Institut Informatika & Bisnis DARMAJAYA
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7

Manajemen PERSEDIAAN

PowerPoint presentation to accompany
Heizer and Render
Operations Management, Eleventh Edition
Principles of Operations Management, Ninth Edition

PowerPoint slides by Jeff Heyl

The top e-commerce companies in Indonesia

- e-commerce companies started as a “virtual” retailer – no inventory, no warehouses, no overhead; just computers taking orders to be filled by others
- Growth has forced to become e-commerce companies leader on Indonesian

Express Courier & Delivery Services

- Courier services operate on all scales, from within specific towns or cities, to regional, national and global services.
- Large courier companies include DHL, Postaplus, DTDC, FedEx, EMS International, TNT, UPS, India Post and Aramex. These offer services worldwide, typically via a hub and spoke model.
- In Indonesia, JNE, TIKI, J&T, Dakota, Lions Express, etc.
- Couriers services utilizing Courier Software provide electronic Proof of Delivery and electronic Tracking details.

INVENTORY MANAGEMENT

The objective of inventory management is to strike a balance between inventory investment and customer service

Importance of Inventory

- One of the most expensive assets of many companies representing as much as 50% of total invested capital
- Operations managers must balance inventory investment and customer service
- Balance the advantages and disadvantages of small and large inventories

Importance of Inventory

- **Pressures for small inventories**
  - Inventory holding cost
  - Cost of capital
  - Storage and handling costs
  - Taxes, insurance, and shrinkage
- **Pressures for large inventories**
  - Customer service
  - Ordering cost
  - Setup cost
  - Labor and equipment utilization
  - Transportation cost
  - Payments to suppliers

Functions of Inventory

1. To provide a selection of goods for anticipated demand and to separate the firm from fluctuations in demand
2. To decouple or separate various parts of the production process
3. To take advantage of quantity discounts
4. To hedge against inflation

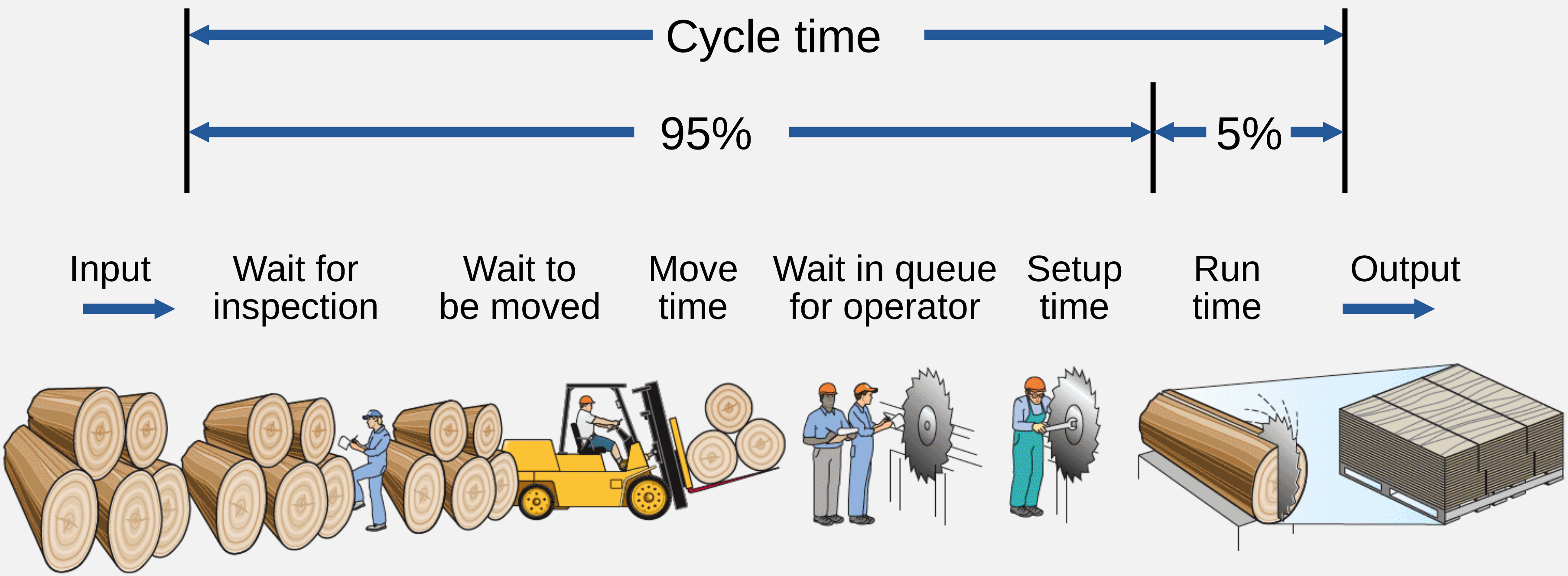
Reasons for Holding Inventory

- To meet anticipated customer demand
- To protect against stock outs
- To take advantage of economic ordercycles
- To maintain independence of operations
- To allow for smooth and flexibleproduction operations
- To guard against price increases

Types of Inventory

- Raw material
  - Purchased but not processed
- Work-in-process (WIP)
  - Undergone some change but not completed
  - A function of cycle time for a product
- Maintenance/repair/operating (MRO)
  - Necessary to keep machinery and processes productive
- Finished goods
  - Completed product awaiting shipment

The Material Flow Cycle



Most of the time that work is in-process (95% of the cycle time) is not productive time.

