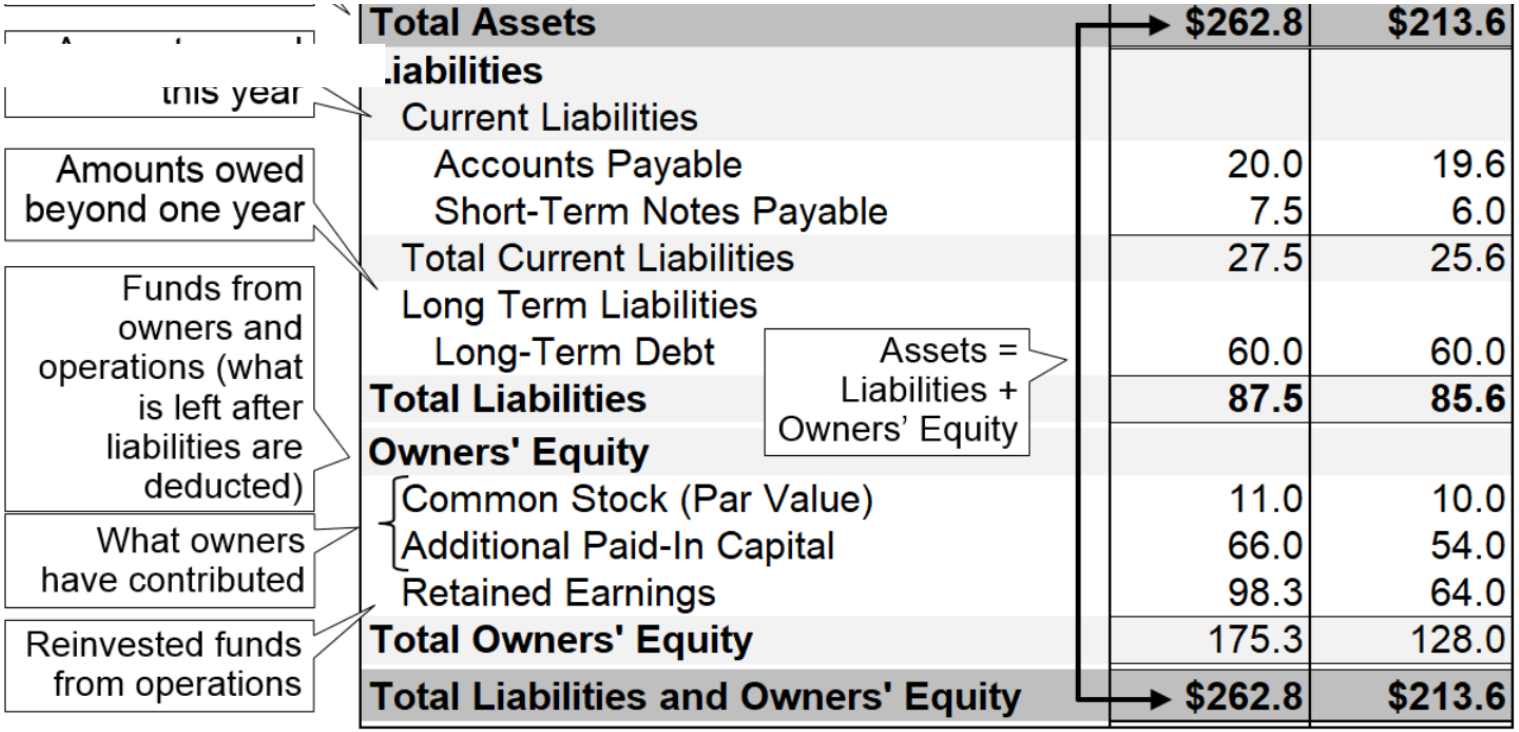
Long-term assets not easily converted to cash

Statement of financial value at a point in time (end of year)

BALANCE SHEETS December 31,	In Millions (000,000) Year 2	Year 1
Assets		
Current Assets		
Cash and Cash Equivalents	$96.5	$56.3
Inventory	59.9	60.4
Accounts Receivable	48.4	44.3
Total Current Assets	**204.9**	**161.1**
Fixed Assets		
Gross Property, Plant, and Equipment	70.0	60.0
Less: Accumulated Depreciation	12.1	7.5
Net Property, Plant, and Equipment	57.9	52.5
Total Assets	**$262.8**	**$213.6**

Inventory

Balance Sheet for Two Years (Liabilities)



Total Assets	**$262.8**	**$213.6**
Liabilities		
Current Liabilities		
Accounts Payable	20.0	19.6
Short-Term Notes Payable	7.5	6.0
Total Current Liabilities	27.5	25.6
Long Term Liabilities		
Long-Term Debt	60.0	60.0
Total Liabilities	**87.5**	**85.6**
Owners' Equity		
Common Stock (Par Value)	11.0	10.0
Additional Paid-In Capital	66.0	54.0
Retained Earnings	98.3	64.0
Total Owners' Equity	175.3	128.0
Total Liabilities and Owners' Equity	**$262.8**	**$213.6**

Inventory

Income Statement for Two Years

Reduce costs:

- Increase profit margin without needing to raise prices

INCOME STATEMENTS For the Years Ending	In Millions (000,000s) except per share amts. Year 2	Year 1
Revenue (Sales)	**$302.6**	**$276.9**
Less: Cost of Goods Sold (COGS)		
Direct Labor	38.3	37.6
Direct Materials	101.5	99.7
Factory Overhead	26.6	26.1
Less: Total Cost of Goods Sold (COGS)	166.4	163.4
Gross Profit	**136.2**	**113.5**
Less: Operating Expenses		
Selling Expenses	30.3	24.9
General and Administrative	27.2	22.2
Lease Expense	12.1	8.3
Less: Total Operating Expenses	69.6	55.4
Less: Depreciation	4.6	4.0
Less: Interest Expense	3.9	3.9
Net Income (Profit) Before Taxes	**58.1**	**50.3**
Less: Income Taxes	16.3	14.1
Net Income (Profit)	**$41.8**	**$36.2**
Net Income (as a Pct. of Revenue)	14%	13%
Net Income Per Share-Basic	**$3.95**	**$3.78**

Profit or loss over a period of time

Product expenses: these expenses are booked when the related units of inventory are sold.

Period expenses: these expenses are recorded in the period in which they are incurred.

Statement of Cash Flows for Two Years

- Beware too much capital tied up in inventory
- Need sufficient cash

A viable firm needs positive cash flow from operations in most years.

Increase in inventory or accounts receivable reduces cash; a decrease will grow cash on hand.

Increase in accounts payable increases cash, while a decrease reduces cash.

Extra cash from financing means more debt or equity investments were issued; reduced cash means debt was paid down or dividends were paid to owners.

