

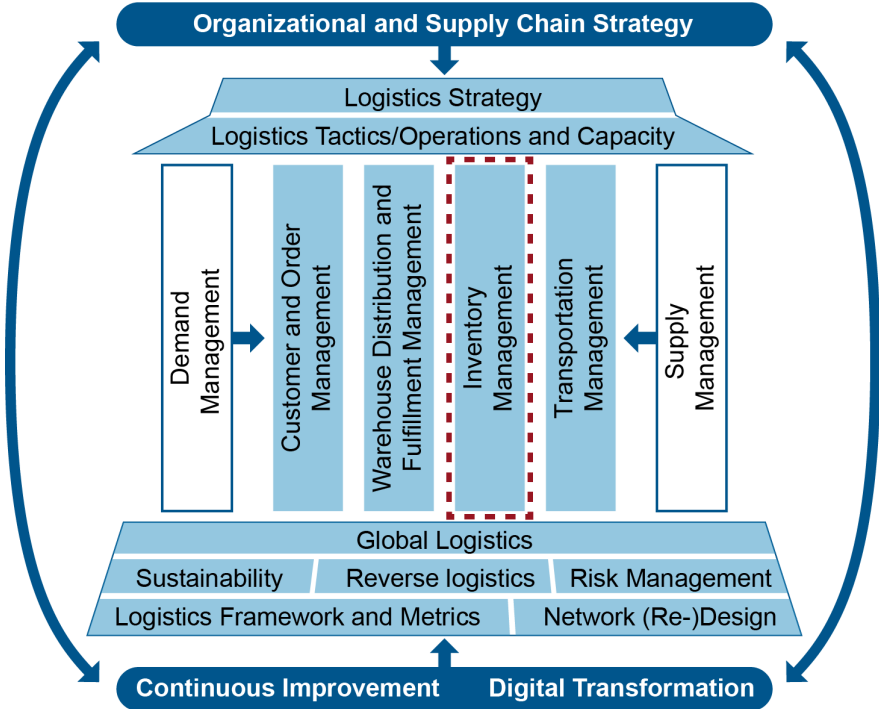
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CERTIFIED IN LOGISTICS,
TRANSPORTATION AND DISTRIBUTION

MODULE 5: INVENTORY MANAGEMENT

Module 5: Inventory Management

Module 5 Overview



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TRANSPORTATION AND DISTRIBUTION

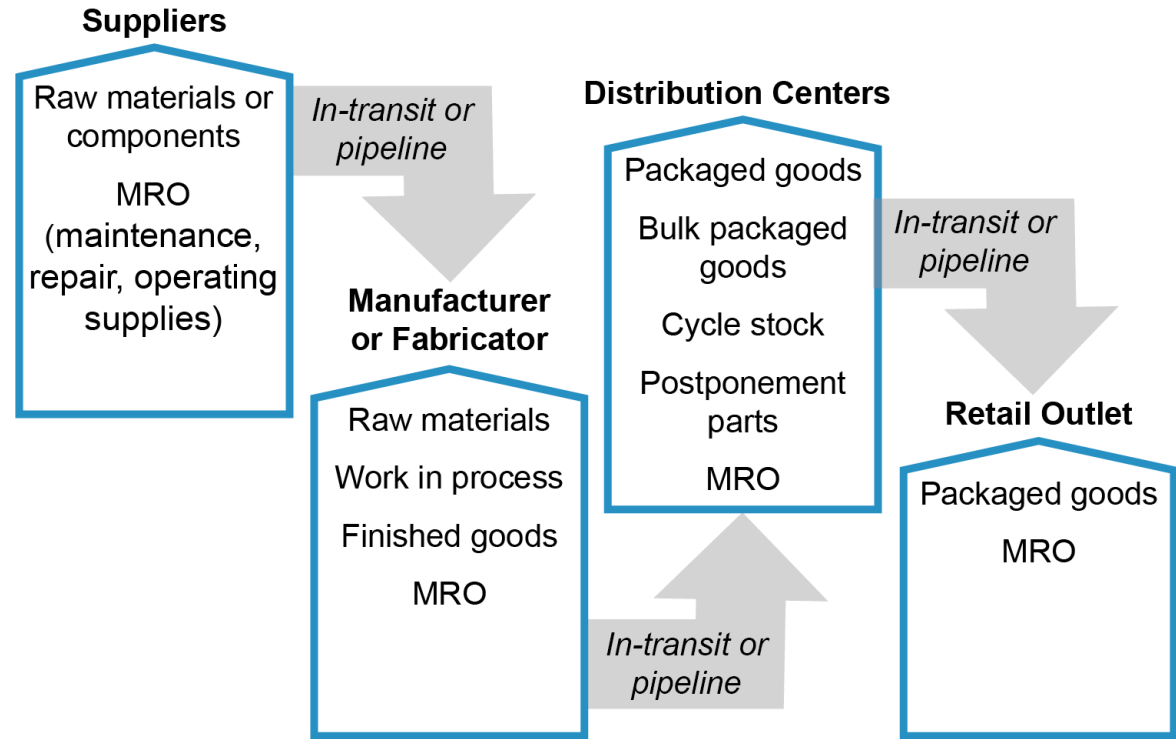
MODULE 5, SECTION A: UNDERSTAND INVENTORY MANAGEMENT FUNDAMENTALS

Understand Inventory Types, Characteristics, and Role

Inventory in the Supply Chain

Inventory to support

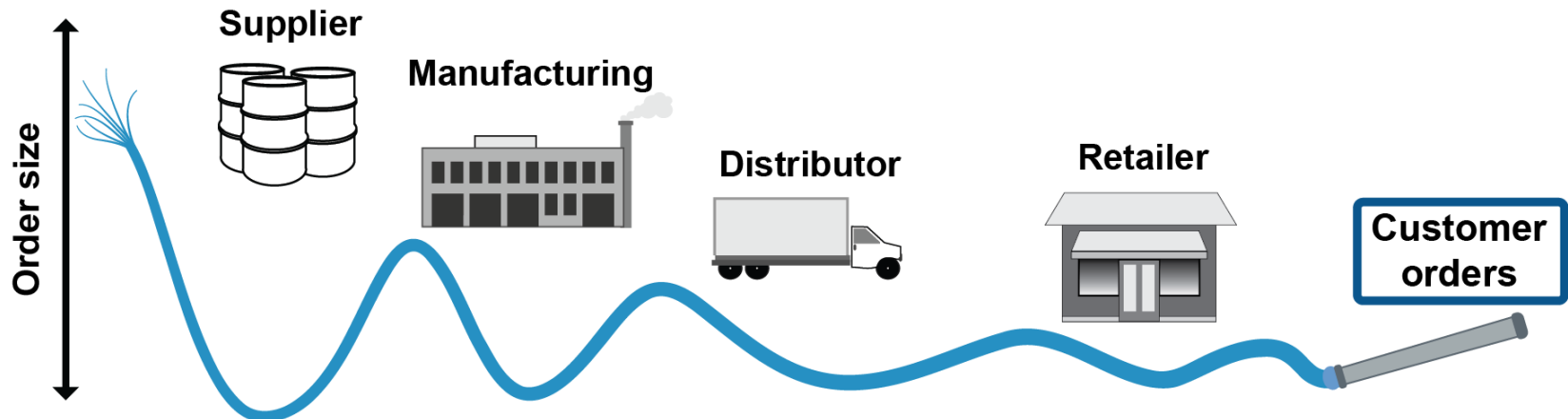
- Production
- Supporting activities
- Customer service
- Channel distribution



Understand Inventory Types, Characteristics, and Role

Bullwhip Effect

- Caused by lack of communication among supply chain partners of consumer demand, plus supply variability
- Primarily impacts make-to-stock environments



Understand Inventory Types, Characteristics, and Role

Stakeholder Perceptions of Inventory

Business leaders

Cost that may limit investments in new opportunities and growth.