Managing Inventory (*ABC analysis*)

1. How inventory items can be classified (*ABC analysis*)
2. How accurate inventory records can be maintained.
3. Stock-keeping units (SKU)
4. Identify the classes so management can control inventory levels
5. A Pareto chart

ABC Analysis

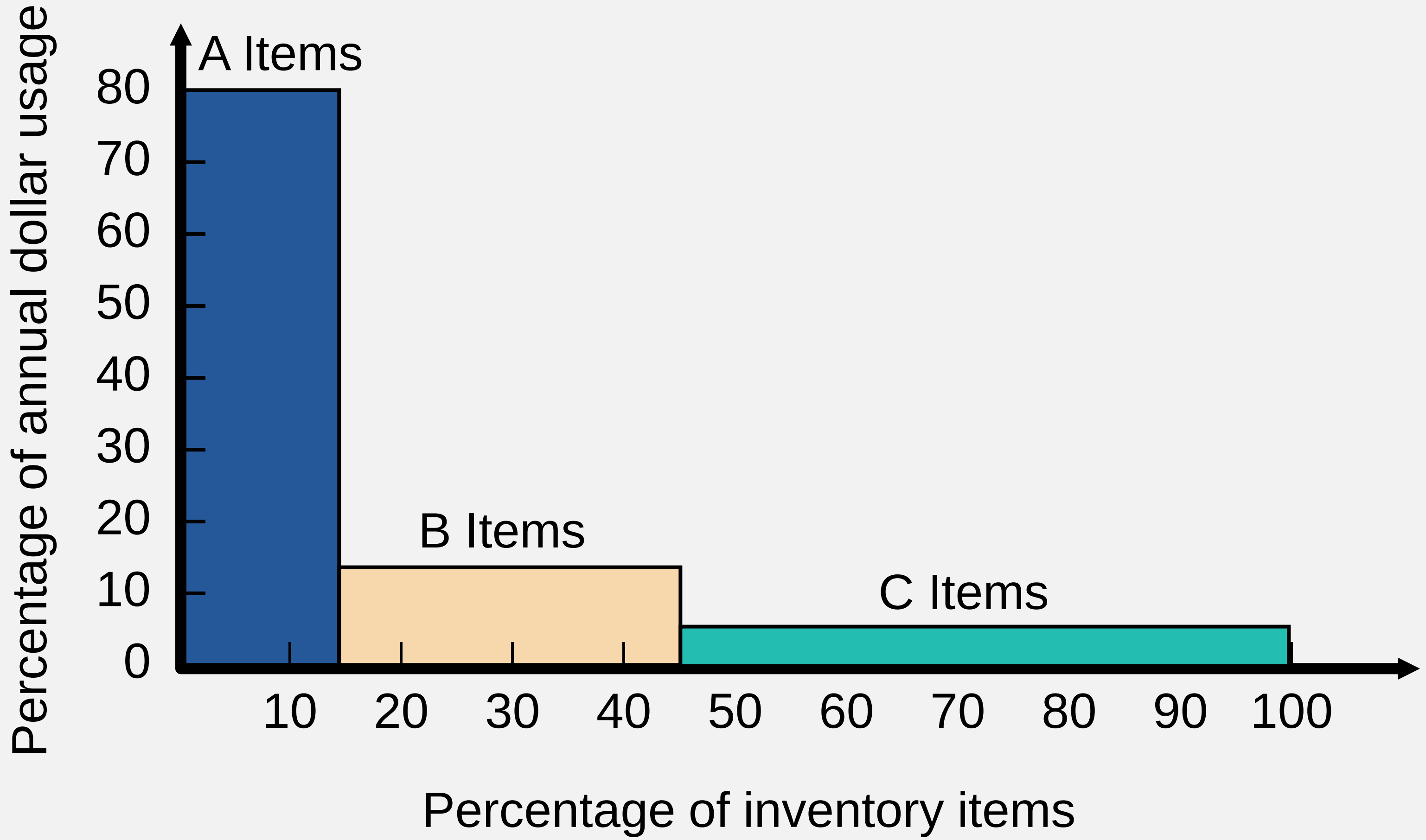
- Divides inventory into three classes based on annual dollar volume
  - Class A - high annual dollar volume
  - Class B - medium annual dollar volume
  - Class C - low annual dollar volume
- Used to establish policies that focus on the few critical parts and not the many trivial ones

ABC Analysis

ABC Calculation

(1) ITEM STOCK NUMBER	(2) PERCENT OF NUMBER OF ITEMS STOCKED	(3) ANNUAL VOLUME (UNITS)	x	(4) UNIT COST	=	(5) ANNUAL DOLLAR VOLUME	(6) PERCENT OF ANNUAL DOLLAR VOLUME		(7) CLASS
#10286	20%	1,000		$ 90.00		$ 90,000	38.8%	72%	A
#11526		500		154.00		77,000	33.2%		A
#12760		1,550		17.00		26,350	11.3%		B
#10867	30%	350		42.86		15,001	6.4%	23%	B
#10500		1,000		12.50		12,500	5.4%		B
#12572		600		$ 14.17		$ 8,502	3.7%		C
#14075		2,000		.60		1,200	.5%		C
#01036	50%	100		8.50		850	.4%	5%	C
#01307		1,200		.42		504	.2%		C
#10572		250		.60		150	.1%		C
		8,550				$232,057	100.0%		