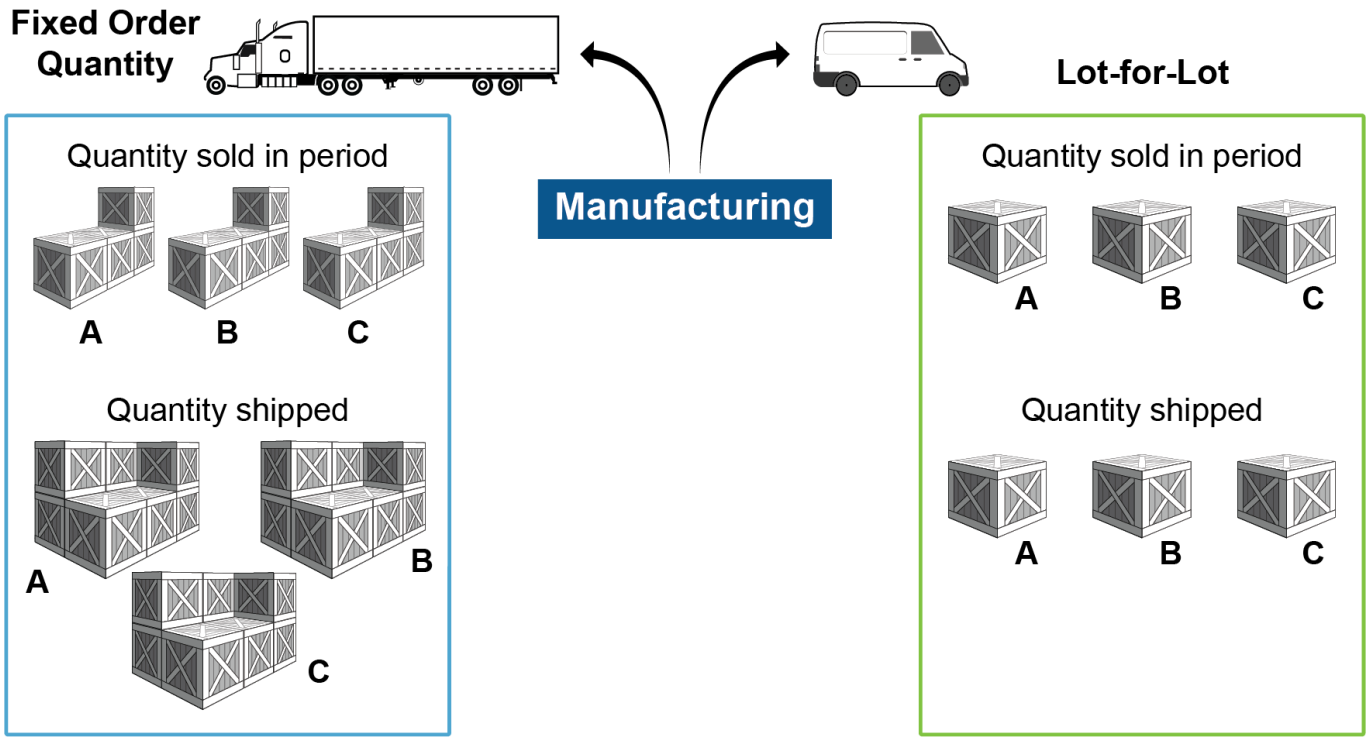
Net Income
+/– Change in (Δ) Operating
+/– Δ Investing
+/– Δ Financing
+ Beginning Cash
= Ending Cash

CASH FLOW STATEMENTS	In Millions (000,000)	
Year (Change in cash balance over a period of time)	Year 2	Year 1
Operating Section		
After-Tax Net Income	$41.8	$36.2
Depreciation Add-Back	4.6	4.0
(Increase)/Decrease in Inventory	0.5	(8.6)
(Increase)/Decrease in Accounts Receivable	(4.1)	(4.1)
Increase/(Decrease) in Accounts Payable	0.4	1.8
Cash Flow from Operations	**43.2**	**29.3**
Investing Section		
Capex Spend (Capital Expenditures)	(10.0)	(10.0)
Cash Flow from Operations and Investment	**33.2**	**19.3**
Financing Section		
Additional Equity Capital	13.0	7.0
Less Dividends Paid	(7.5)	(5.0)
Increase/(Decrease) in Long-Term Debt	-	-
Increase/(Decrease) in Short-Term Notes	1.5	(1.5)
Cash Flow from Operations, Investments, and Financing	**40.2**	**19.8**
Beginning Cash Balance	56.3	36.5
Ending Cash Balance	**$96.5**	**$56.3**

Investments in extra capacity reduce cash.

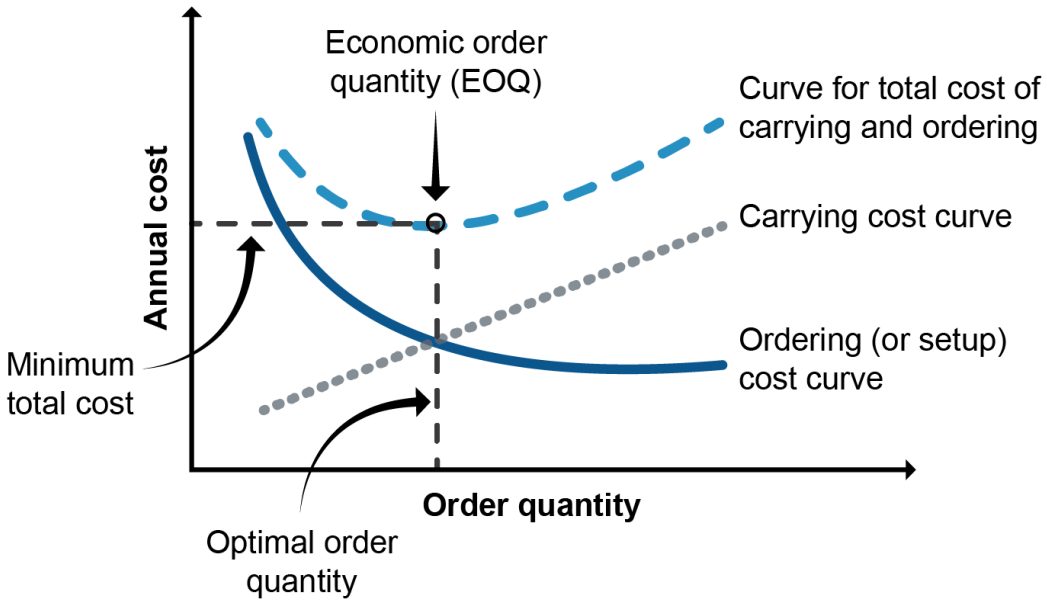
Replenishment Strategies

Lot-for-Lot versus Fixed Order Quantity (FOQ)