Financial managers

Keep value of inventory low as it affects business financials.

Operations managers

Inventory is key to output; long production runs reduce production costs.

Sales and marketing

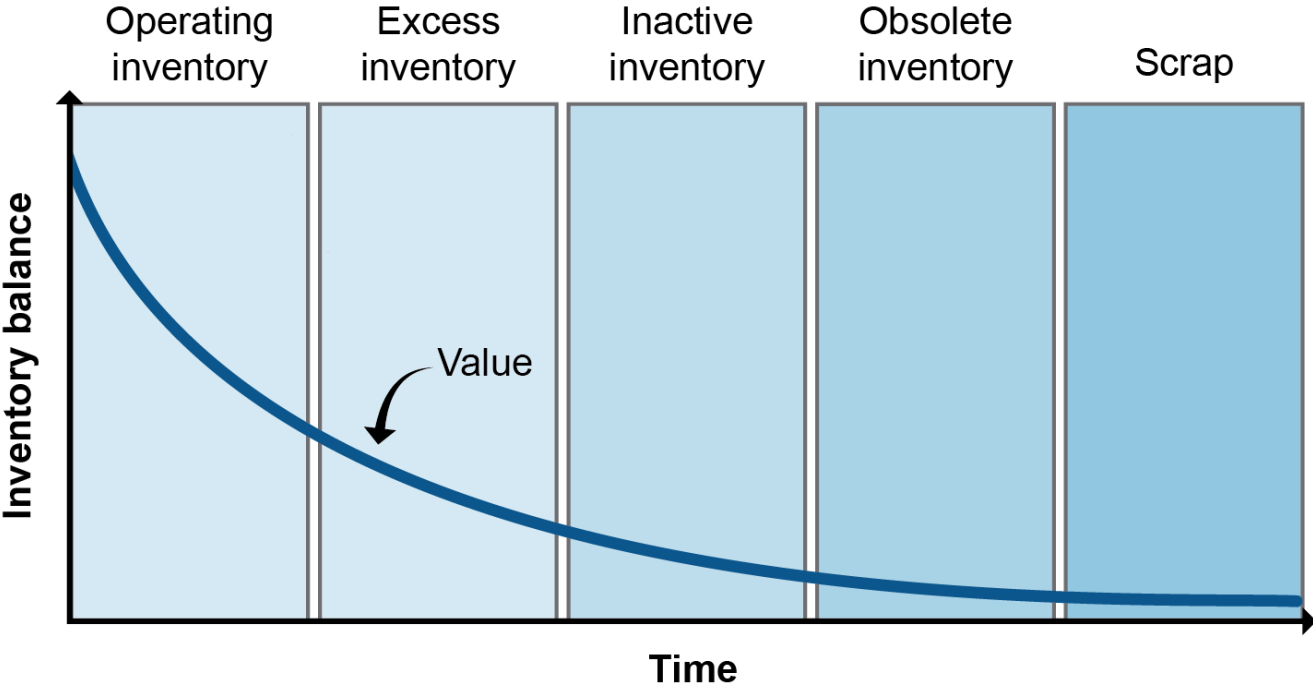
Enough inventory to satisfy demand.

Consumers

Right product in the right amount at the right time.

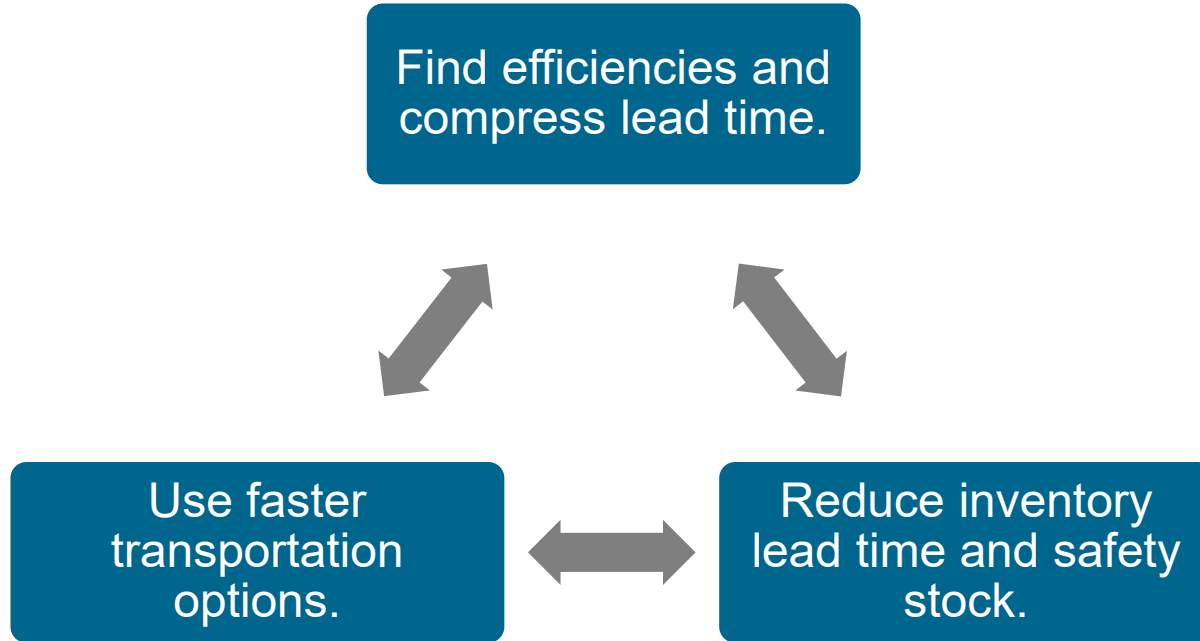
Understand Inventory Types, Characteristics, and Role

Inventory and Time



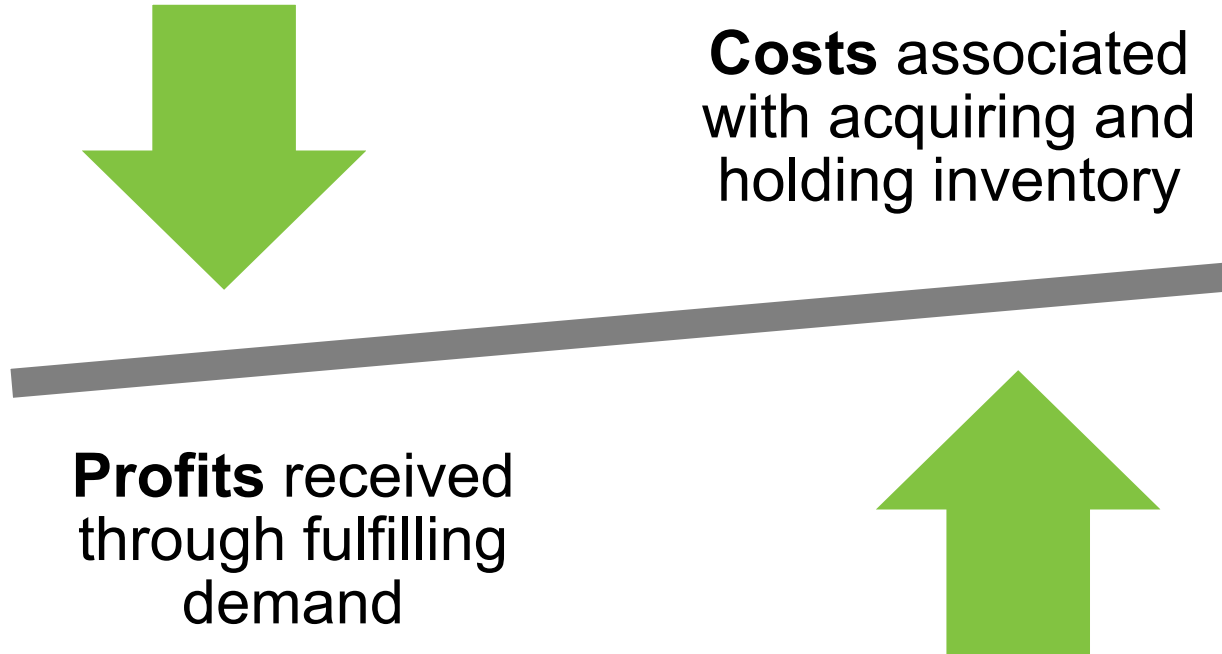
Understand Inventory Types, Characteristics, and Role