ABC Analysis



ABC Analysis

- Other criteria than annual dollar volume may be used
  1. High shortage or holding cost
  2. Anticipated engineering changes
  3. Delivery problems
  4. Quality problems
- Policies employed may include
  1. More emphasis on supplier development for A items
  2. Tighter physical inventory control for A items
  3. More care in forecasting A items

Record Accuracy

- Accurate records are a critical ingredient in production and inventory systems
  - Periodic systems require regular checks of inventory
    - Two-bin system
  - Perpetual inventory tracks receipts and subtractions on a continuing basis
    - May be semi-automated

Record Accuracy

- Incoming and outgoing record keeping must be accurate
- Stockrooms should be secure
- Necessary to make precise decisions about ordering, scheduling, and shipping

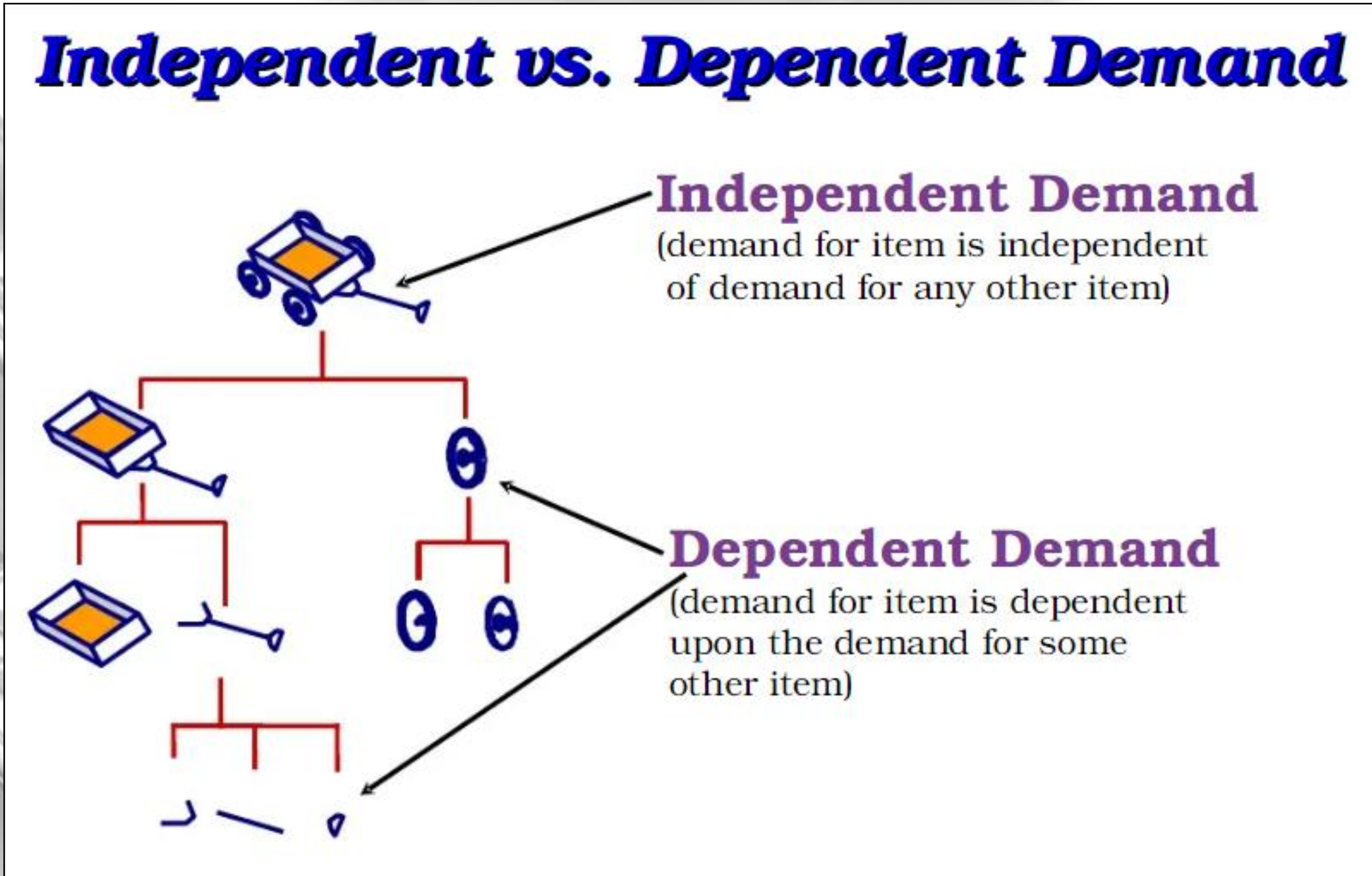
Control of Service Inventories

- Can be a critical component of profitability
- Losses may come from shrinkage or pilferage
- Applicable techniques include
  1. Good personnel selection, training, and discipline
  2. Tight control of incoming shipments
  3. Effective control of all goods leaving facility

Inventory Models

- **Independent demand** - the demand for item is independent of the demand for any other item in inventory
- **Dependent demand** - the demand for item is dependent upon the demand for some other item in the inventory

INVENTORY MODELS



INVENTORY MODELS

- **Holding costs** - the costs of holding or "carrying" inventory over time
- **Ordering costs** - the costs of placing an order and receiving goods
- **Setup costs** - cost to prepare a machine or process for manufacturing an order
  - May be highly correlated with **setup time**