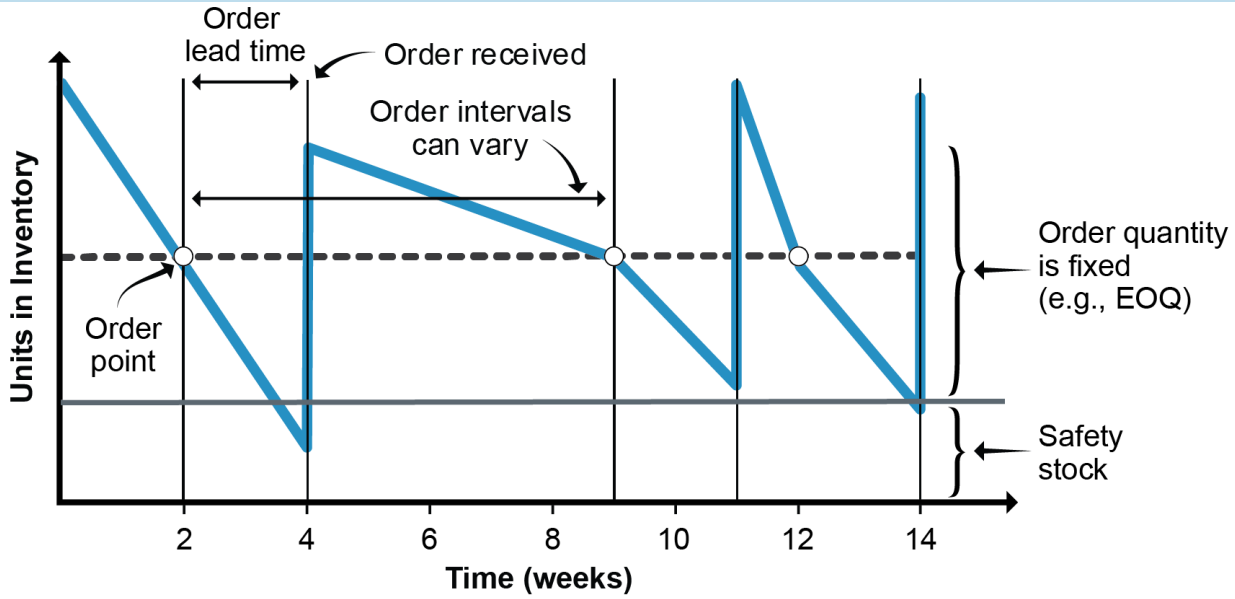
Economic Order Quantity (EOQ)

- Minimum cost: carrying costs = ordering costs
- $EOQ = \sqrt{\frac{2 \times A \times S}{i \times c}}$
  - Q = Order quantity in units
  - *i* = Annual carrying cost %
  - *c* = Unit cost in $
  - A = Annual usage in units
  - S = Ordering Cost in $/orde



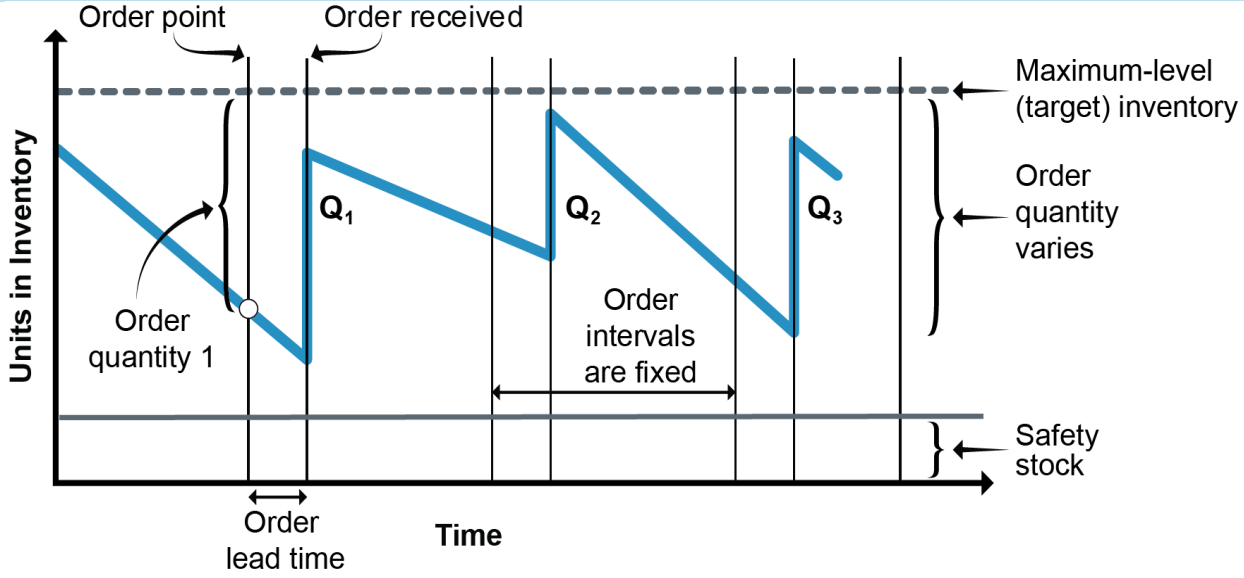
Ordering Systems: Order Point System

- Order Point = Demand During the Lead Time + Safety Stock
- Order Point = (50 Units/Week × 2 Weeks) + 100 Units = 200 Units



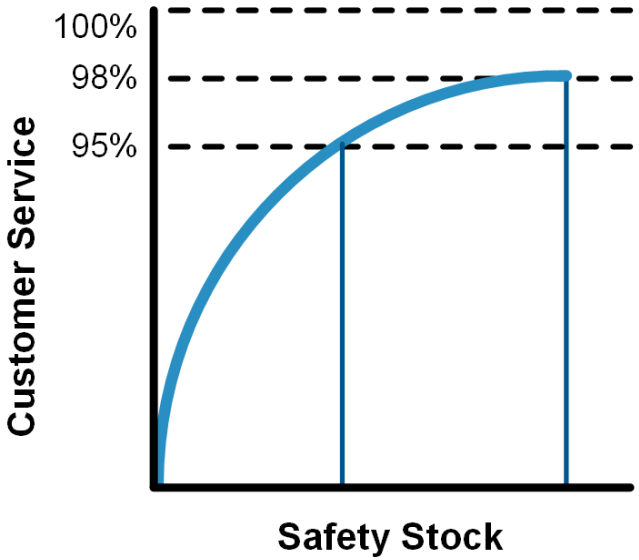
Ordering Systems: Periodic Review System

- Maximum-Level Inventory = D × (T + L) + SS
- Order Quantity = Maximum-Level Inventory − Inventory On Hand
- D = Demand/unit of time, T = Order interval, L = Lead time, SS = Safety stock



Safety Stock

- Inventory to protect against demand and lead time variations.
- Set/review target frequency for use.
- Methods for setting level: fixed amount, coverage, statistical.
- Need to balance cost of safety stock and cost of stockouts.
- To decrease: less frequent orders, less demand variability, shorter lead time, more accurate forecasts.
- Organizational, regulatory, or industry requirements ma mandate a minimum level of safety stock.