Faster Inventory Turns Means Less Cash Investment



Define Functions of Inventory and Related Strategies

Demand Fulfillment

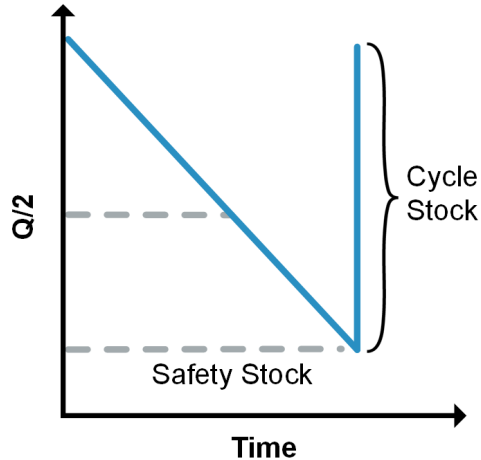


Define Functions of Inventory and Related Strategies

Cycle and Pipeline Stock

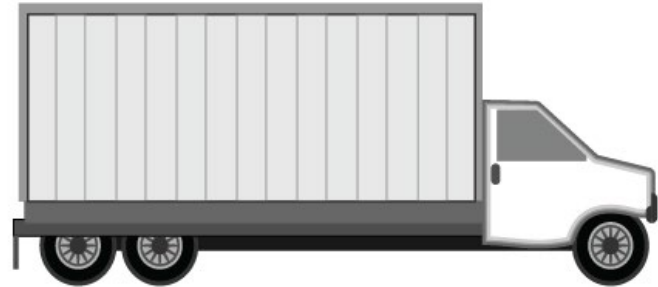
Cycle stock

Amount of inventory required to satisfy normal demand

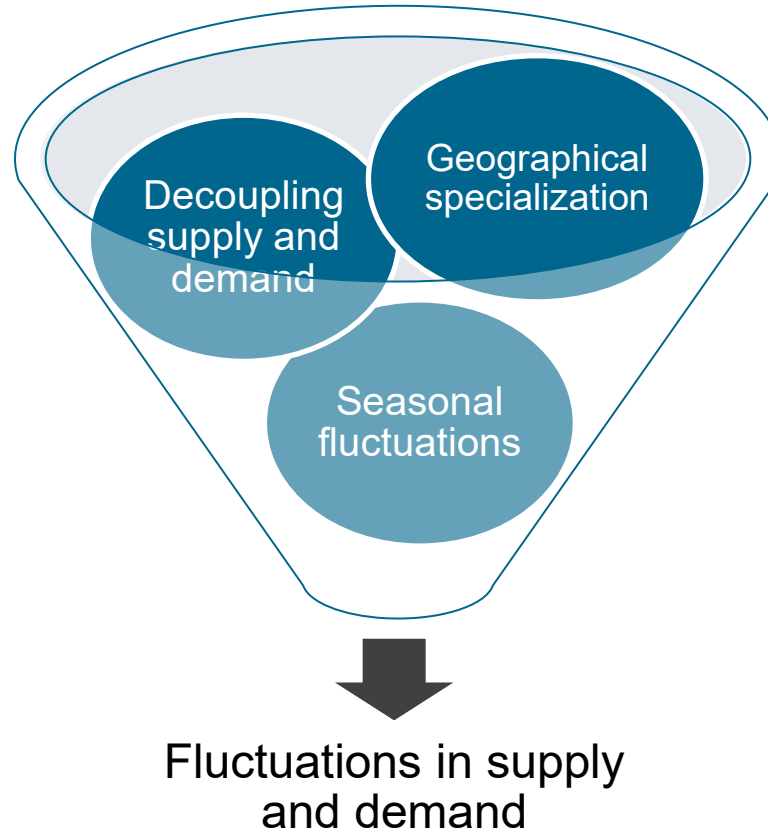


Pipeline stock

Amount of inventory in the transportation network and distribution system



Define Functions of Inventory and Related Strategies



Define Functions of Inventory and Related Strategies

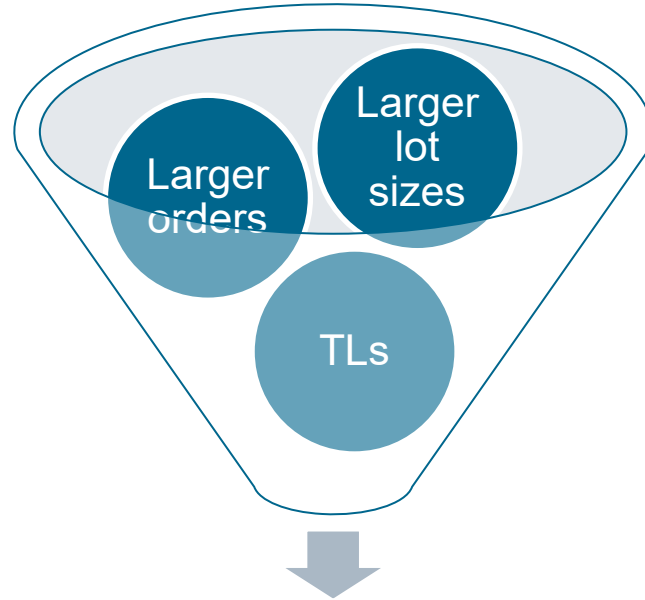
Safety Stock, Safety Lead Time, and Hedge Inventory

- Safety lead time: get before real need date
- Hedge inventory: buffer against uncertain events



Define Functions of Inventory and Related Strategies

Cost Savings from Economies of Scale



Lower cost per unit by distributing fixed costs over larger quantity.

Define Functions of Inventory and Related Strategies

Inventory Management Strategies

- Minimize: MTO, postpone, share demand
- Standard service level for all or tiered service level
- Maximize inventory profitability
- Meet budget constraints
- Maximize economies of scale
- Maximize transportation capacity utilization
- Liquidate inactive

Understand Role of Technology in Inventory Management

Digital Transformation for Better Inventory Management

Digital Transformation/Industry 4.0

- High level of supply chain maturity
- Capabilities with technology enablers
- Control towers
- Real-time forecasting and analytics

Inventory management systems (IMS)

- Integrate
- Control
- Visualize
- AI-enabled forecasting

Internet of Things (IOT)

- Sensors report on status
 - In vehicles, payloads, warehouse systems, reusable assets
- Location
- Temperature

Robotics

- Reduce inventory cost by reducing labor
- Higher fixed cost

Understand Role of Technology in Inventory Management

Barcoding/RFID

Barcodes

- Machine-readable code: manufacturer and SKU
- Examples:
 - 1D: UPC, GS1 DataBar



- 2D: QR code



- Goal: all POS accept 2D

RFID



- Smart chips to identify and locate units
 - Case, pallet
- Signals automatically picked up by readers/interrogators.