Holding Costs

TABLE	Determining Inventory Holding Costs
CATEGORY	**COST (AND RANGE) AS A PERCENT OF INVENTORY VALUE**
Housing costs (building rent or depreciation, operating costs, taxes, insurance)	6% (3 - 10%)
Material handling costs (equipment lease or depreciation, power, operating cost)	3% (1 - 3.5%)
Labor cost (receiving, warehousing, security)	3% (3 - 5%)
Investment costs (borrowing costs, taxes, and insurance on inventory)	11% (6 - 24%)
Pilferage, space, and obsolescence (much higher in industries undergoing rapid change like PCs and cell phones)	3% (2 - 5%)
Overall carrying cost	26%

Holding Costs

TABLE 12.1	Determining Inventory Holding Costs
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
In[illegible] (...owing costs, taxes, and insurance on inventory)	11% (6 - 24%)
Pilferage, space, and obsolescence (much higher in industries undergoing rapid change like PCs and cell phones)	3% (2 - 5%)
Overall carrying cost	26%

Holding costs vary considerably depending on the business, location, and interest rates. **Generally greater than 15%**, some **high tech and fashion** items have holding **costs greater than 40%.**

Inventory Models for Independent Demand

Need to determine when and how much to order

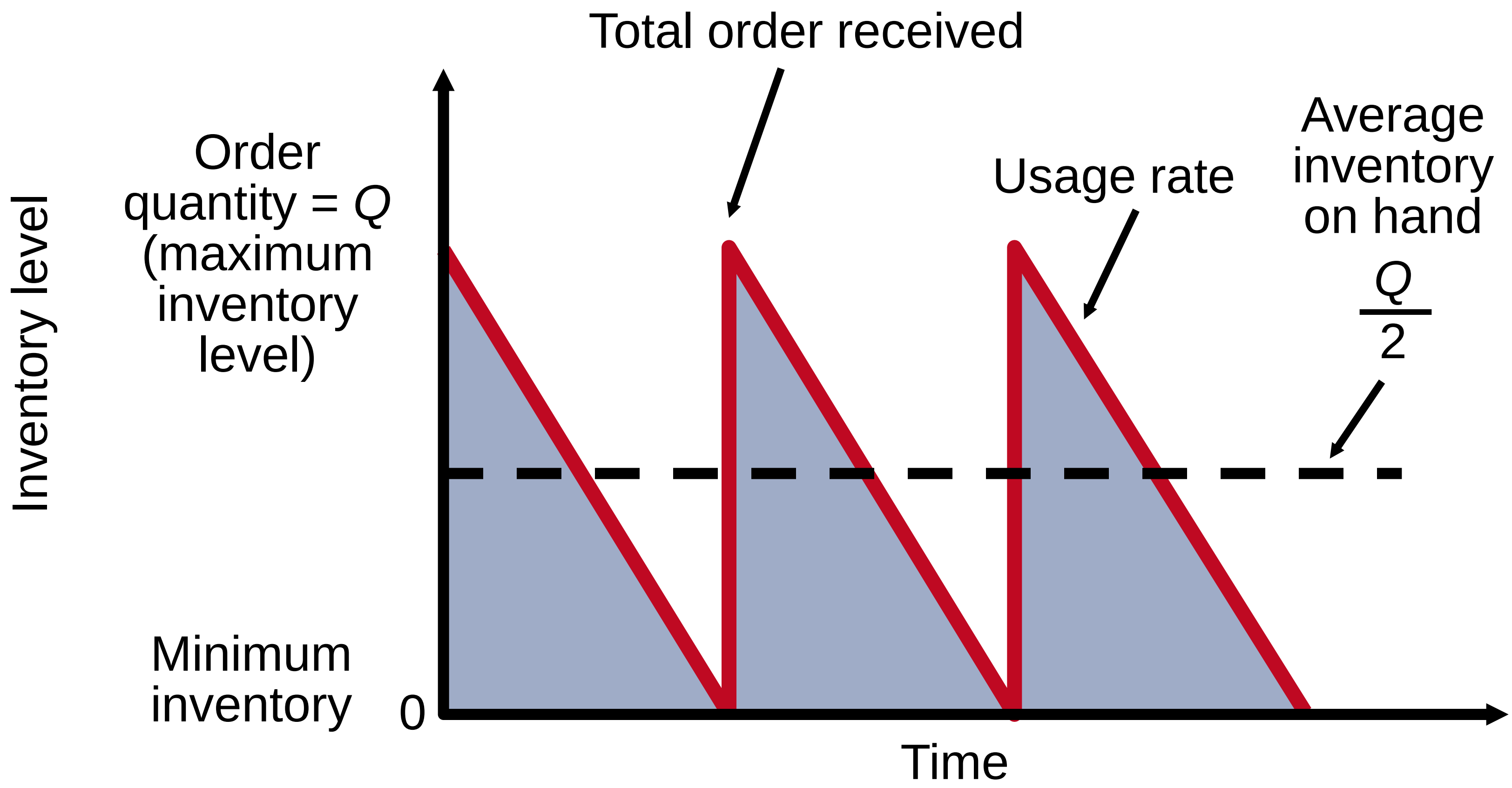
1. Basic economic order quantity (EOQ) model
2. Production order quantity model
3. Quantity discount model