Replenishment Strategies

Safety Lead Time

- Replenishment orders placed before (or after) normal order point.
- Could result in overstocks.
- Can impact bullwhip effect.
- Large orders with long lead times, e.g., on container ships, could result in significant overstocks (or stockouts).

Traceability, Accuracy, and Disposition

Product Traceability and Configuration Management

- Reduces size of recalls
- Differentiates for region-specific bans
- Compliance audits
- Compliance with free trade zone agreements and labels such as “Made in Italy.”
- Customs inspections

Assessing Inventory Accuracy

Periodic Count

- Necessary for, e.g., retail.
- Traditional method, requires store shutdown.
- Annual count of all items.
- Often done by temporary employees.
- Disruptive, expensive, error-prone.

Cycle Count

- Count some items each day.
- Count all items a set number of times annually.
- Count A items more often than B or C items.
- Timely correction of errors, no store shutdown.

May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr

Traceability, Accuracy, and Disposition

Assessing Inventory Accuracy

Cycle Counting Example

Class	Qty.	Policy	Items/Day
A	1,000	Per month 20 days	1,000/20 = 50/day
B	3,500	Per quarter 60 days	3,500/60 = 58/day
C	5,500	Semi-annually 120 days	5,500/120 = 46/day
			154/day

Improving Tracking and Counting

- Keep it secure.
- Keep it neat.
- Make labels easily visible and put on everything.
- Use bins and arrangements to ease counting.
- Treat A, B, C items suitably.
- Use technology.

Traceability, Accuracy, and Disposition

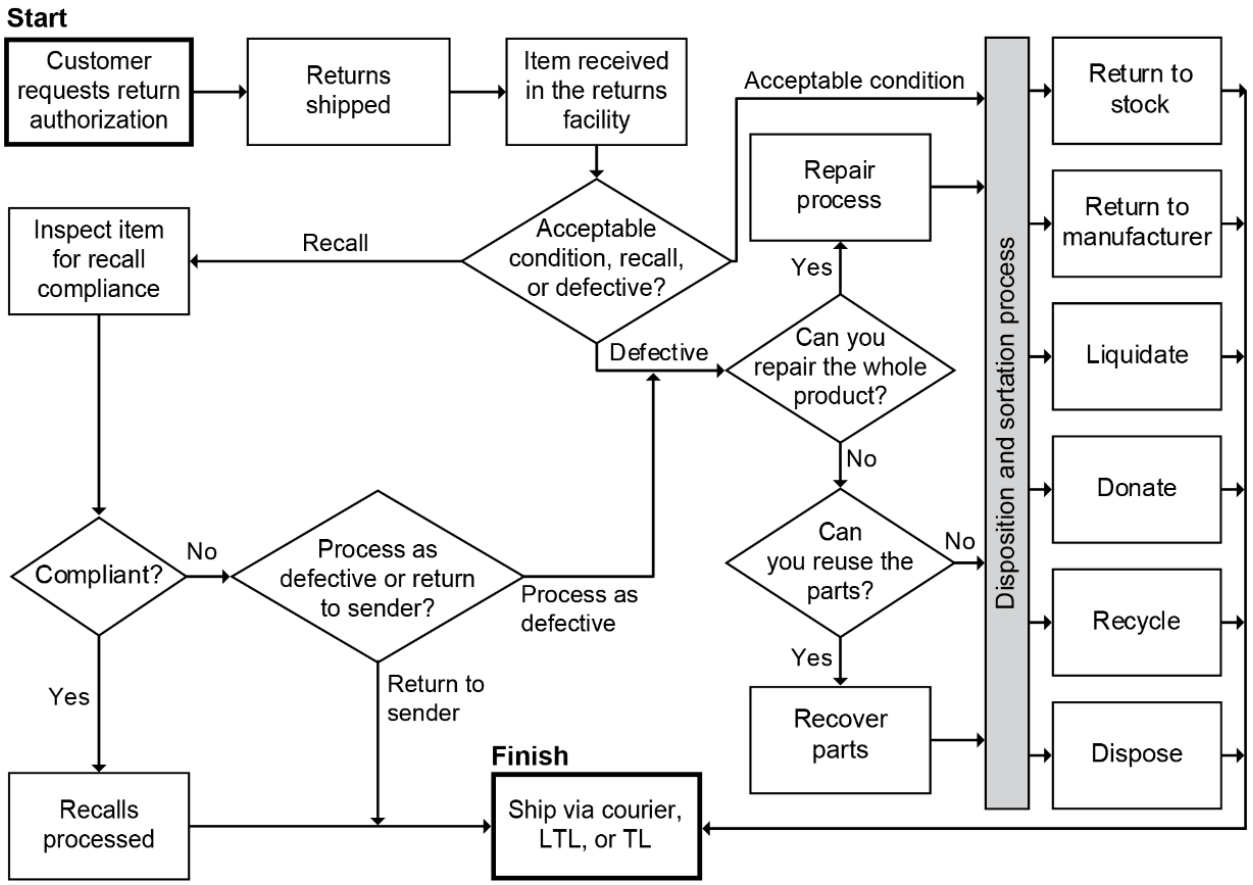
Product End-of-Life

- Use end-of-life management for phase-out and phase-in plan.
- Set end-of-sales strategy.
  - Official communication needed so as not to ruin sales
  - May need time for supply chain inventory to sell
- Set end-of-service strategy.
  - Could stay profitable or be loyalty generator
  - Provide less expensive services
- Revisit equipment and space use.
- Consider backward compatibility.
- Accept product at end of life.
- Do risk and crisis management.