Understand Role of Technology in Inventory Management

RFID Tag Types

Passive tag

- Does not send out data
- Not self-powered
- Reader temporarily powers tag
- Can transmit data at short range
- Cheap if purchased in bulk

Semipassive tag

- Tag sends out data
- Self-powered
- Widens range by harnessing power from reader



Active tag

- Broadcasts information
- Has power source
- Can transmit data to reader at long ranges
- Most expensive type
- For containers or pallets

Understand the Costs of Inventory

Inventory Costs

Acquisition Costs	Carrying Costs	Stockout Costs
<ul style="list-style-type: none">▪ Unit cost<ul style="list-style-type: none">– Overhead costs▪ Ordering cost<ul style="list-style-type: none">– External orders– Internal setup costs▪ Handling cost	<ul style="list-style-type: none">▪ Capital cost▪ Storage▪ Insurance▪ Taxes▪ In-transit cost	<ul style="list-style-type: none">▪ Immediate loss of revenue▪ Damaged customer relations▪ Damaged business reputation▪ Lost future revenue

Understand the Costs of Inventory

Acquisition Costs

Unit cost

- Material
- Labor to produce items
- Overhead
- Packaging
- Inbound transportation

Ordering costs

- Costs that increase per order
- Setup costs (calibration, downtime)

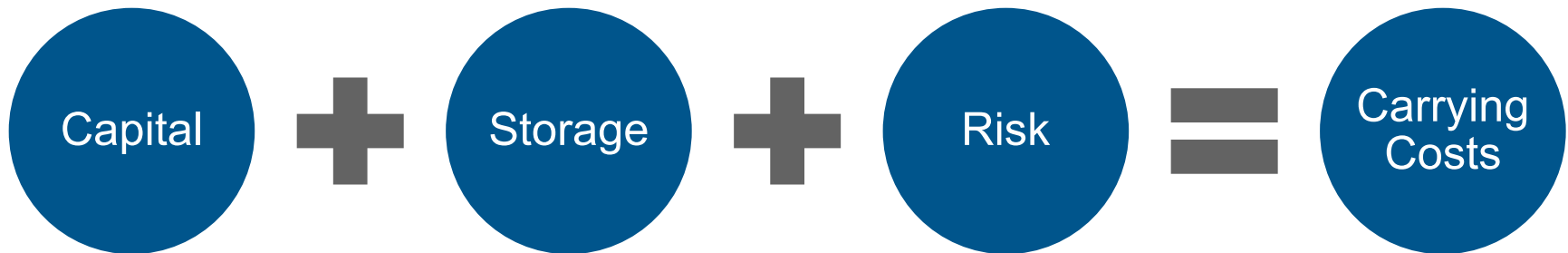
Handling costs

- Share of capital costs, labor, packaging for transportation

Understand the Costs of Inventory

Carrying Costs

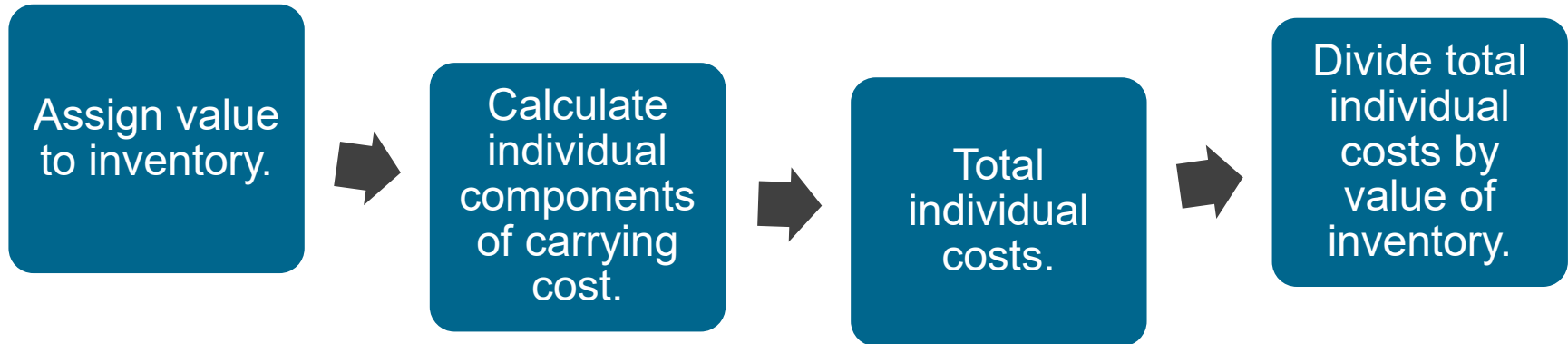
“The cost of holding inventory, usually defined as a percentage of the dollar value of inventory per unit of time (generally one year).”



Understand the Costs of Inventory

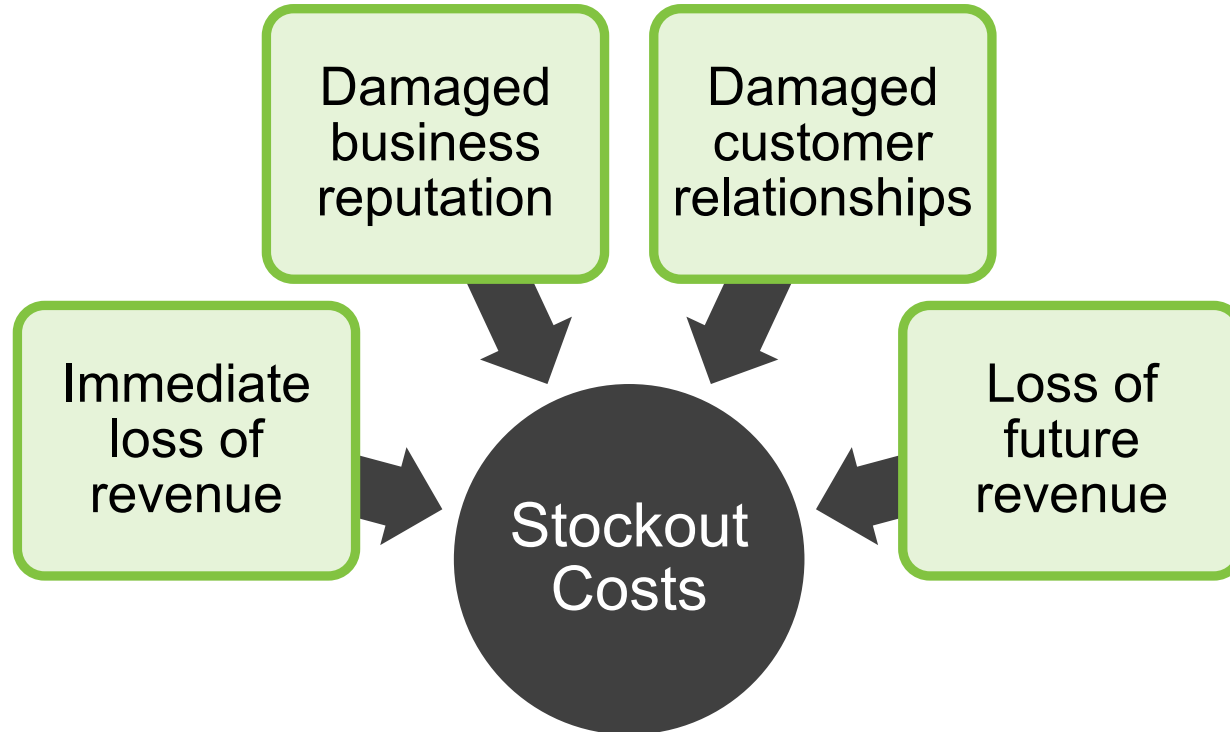
Calculating Carrying Cost

Carrying cost is shown as a percentage of the value of inventory.