Basic EOQ Model

Important assumptions

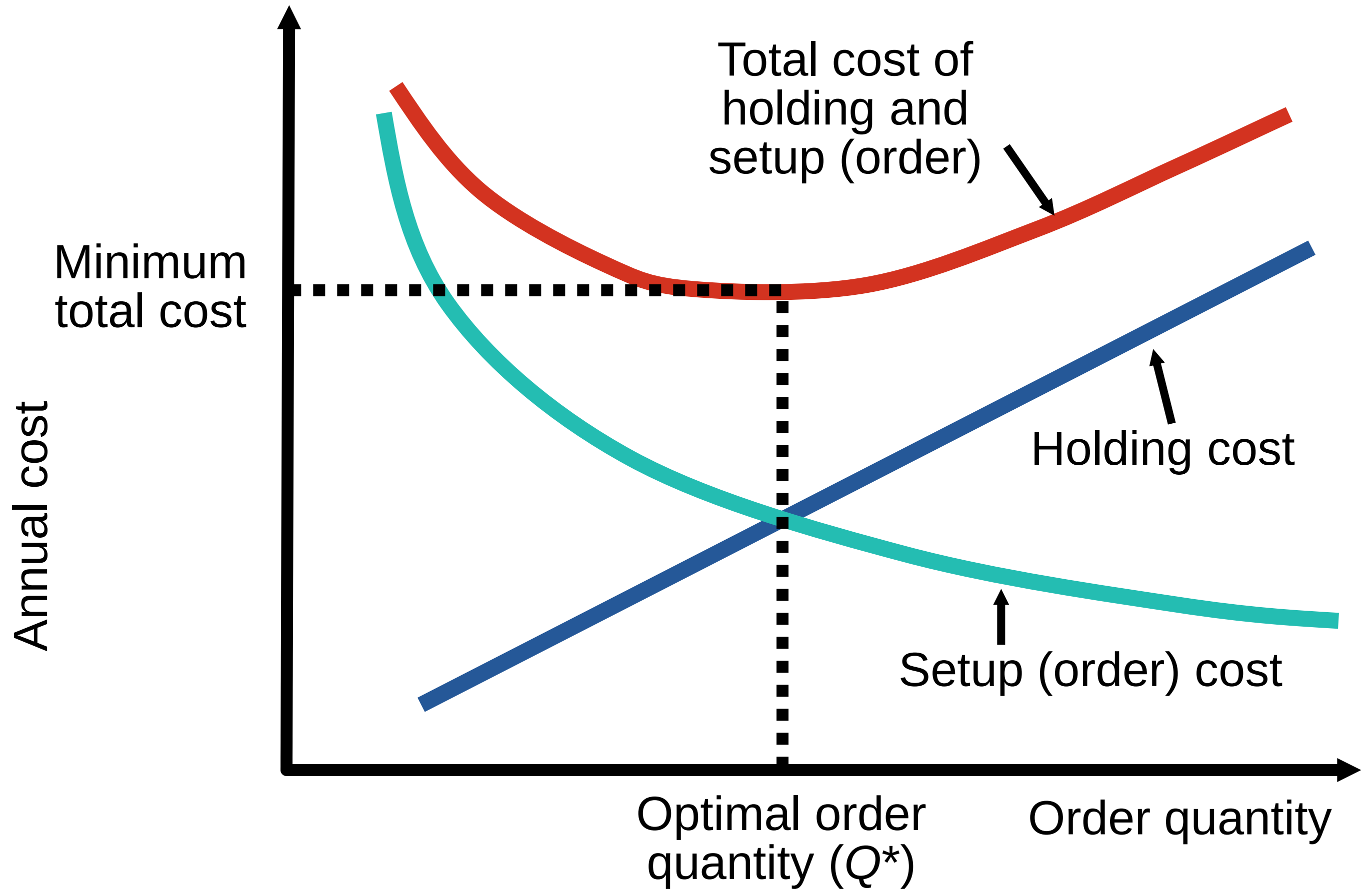
1. Demand is known, constant, and independent
2. Lead time is known and constant
3. Receipt of inventory is instantaneous and complete
4. Quantity discounts are not possible
5. Only variable costs are setup (or ordering) and holding
6. Stockouts can be completely avoided

INVENTORY USAGE OVER TIME (EOQ MODEL)



Minimizing Costs

Objective is to minimize total costs



Minimizing Costs

- By minimizing the sum of setup (or ordering) and holding costs, total costs are minimized
- Optimal order size Q^* will minimize total cost
- A reduction in either cost reduces the total cost
- Optimal order quantity occurs when holding cost and setup cost are equal