Traceability, Accuracy, and Disposition

Disposition of Returned Products

- Assess and categorize
- Return material authorization or policy
- Centralize



Legal, Security, and Regulatory Requirements

Security and Regulatory Concerns

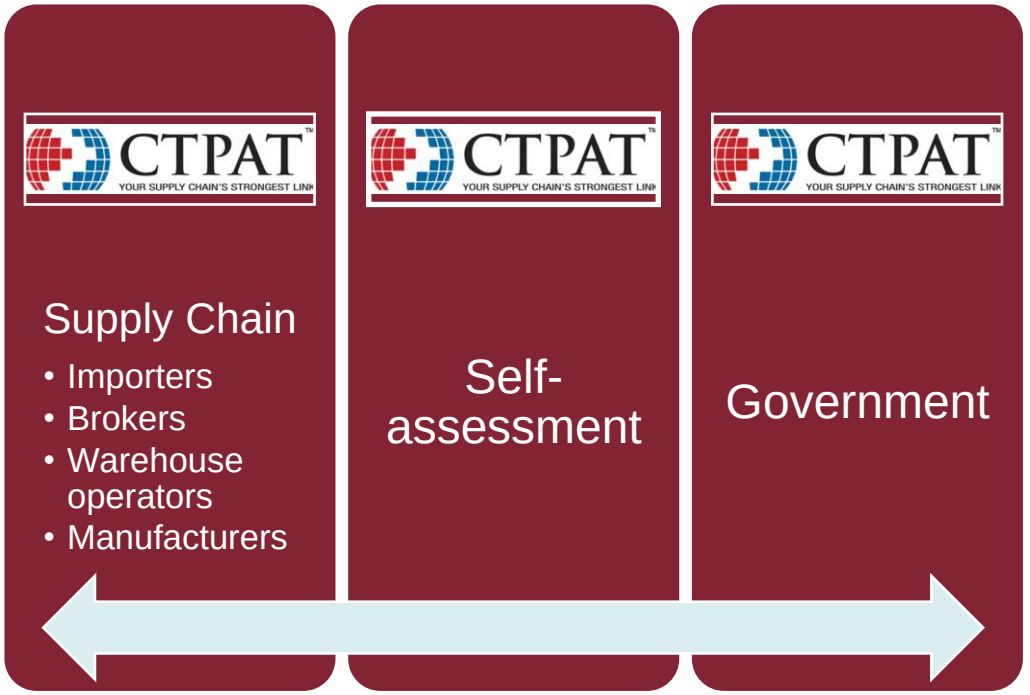
- Physical security of transportation and storage
- Meeting increased identification requirements
- Systems to deny access
- Keeping SC IS secure from hacking
- Voluntarily comply with global antiterrorism initiatives (e.g., CTPAT or AEO)?
- Internal operational and financial controls

CTPAT (Customs Trade Partnership Against Terrorism)

Legal, Security, and Regulatory Requirements

Benefits:

- Fewer inspections, reduced border time (neither guaranteed)
- Account manager
- Access to membership list
- Special account processes
- Self-policing
- Positive risk-assessment factor
- Good community partner
- Mutual recognition



Legal, Security, and Regulatory Requirements

Complying with Import and Export Requirements

- International requirements and trade agreements (e.g., harmonized system)
- Exceptions expertise
- Electronic messaging to preclear shipments
- Prohibited goods
  - Check prohibited lists.
- Labeling and documentation
  - Labeling requirements
  - Language of each country goods pass through?
  - Documentation complete and correct?
  - Electronic messaging used?

Legal, Security, and Regulatory Requirements

International Labor Considerations

Your Organization's…	Compared Against…
Entry-level wage	Minimum wage and gender disparity
Average wages	Market rates and gender disparity
Senior position	Local staffing
Infrastructure	Local job base investments
New hires	Diversity and retention by subgroups
Full-time benefits	Part-time
Parental leave	Support and postpartum retention
Layoffs/plant closings	How communicated, unions, and support services
Health and safety	Worker committee representation, union/nonunion
Injuries	Region and gender
Training	Gender or role
Grievances	Existence and efficacy

Import/Export Regulations and Documentation

Import/Export Road Map

- Import licensing/government
  - World Trade Organization (WTO)
- To clear customs, even large organizations rely on experienced customs house brokers.
  - Regulations change.
  - Must be certified to clear shipments.
- Customs regulations serve two purposes:
  - Provide revenue.
  - Protect domestic industries.
- Customs intentions:
  - Confirm stated cargo value.
  - Verify correct markings.
  - Find forbidden/illegal items.
  - Enforce quotas.
  - Ensure invoice is correct.
  - Discourage trade dumping.

Import/Export Regulations and Documentation

Incoterms®

What are Incoterms®?

- International Commercial Terms define the obligations of exporters and importers.

Are they legally binding?

- No. But buyers and sellers may use them in POs. Contracts must specify the Incoterm® year.

Example: **FOB** Med Shipping Terminal, Port of Baltimore, Incoterms® 2020

Import/Export Regulations and Documentation

Incoterms® 2020 Definitions

EXW	Ex Works (buyer takes over goods at seller's location; loads vehicle)
FCA	Free Carrier (if named place is seller's premises, seller loads on buyer's means of transport (e.g., truck))
CPT	Carriage Paid To (seller selects and pays for main carriage)
CIP	Carriage and Insurance Paid To (seller pays main carriage and insurance)
DAP	Delivered at Place (seller delivers goods and buyer receives and unloads)
DPU	Delivered at Place Unloaded (seller delivers goods to a location and unloads)
DDP	Delivered Duty Paid (seller incurs all costs, including import duty)
FOB	Free on Board (seller puts goods on ocean vessel)
FAS	Free Alongside Ship (buyer lifts cargo onboard)
CFR	Cost and Freight (seller selects/pays for main carriage)
CIF	Cost, Insurance, and Freight (seller pays main carriage and insurance)