Understand the Costs of Inventory

Stockout Costs



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MODULE 5, SECTION B: DEVELOP INVENTORY STRATEGY AND POLICY AND IMPLEMENT INVENTORY CONTROL

Determine When and How Much to Order

Demand Types

Independent demand

- Finished goods
- Forecasted
- Inventory approaches
 - Fixed order quantity
 - Fixed order period

Dependent demand

- Components or kits
- Calculated
- Approaches
 - MRP for components
 - DRP for kits

Dual demand

- Independent:
Service parts
- Dependent:
Components

Determine When and How Much to Order

When to Order: Order Point

$$\text{Order Point} = \text{Anticipated Demand (D)} \times \text{Lead Time (L)}$$

Demand:

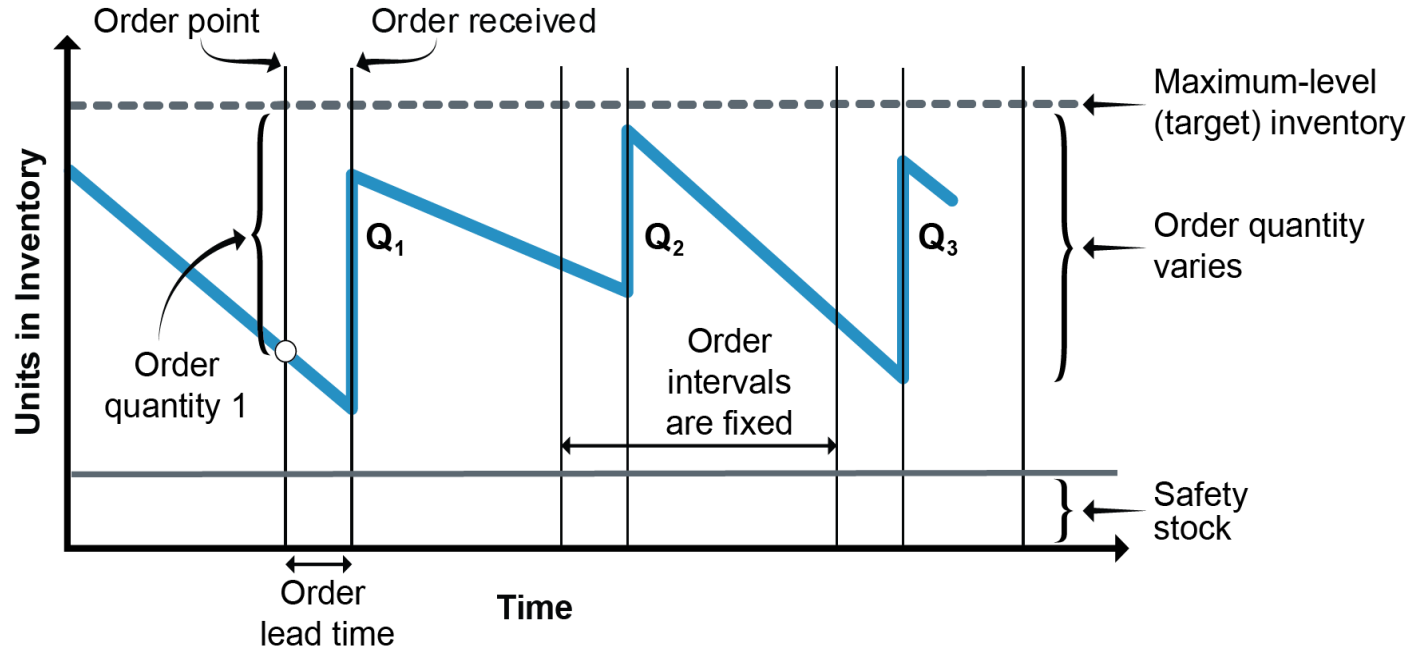
- Historical data
- Forecasts
- Analysis of current trends

Lead time:

- Inventory review
- Prepare and submit orders
- Supplier reviews and processes
- Transit time
- Receipt, check, and stock