Minimizing Costs

Annual setup cost = $\frac{D}{Q}S$

Q = Number of pieces per order

Q^* = Optimal number of pieces pe

D = Annual demand in units for the inventory item

S = Setup or ordering cost for each order

H = Holding or carrying cost per unit per year

Annual setup cost = (Number of orders placed per year) x (Setup or order cost per order)

$$= \left(\frac{\text{Annual demand}}{\text{Number of units in each order}}\right)\left(\begin{array}{c}\text{Setup or order}\\ \text{cost per order}\end{array}\right)$$

$$= \left(\frac{D}{Q}\right)S$$

Minimizing Costs

Q = Number of pieces per order

Q^* = Optimal number of pieces pe

D = Annual demand in units for th

S = Setup or ordering cost for each order

H = Holding or carrying cost per unit per year

Annual setup cost = $\frac{D}{Q}S$

Annual holding cost = $\frac{Q}{2}H$

Annual holding cost = (Average inventory level)
x (Holding cost per unit per year)

$$= \left(\frac{\text{Order quantity}}{2}\right)\text{(Holding cost per unit per year)}$$

$$= \left(\frac{Q}{2}\right)H$$

Minimizing Costs

Q = Number of pieces per order

Q^* = Optimal number of pieces pe

D = Annual demand in units for th

S = Setup or ordering cost for each order

H = Holding or carrying cost per unit per year

Annual setup cost = $\frac{D}{Q}S$

Annual holding cost = $\frac{Q}{2}H$

Optimal order quantity is found when annual setup cost equals annual holding cost

$$\frac{D}{Q}S = \left(\frac{Q}{2}\right)H$$

Solving for Q^*

$$2DS = Q^2H$$

$$Q^2 = \frac{2DS}{H}$$

$$Q^* = \sqrt{\frac{2DS}{H}}$$

An EOQ Example

Determine **optimal number of needles to order**

D = 1,000 units

S = \$10 per order

H = \$.50 per unit per year

$$Q^* = \sqrt{\frac{2DS}{H}}$$

$$Q^* = \sqrt{\frac{2(1{,}000)(10)}{0.50}} = \sqrt{40{,}000} = 200 \text{ units}$$

An EOQ Example

Determine **expected number of orders**

D = 1,000 units

Q^* = 200 units

S = $10 per order

H = $.50 per unit per year

$$\text{Expected number of orders} = N = \frac{\text{Demand}}{\text{Order quantity}} = \frac{D}{Q^*}$$

$$N = \frac{1{,}000}{200} = 5 \text{ orders per year}$$

An EOQ Example

Determine **optimal time between orders**

D = 1,000 units

S = \$10 per order

H = \$.50 per unit per year

Q^* = 200 units

N = 5 orders/year

$$\text{Expected time between orders} = T = \frac{\text{Number of working days per year}}{\text{Expected number of orders}}$$

$$T = \frac{250}{5} = 50 \text{ days between orders}$$

An EOQ Example

Determine the **total annual cost**

D = 1,000 units

S = \$10 per order

H = \$.50 per unit per year

Q^* = 200 units

N = 5 orders/year

T = 50 days

Total annual cost = Setup cost + Holding cost

$$TC = \frac{D}{Q}S + \frac{Q}{2}H$$

$$= \frac{1{,}000}{200}(\$10) + \frac{200}{2}(\$.50)$$

$$= (5)(\$10) + (100)(\$.50)$$

$$= \$50 + \$50 = \$100$$

The EOQ Model

When including actual cost of material P

Total annual cost = Setup cost + Holding cost + Product cost

$$TC = \frac{D}{Q}S + \frac{Q}{2}H + PD$$

Robust Model

- The EOQ model is robust
- It works even if all parameters and assumptions are not met
- The total cost curve is relatively flat in the area of the EOQ

The EOQ Model

Determine optimal number of
D = ~~1,000 units~~ 1,500 units
S = \$10 per order
H = \$.50 per unit per year