Import/Export Regulations and Documentation

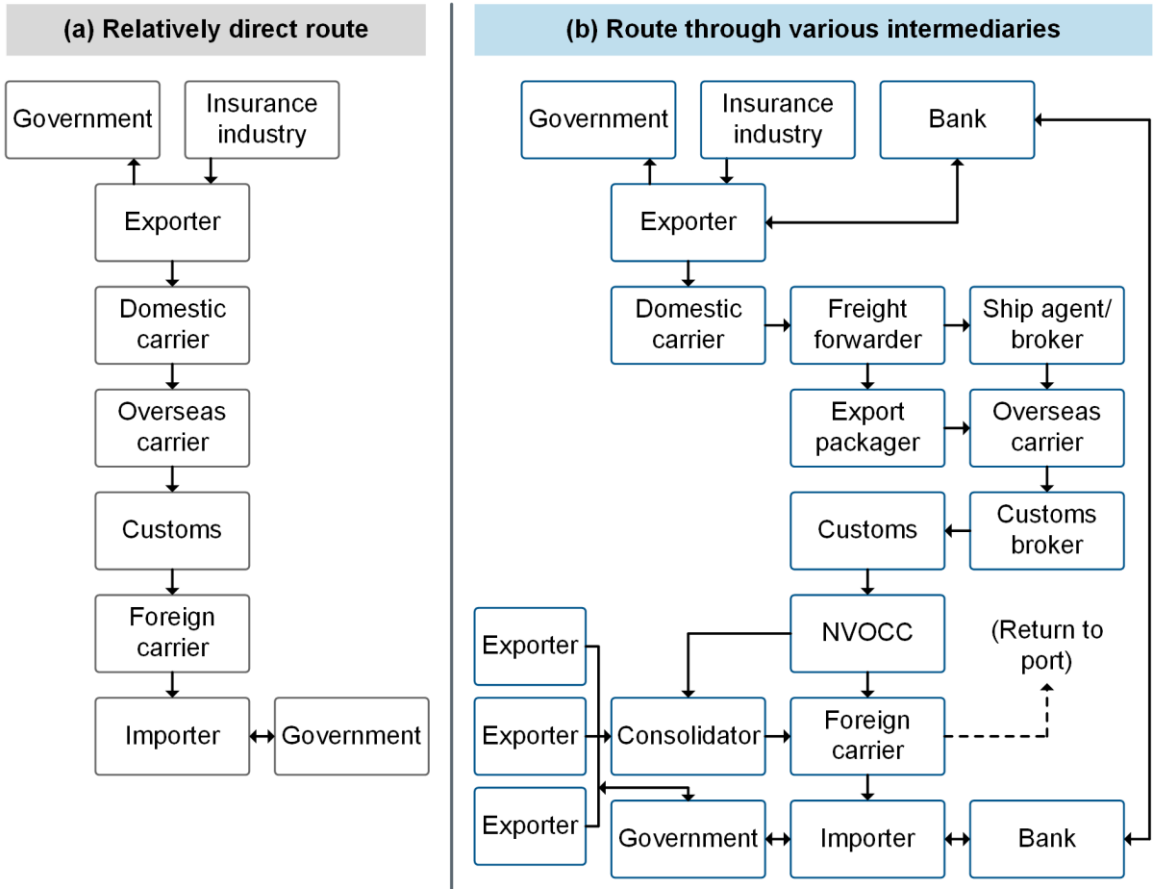
Export-Import Participants

- Exporter
- Importer
- Domestic carrier
- Overseas carrier
- Freight forwarder
- NVOCC
- Consolidator
- Custom house broker
- EMC
- ETC
- Shipping association
- Ship broker
- Ship agent
- Export packing company

Import/Export Regulations and Documentation

Export-Import Flowchart

- Determine which intermediaries make sense



Import/Export Regulations and Documentation

Export Documentation

- Export declaration
- Export license
- Commercial invoice
- ATA carnet
- Certificate of origin
- Bills of lading
- Air waybills
- Dock receipt
- Certificate of insurance
- TIR Convention and TIR Carnet
- CMR convention and CMR waybill

Import/Export Regulations and Documentation

Import Documentation

- Harmonized system classification codes
- Declared value/duty drawbacks
- Calculating import costs
  - Import duties
  - Value-added taxes (VAT)

Live	
0301.99-290	Fish (excluding ornamental fish, fry for culture and 0301.99-210), live (import)
0301.99-900	Other live fish (export)
Fresh or chilled	
0302.11-000	"Masu" (*Salmo trutta, Oncorhynchus mykiss, O. clarki, O. aguabonita, O. gilae, O. apache* and *O. chrysogaster*) (import and export)
0302.12-000	Pacific, Atlantic or Danube *sake* (export only)
0302.12-011	"Benizake", red salmon *O. nerka* (import only)
0302.12-012	"Ginzake", silver salmon *O. kitsutch* (import only)
0302.12-019	Pacific salmon excluding *O. nerka* and *O. kitsutch* (import only)
0302.12-020	Atlantic or Danube Salmon (import only)
0302.70-000	Livers, eggs and soft roe of fishes (export only)
0302.70-090	Livers, eggs and soft roe of fishes (not *Clupea, Gadus* or *Merluccius* spp.) Fish livers and roes nes) (import only)
Frozen	
0303.10-000	Pacific sake (prior to 2002) (export only)
0303.11-000	"Benizake" Sockeye salmon or red salmon *O. nerka* 2002 onward (imports and exports)—prior to 2002, code 0303.10-010 was used for imports and 0303.10-000 was used for exports)
030.19.000	Other Pacific "sake" 2002 onward (export only)
030.19-010	"Ginzake" silver salmon *O. kisutch* 2002 onward—previously 0303.10-020 (prior to 2002) (import only)

Trade Zones and Blocs

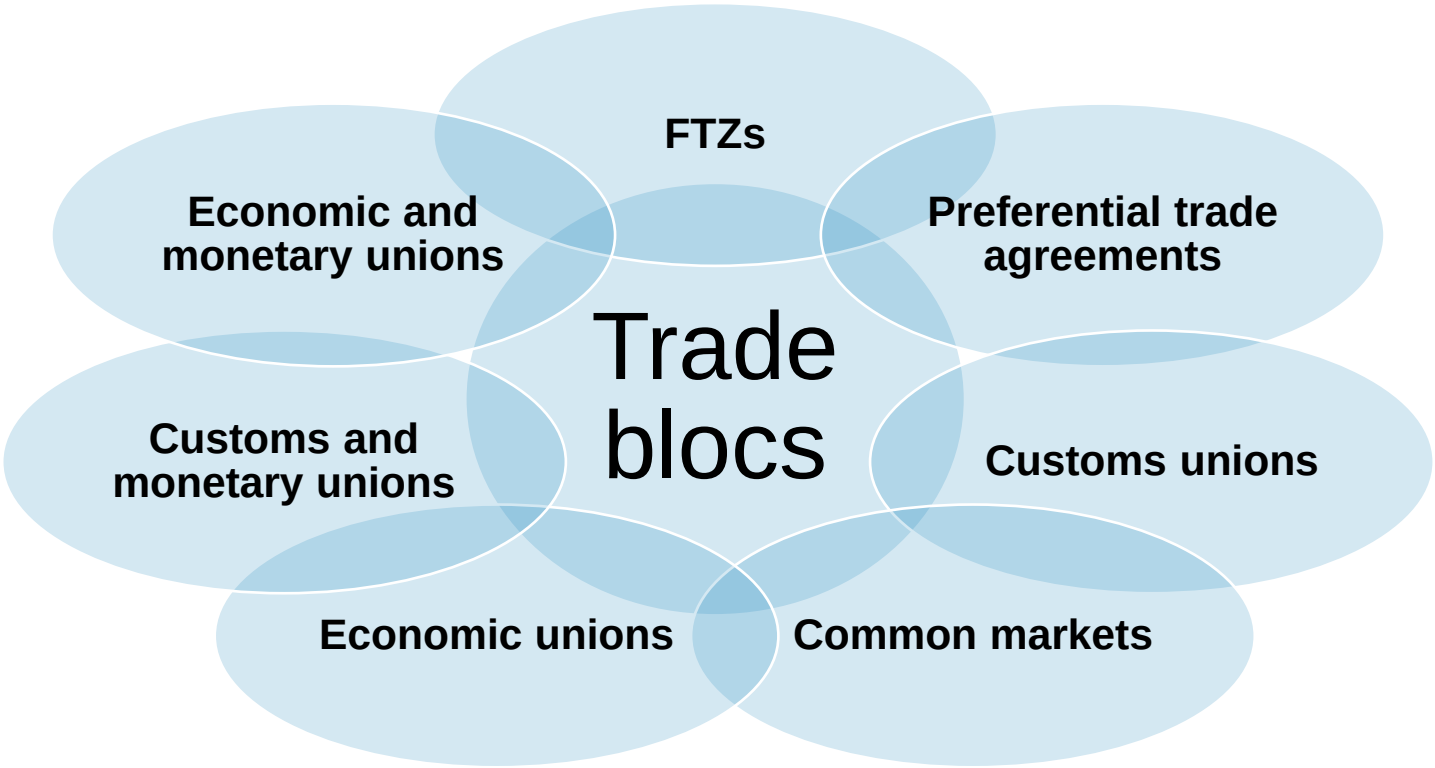
Free Trade Zones (FTZs)