Determine When and How Much to Order

When to Order: Fixed Order Period

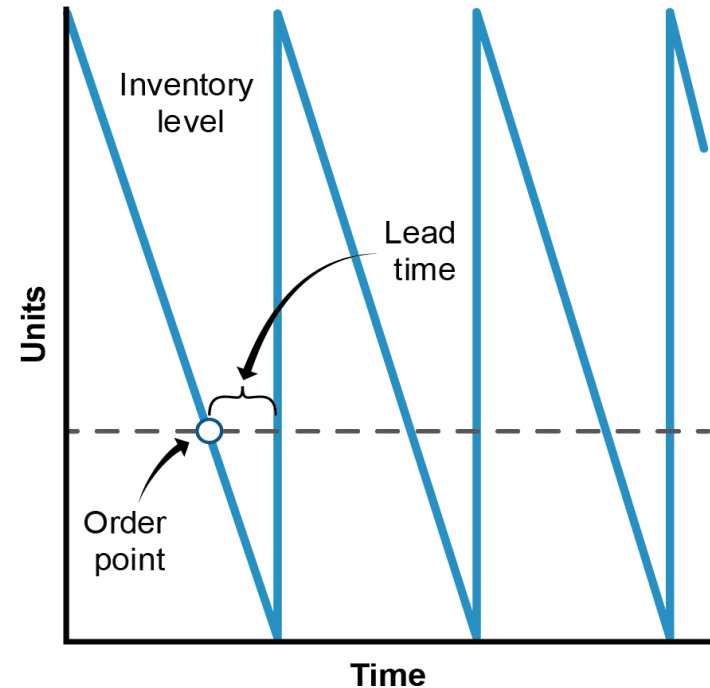


Source: APICS Certified Supply Chain Professional Learning System, Version 4.0

Determine When and How Much to Order

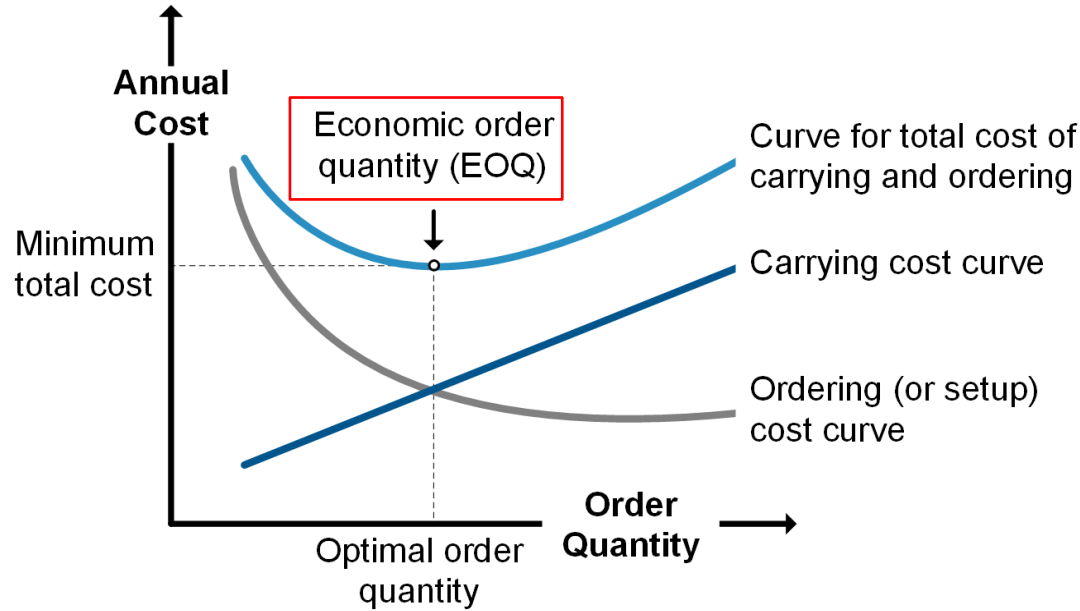
How Much to Order: Fixed Order Quantity

- Quantity of order remains the same.
- Uses an order point to trigger replenishment.
- Time between orders (order period) may vary.



Determine When and How Much to Order

Economic Order Quantity (EOQ)



Source: APICS Certified Supply Chain Professional Learning System, Version 4.0

$$EOQ = \sqrt{\frac{2AS}{IC}}$$

Where:

- A = Annual usage in units
- S = Ordering (or setup) costs in a currency amount
- I = Annual carrying cost rate
- C = Unit cost

Determine When and How Much to Order

EOQ versus Period Order Quantity (POQ)

Using EOQ of 298 units:

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	SUM
Net Requirements	50	80	100	100	80	60	0	70	90	100	100	150	200	1,180
Planned Order Receipt	298			298					298			298		1,192
Ending Inventory	248	168	68	266	186	126	126	56	264	164	64	212	12	1,960

Using POQ of 3 weeks:

$$\text{POQ's Ideal Number of Periods} = \frac{\text{EOQ}}{\text{Average Usage per Period}} = \frac{298}{100} \cong 3$$

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	SUM
Net Requirements	50	80	100	100	80	60	0	70	90	100	100	150	200	1,180
Planned Order Receipt	230			240				260			450			1,180
Ending Inventory	180	100	0	140	60	0	0	190	100	0	350	200	0	1,320

Order period can vary

Determine When and How Much to Order

How Much: Target Inventory (Min-Max Systems)

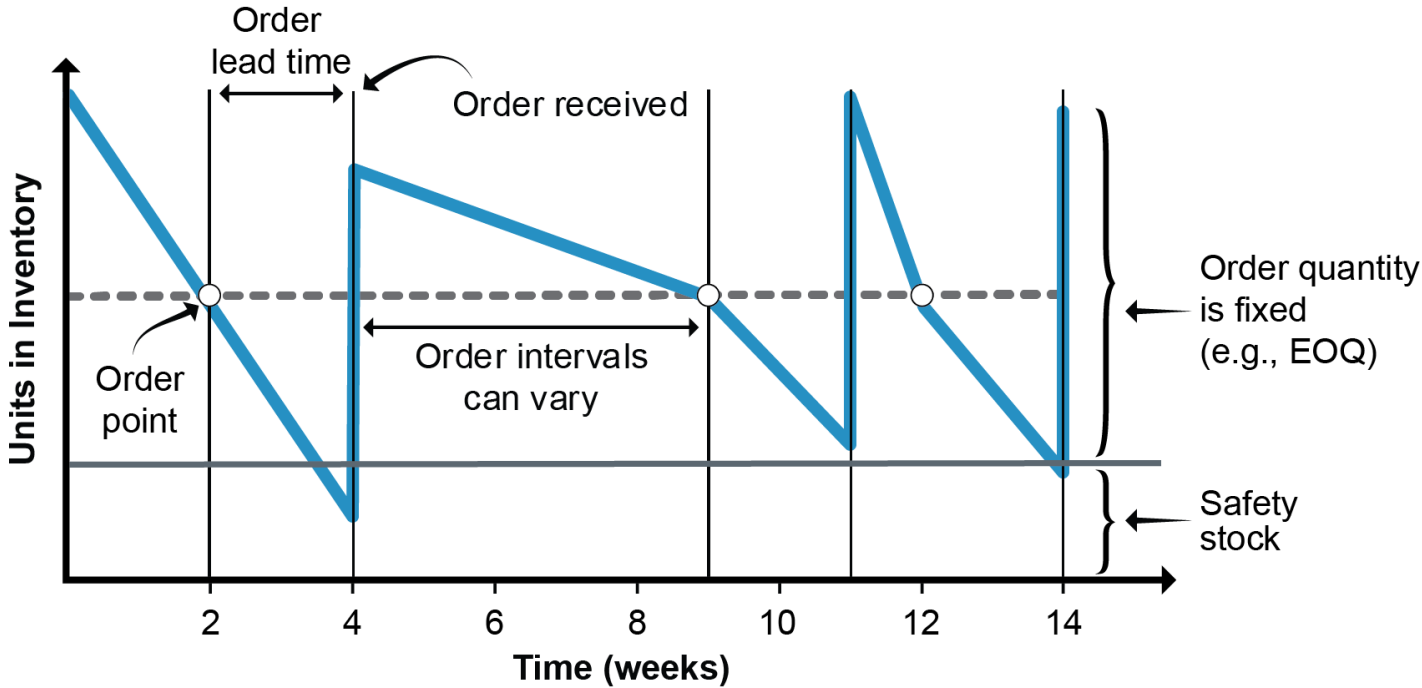
- Type of order point replenishment system
 - Hybrid approach to inventory control
 - Variable order quantity
-
- Minimum (min) is the order point.
 - Maximum (max) is the order up to inventory target level.

Determine When and How Much to Order

Just in Time (JIT) with Kanban

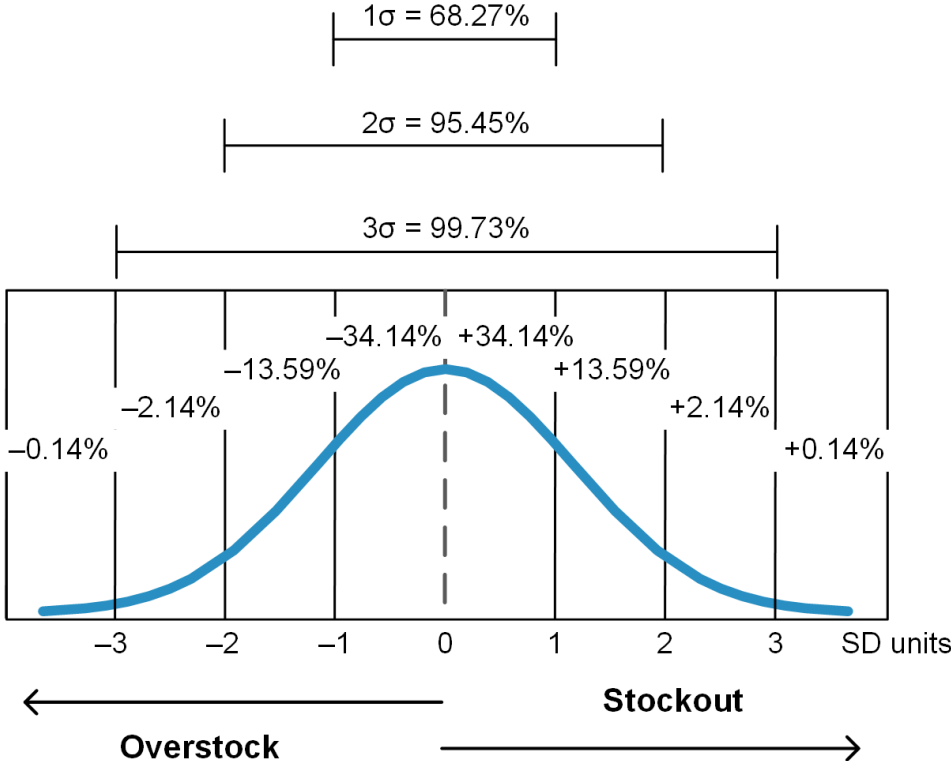
- Aims at reducing waste
- Works to reduce uncertainty of what to produce or what and how much to order
- Kanban: standard containers or lot sizes pulled on demand signal