Only 2% less than the total cost of \$125 when the order quantity was 200

$$TC = \frac{D}{Q}S + \frac{Q}{2}H$$

$$= \frac{1{,}500}{200}(\$10) + \frac{200}{2}(\$.50)$$

$$= \$75 + \$50 = \$125$$

$$= \frac{1{,}500}{244.9}(\$10) + \frac{244.9}{2}(\$.50)$$

$$= 6.125(\$10) + 122.45(\$.50)$$

$$= \$61.25 + \$61.22 = \$122.47$$

Reorder Points

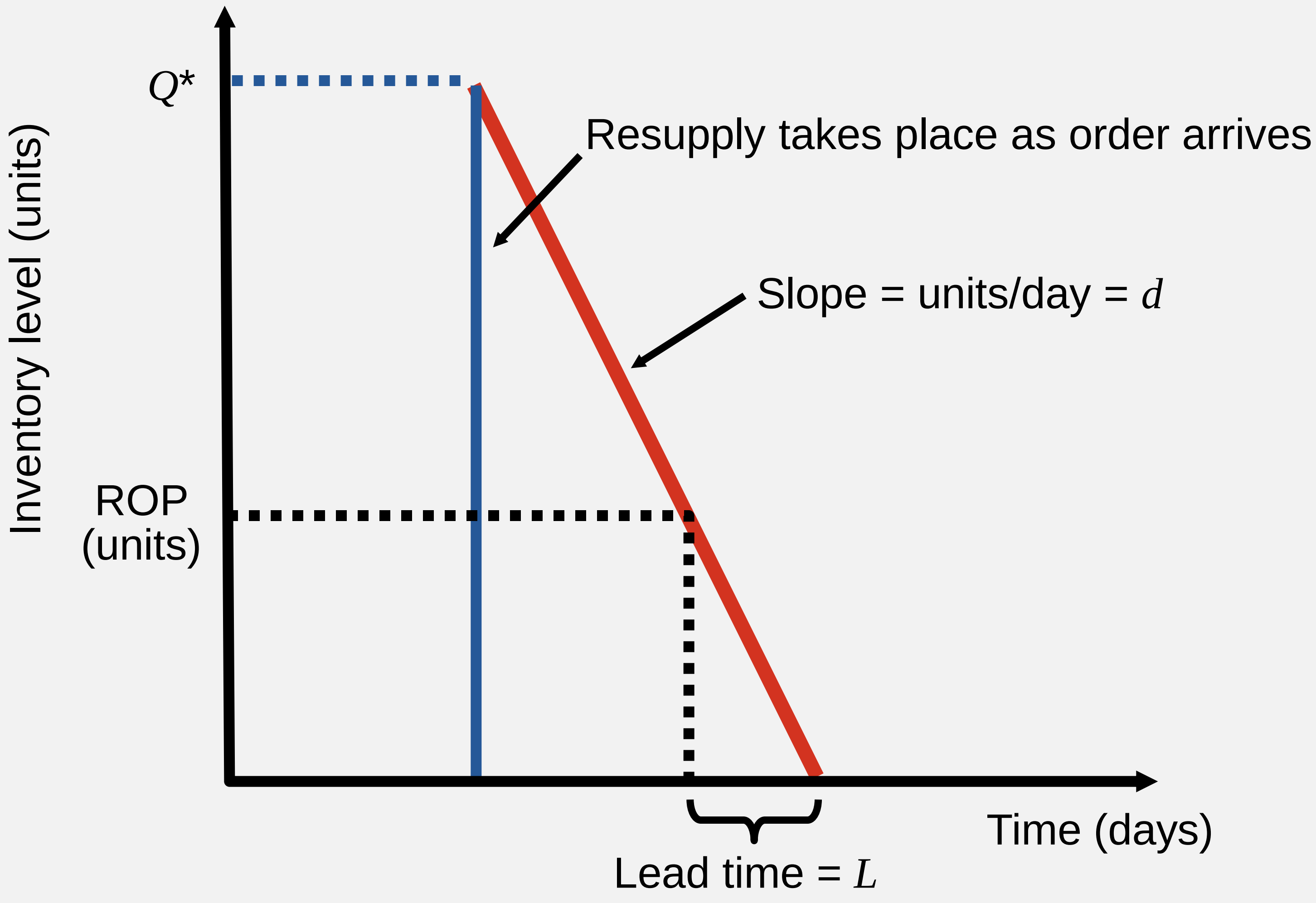
- EOQ answers the "how much" question
- The reorder point (ROP) tells "when" to order
- Lead time (L) is the time between placing and receiving an order

$$\text{ROP} = \begin{pmatrix}\text{Demand} \\ \text{per day}\end{pmatrix}\begin{pmatrix}\text{Lead time for a new} \\ \text{order in days}\end{pmatrix}$$

$$= d \times L$$

$$d = \frac{D}{\text{Number of working days in a year}}$$

Reorder Point Curve



Reorder Point Curve Example

Demand = 8,000 iPods per year
250 working day year
Lead time for orders is 3 working days, may take 4

$$d = \frac{D}{\text{Number of working days in a year}}$$

$= 8{,}000/250 = 32$ units

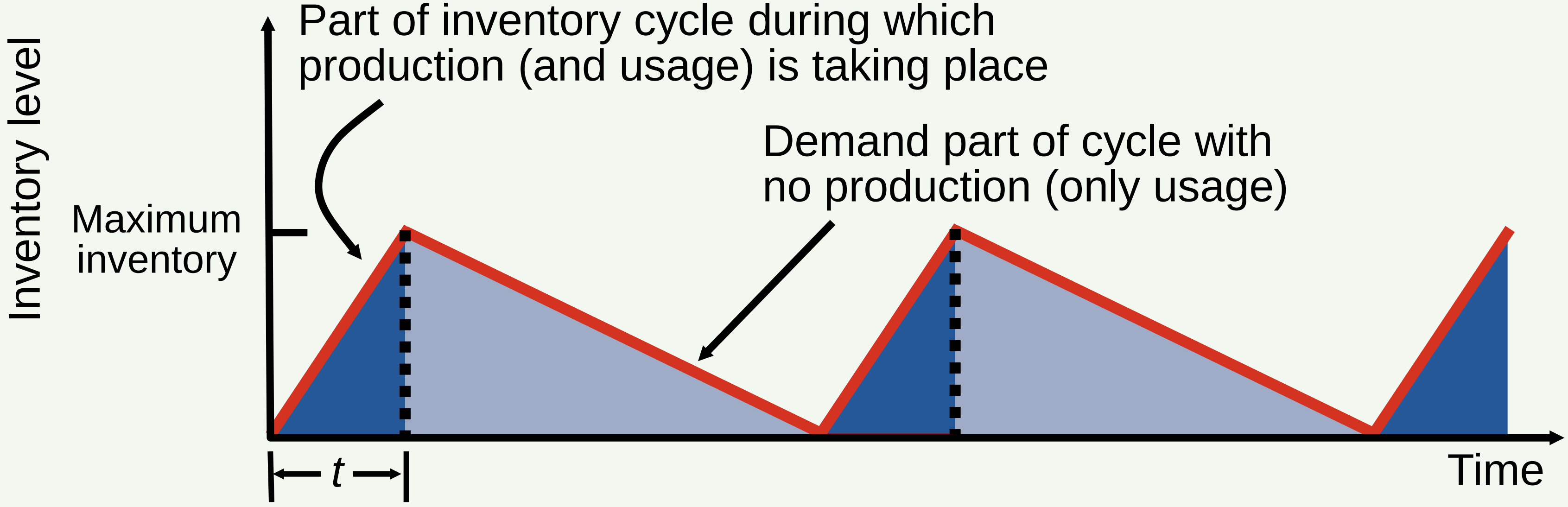
ROP $= d \times L$

$= 32$ units per day x 3 days $= 96$ units

$= 32$ units per day x 4 days $= 128$ units

Production Order Quantity Model

1. Used when inventory builds up over a period of time after an order is placed
2. Used when units are produced and sold simultaneously