- **Benefits:**
  - Deferral of all duties and excise taxes until goods leave the FTZ for customs—a chance to repack, reprocess, etc., for compliance
  - Reduced import duties on some cargoes
  - Chance to inspect (and reject) cargo before paying duties
  - Avoidance of quotas
  - Indefinite cost-effective storage
  - Manufacture and assembly without “inverted duties”

- **There will be NO:**
  - Customs formalities, duties, or quotas
  - Duties or quotas on reexports
  - Fines
  - Retail trade.

Trade Zones and Blocs

Trade Blocs



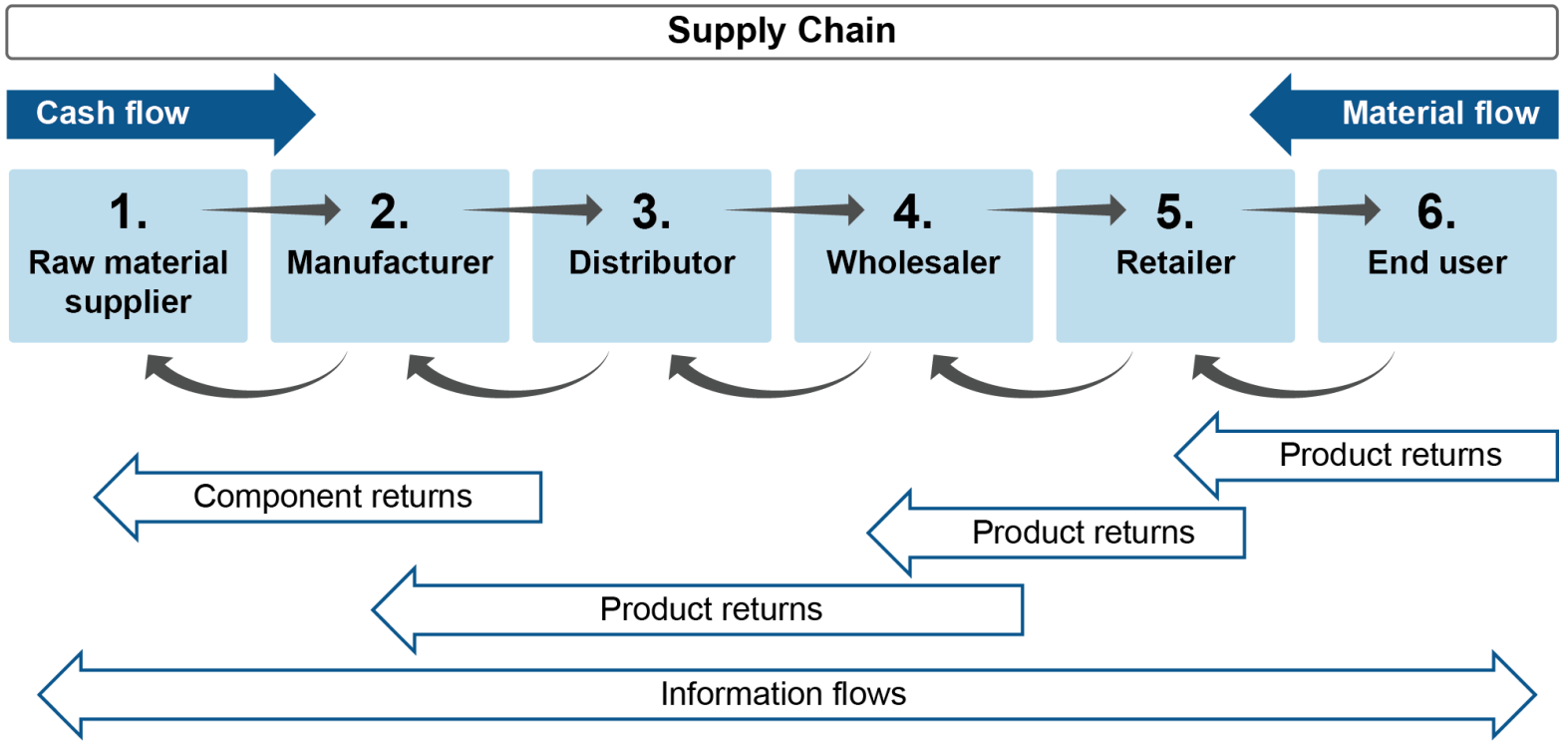
Trade Zones and Blocs

United States-Mexico-Canada Agreement (USMCA)

- Went into effect on July 1, 2020
- Replaces the North American Free Trade Agreement (NAFTA); generally consistent with it
- Changes to rules of origin
- Certificate of origin eliminated
- De minimis levels to streamline trade and support small/medium-size enterprises
- Reviewed every six years; expiry July 1, 2036

Reverse Logistics

Reverse Logistics



Reverse Logistics

Benefits

- Lucrative service contracts
- Mitigation of unprofitable effects of returns
- Enhanced customer loyalty and reputation
- Valuable raw materials in product returns
- More efficient products and logistical tactics
- Profits from resale of refurbished products/ parts
- New types of jobs
- More sustainable use of energy and resources
- Reduction of harmful emissions and pollutants
- Reduced need for landfills and incinerators

Reverse Logistics

Total Cost of Reverse Logistics

+ Returned product liquidation revenue
+ Recycling revenue
+ Repair revenue
+ Restocking charges and warranty/service program fees
+ Increase in sales from warranties, remanufacture programs, environmental reputation, etc.
+ Capture of tax savings or incentive program benefits
- Returned product cost of goods sold
- Processing and handling costs
- Transportation costs
- Repair and spare parts costs
- Warranty expenses and returns credits

Total cost of reverse logistics

Requirements for Reverse Logistics

Cost avoidance

Keep more revenue by investing in reverse logistics strategy and management.