Effect of Uncertainty on Reorder Frequency



Source: APICS Certified Supply Chain Professional Learning System, Version 4.0

Standard Deviations in a Normal Distribution

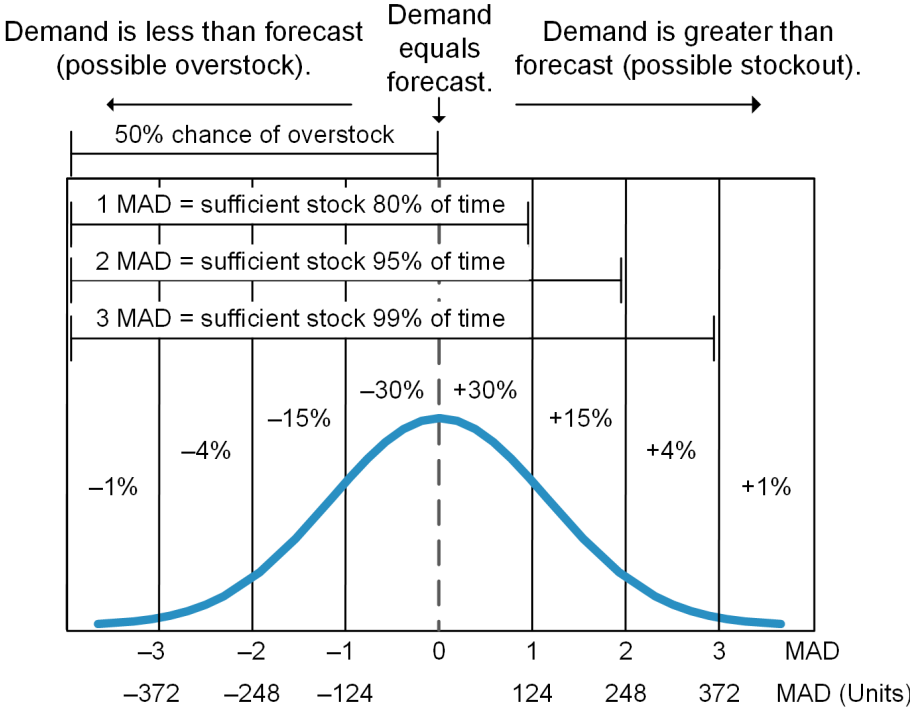


Calculating Standard Deviation in Units

- This example: $n = 10$ -week period
- If using a complete set of data, use n
- If using a sample to represent the whole, use $n - 1$

Week	Forecast	Actual	Absolute Deviation	Actual – Mean	(Actual – Mean) Squared
1	1,000	1,100	100	24	576
2	1,000	950	50	-126	15,876
3	1,000	1,150	150	74	5,476
4	1,000	1,400	400	324	104,976
5	1,000	1,000	0	-76	5,776
6	1,000	900	100	-176	30,976
7	1,000	920	80	-156	24,336
8	1,000	1,300	300	224	50,176
9	1,000	990	10	-86	7,396
10	1,000	1,050	50	-26	676
Sum		10,760	1,240		246,240
Mean		1,076			
Sum of (Actual – Mean) ² / $n - 1$					27,360
Standard deviation (square root of line above)					165.4

Mean Absolute Deviation



Week	Forecast	Actual	Absolute Deviation
1	1,000	1,100	100
2	1,000	950	50
3	1,000	1,150	150
4	1,000	1,400	400
5	1,000	1,000	0
6	1,000	900	100
7	1,000	920	80
8	1,000	1,300	300
9	1,000	990	10
10	1,000	1,050	50
Sum			1,240
Mean absolute deviation (sum absolute deviation/n)			124

Calculating Safety Stock from Service Level

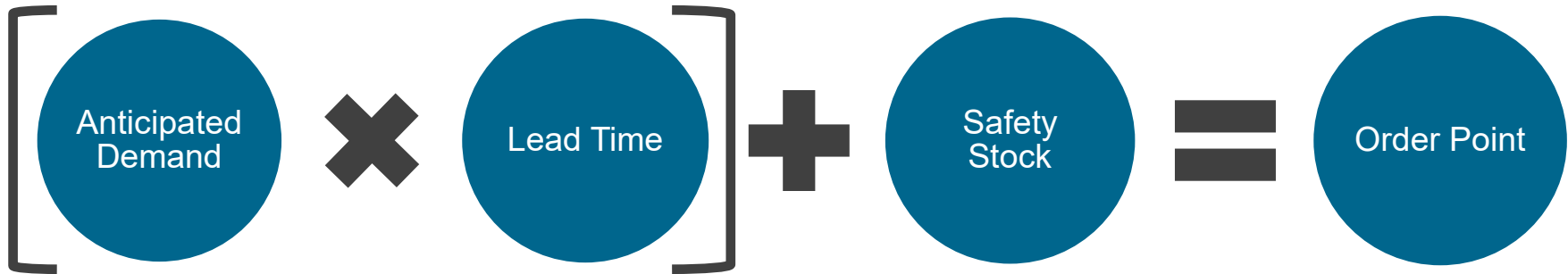
- Safety factor table:
- For example, for 90% service level:
 - 165.4 SD in units
x 1.28 = 211.7
units ~ 212 units
 - 124 MAD in units
x 1.60 = 198.4
units ~ 199 units

Percentile Customer Service Level	SD Units × Factor Below	MAD Units × Factor Below
85.00	1.04	1.30
89.44	1.25	1.56
90.00	1.28	1.60
93.32	1.50	1.88
95.00	1.65	2.06
97.72	2.00	2.50
98.00	2.05	2.56

Calculating Safety Stock: Order Point

Demand during the lead time (DDLT) = Anticipated Demand × Lead Time

DDLT + Safety Stock = Order Point



Other Safety Stock/Safety Lead Time Methods

- Based on order cycle time (OCT) and OCT variability
 - Uses OCT, SD of OCT, and desired service level
 - Lower safety stock need: reduce OCT or OCT variability
- Safety lead time: SD of lead time, adjust by safety factor

Stockout cost validation example for safety stock:

- 60% backorders x \$100 per backorder
- + 15% lost sales x \$500 lost profit
- + 5% lost customers x \$25,000 lost lifetime revenue
- = \$60 + \$75 + \$1,250 = \$1,385

Vendor-Managed Inventory (VMI) and Consignment

VMI

Role of
supplier
greater

Stronger,
more strategic
relationships

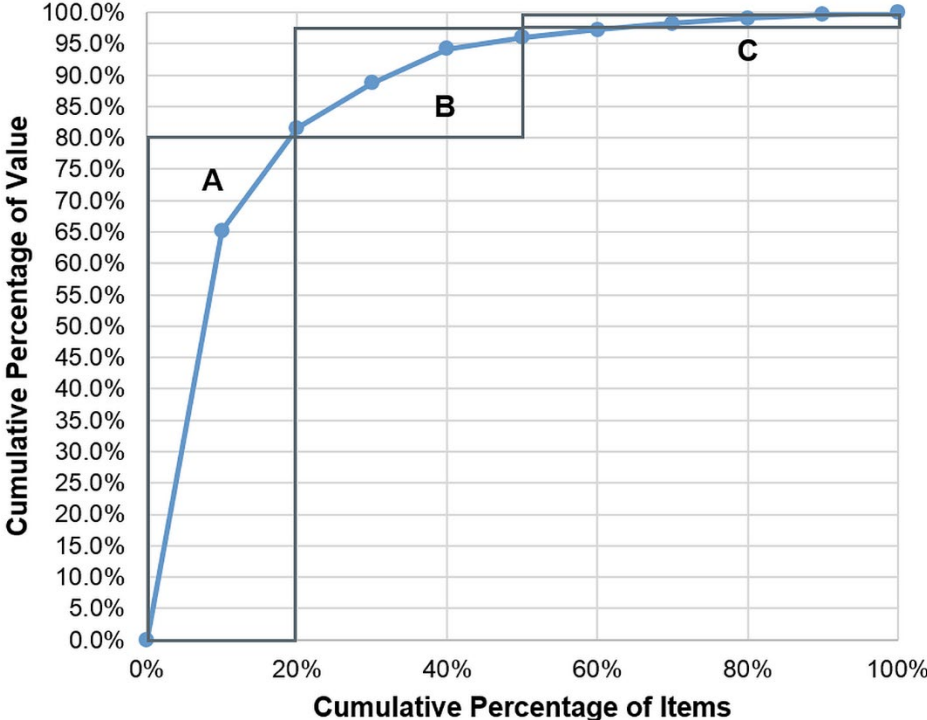
Fewer
vulnerabilities
more
opportunities

Consignment

- Customer does not own goods upon receipt
- Pays only when withdrawn
- Advantage to buyer = avoids investing capital in stock.
- Advantage to seller = guarantees seller's products (vs. competitors) are used in process.

Conduct Inventory Classification: ABC Analysis of Inventory

ABC Analysis of Inventory



Conduct Inventory Classification: ABC Analysis of Inventory

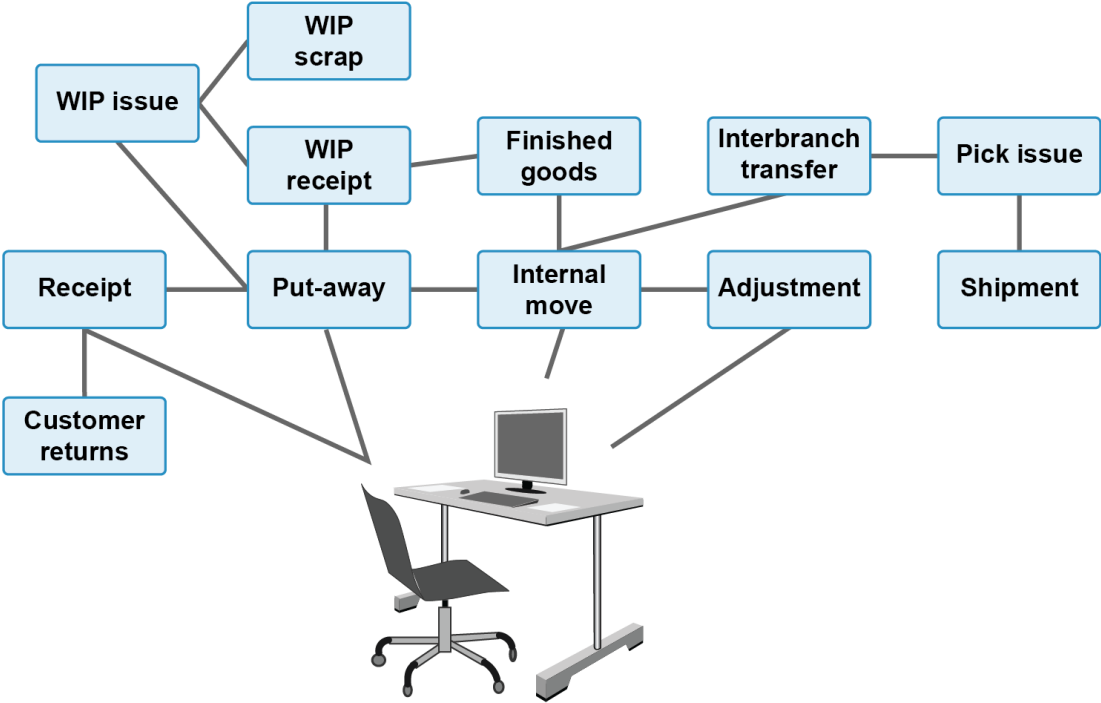
ABC Analysis by Revenue

Item Code	Annual Revenue	% Annual Revenue	% Cumulative Revenue	% Items	ABC Class
01A	40,000	40.0	40.0	9	A
14V	30,000	30.0	70.0	16	A
78Y	10,000	10.0	80.0	20	A
98H	6,000	6.0	86.0	36	B
09P	5,000	5.0	91.0	45	B
65T	4,000	4.0	95.0	55	B
23W	3,000	3.0	98.0	64	C
12Q	800	0.8	98.8	73	C
99M	700	0.7	99.5	82	C
88B	500	0.5	100.0	96	C
04Z	0	0.0	100.0	100	D
TOTAL	US\$100,000	100%			

Dead stock (D) or slow-moving, inactive, or new with no sales history:

- No sales during 12-month period

Inventory Transaction Points



Inventory Record

Source: David F. Ross. *Distribution Planning and Control—Managing in the Era of Supply Chain Management*. Used with permission.

Inventory Review Approaches

Periodic inventory review



- Checked at designated intervals to see if order points have been triggered.

Continuous inventory review



Checked whenever:

- A change in inventory level occurs.
- Order point is reached.
- Restocking order released.

Inventory Auditing

GOAL: To measure, confirm, and improve, if necessary, inventory accuracy.

Approaches to cycle counting:

ABC
classification

Zone method

Just-before-
order
replenishment

Demand order
pick

Develop and Monitor Inventory Performance Metrics

Inventory Control Metrics

- **Days' Inventory Outstanding (DIO)** = $\frac{\text{Inventory on Hand}}{\text{Average Daily Use}}$
- **Weeks of Supply** = $\frac{\text{Inventory on Hand}}{\text{Average Weekly Use}}$

Inventory Reduction Methods and Benefits

Methods

- More accurate forecasting
- Reducing usage and lead times
- Recalculating order quantities
- Reducing safety stocks
- ABC classification
- Cycle counting
- Monitoring deliveries
- VMI or consignment

Benefits

Reduction in carrying cost

Reduction in risk of excess inventory

Reduction in risk of obsolete inventory

Increase in available cash

Develop and Monitor Inventory Performance Metrics

Calculating Inventory Turnover Rate (Variants)

Inventory Turnover =

- $$\frac{\text{COGS}}{\text{Average Inventory Valued at Cost During Period}}$$
- $$\frac{\text{Sales Revenue}}{\text{Average Inventory Valued at Selling Price During Period}}$$
- $$\frac{\text{Units Sold}}{\text{Average Unit Inventory During Period}}$$