Aftermarket savings

Sell metals, etc., from returns, containers.

Competitive edge

Win customers with service excellence.

Environmental concern

Do the right thing.

Pressure

Comply with “green” pressure from stakeholders.

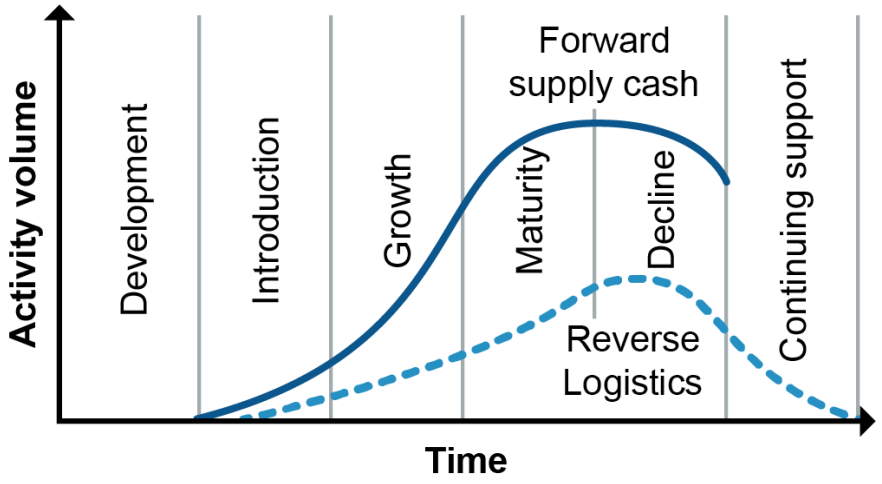
Growing market

Market “organic,” chemical free products.

Reverse Logistics

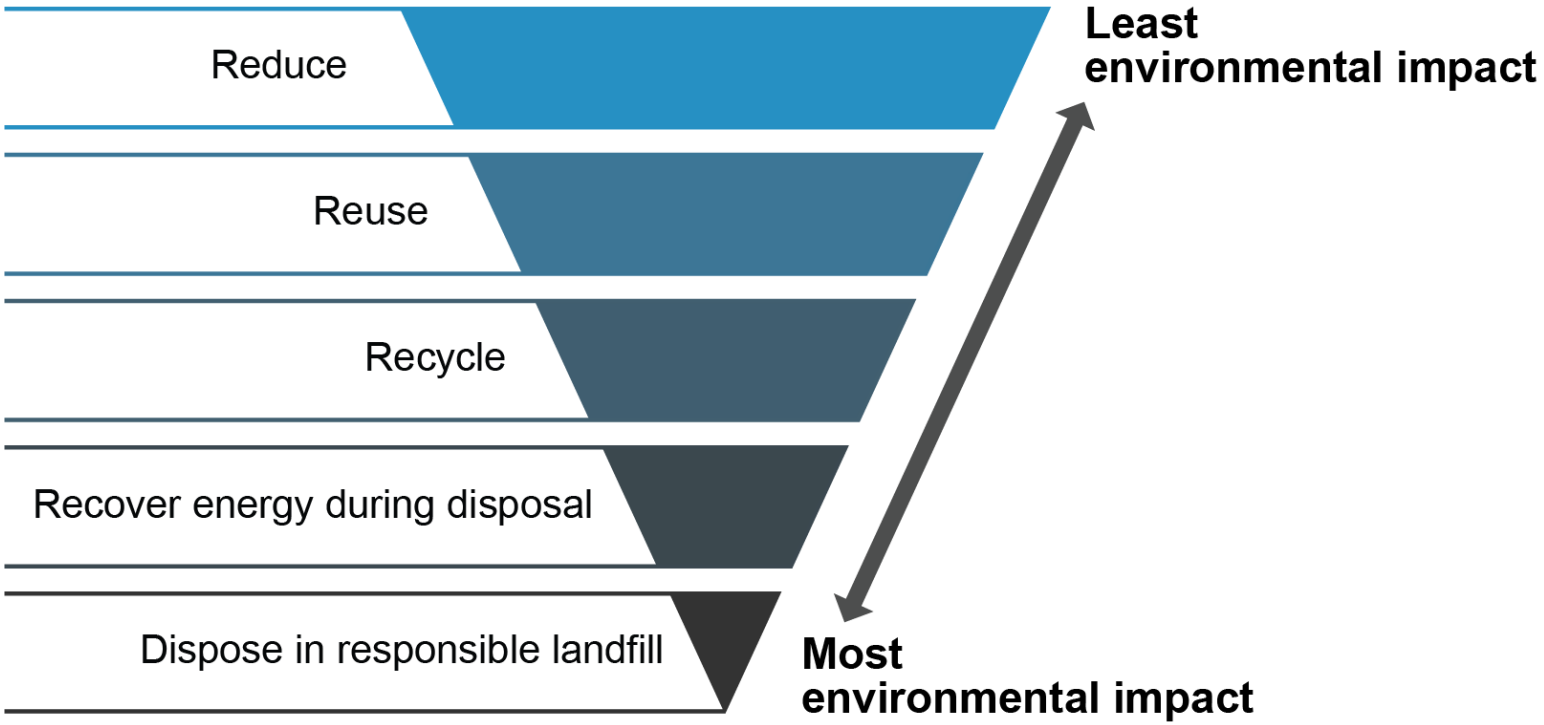
Reverse Logistics Design

- Reverse flows require their own systems.
- Design warranties and RMAs.
- Life cycle design considers reduce, reuse, recycle, and recover energy (4 Rs) in all phases.



Waste

Waste Hierarchy



Waste Regulations and Compliance

WEEE	• Burden of disposing computers, monitors, televisions, printers, etc., on manufacturers. • Manufacturers cannot charge a fee to take. • Known as “E-waste” in a many U.S. states
RoHS	• Aimed at reducing waste. • Impacts the PDLC. • Limits what new electrical and electric equipment can contain to be sold in EU from any source: — Lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyl, polybrominated diphenyl ether

Recap, Q&A and Homework Assignment

Recap of Key Points

- Alignment of inventory requirements with demand.
- Product traceability and chain of custody.
- Physical inventory and cycle counting.
- Product disposition and obsolescence.
- Import and Export regulations, trade zones and compliance
- Reverse logistics

Homework Assignment

- **Task: 50 -**Multiple-Choice Questionnaire: Logistics and Distribution