Production Order Quantity Model

Q = Number of pieces per order
H = Holding cost per unit per year
t = Length of the production run in days
p = Daily production rate
d = Daily demand/usage rate

$$\begin{pmatrix}\text{Annual inventory}\\ \text{holding cost}\end{pmatrix} = (\text{Average inventory level}) \times \begin{pmatrix}\text{Holding cost}\\ \text{per unit per year}\end{pmatrix}$$

$$\begin{pmatrix}\text{Annual inventory}\\ \text{level}\end{pmatrix} = (\text{Maximum inventory level})/2$$

$$\begin{pmatrix}\text{Maximum}\\ \text{inventory level}\end{pmatrix} = \begin{pmatrix}\text{Total produced during}\\ \text{the production run}\end{pmatrix} - \begin{pmatrix}\text{Total used during}\\ \text{the production run}\end{pmatrix}$$

$$= pt - dt$$

Production Order Quantity Model

Q = Number of pieces per order
H = Holding cost per unit per year
t = Length of the production run in days
p = Daily production rate
d = Daily demand/usage rate

$$\begin{pmatrix}\text{Maximum}\\ \text{inventory level}\end{pmatrix} = \begin{pmatrix}\text{Total produced during}\\ \text{the production run}\end{pmatrix} - \begin{pmatrix}\text{Total used during}\\ \text{the production run}\end{pmatrix}$$

$$= pt - dt$$

However, Q = total produced = pt ; thus $t = Q/p$

$$\begin{pmatrix}\text{Maximum}\\ \text{inventory level}\end{pmatrix} = p\left(\frac{Q}{p}\right) - d\left(\frac{Q}{p}\right) = Q\left(1 - \frac{d}{p}\right)$$

$$\text{Holding cost} = \frac{\text{Maximum inventory level}}{2}(H) = \frac{Q}{2}\left[1 - \left(\frac{d}{p}\right)H\right]$$

Production Order Quantity Model

Q = Number of pieces per order

H = Holding cost per unit per year

t = Length of the production run in days

p = Daily production rate

d = Daily demand/usage rate

$$\text{Setup cost} = (D/Q)S$$

$$\text{Holding cost} = \tfrac{1}{2}HQ\left[1 - \left(d/p\right)\right]$$

$$\frac{D}{Q}S = \tfrac{1}{2}HQ\left[1 - \left(d/p\right)\right]$$

$$Q^2 = \frac{2DS}{H\left[1 - \left(d/p\right)\right]}$$

$$Q_p^* = \sqrt{\frac{2DS}{H\left[1 - \left(d/p\right)\right]}}$$

Production Order Quantity Model (Example)

D = 1,000 units

S = \$10

H = \$0.50 per unit per year

p = 8 units per day

d = 4 units per day

$$Q_p^* = \sqrt{\frac{2DS}{H\left[1 - \left(d/p\right)\right]}}$$

$$Q_p^* = \sqrt{\frac{2(1{,}000)(10)}{0.50\left[1 - (4/8)\right]}}$$

$$= \sqrt{\frac{20{,}000}{0.50(1/2)}} = \sqrt{80{,}000}$$

$= 282.8$ hubcaps, or 283 hubcaps

Production Order Quantity Model

Note:

$$d = 4 = \frac{D}{\text{Number of days the plant is in operation}} = \frac{1{,}000}{250}$$

When annual data are used the equation becomes

$$Q_p^* = \sqrt{\frac{2DS}{H\left(1 - \frac{\text{Annual demand rate}}{\text{Annual production rate}}\right)}}$$

Quantity Discount Models

- Reduced prices are often available when larger quantities are purchased
- Trade-off is between reduced product cost and increased holding cost

TABLE 12.2	A Quantity Discount Schedule		
DISCOUNT NUMBER	DISCOUNT QUANTITY	DISCOUNT (%)	DISCOUNT PRICE (P)
1	0 to 999	no discount	$5.00
2	1,000 to 1,999	4	$4.80
3	2,000 and over	5	$4.75

Quantity Discount Models

Total annual cost = Setup cost + Holding cost + Product cost

$$TC = \frac{D}{Q}S + \frac{Q}{2}H + PD$$

where
Q = Quantity ordered
D = Annual demand in units
S = Ordering or setup cost per order
P = Price per unit
H = Holding cost per unit per year

$$Q^* = \sqrt{\frac{2DS}{IP}}$$

Because unit price varies, holding cost (H) is expressed as a percent (I) of unit price (P)

Quantity Discount Models

Steps in analyzing a quantity discount

1. For each discount, calculate *Q**
2. If *Q** for a discount doesn't qualify, choose the lowest possible quantity to get the discount
3. Compute the total cost for each *Q** or adjusted value from Step 2
4. Select the *Q** that gives the lowest total cost

Quantity Discount Models

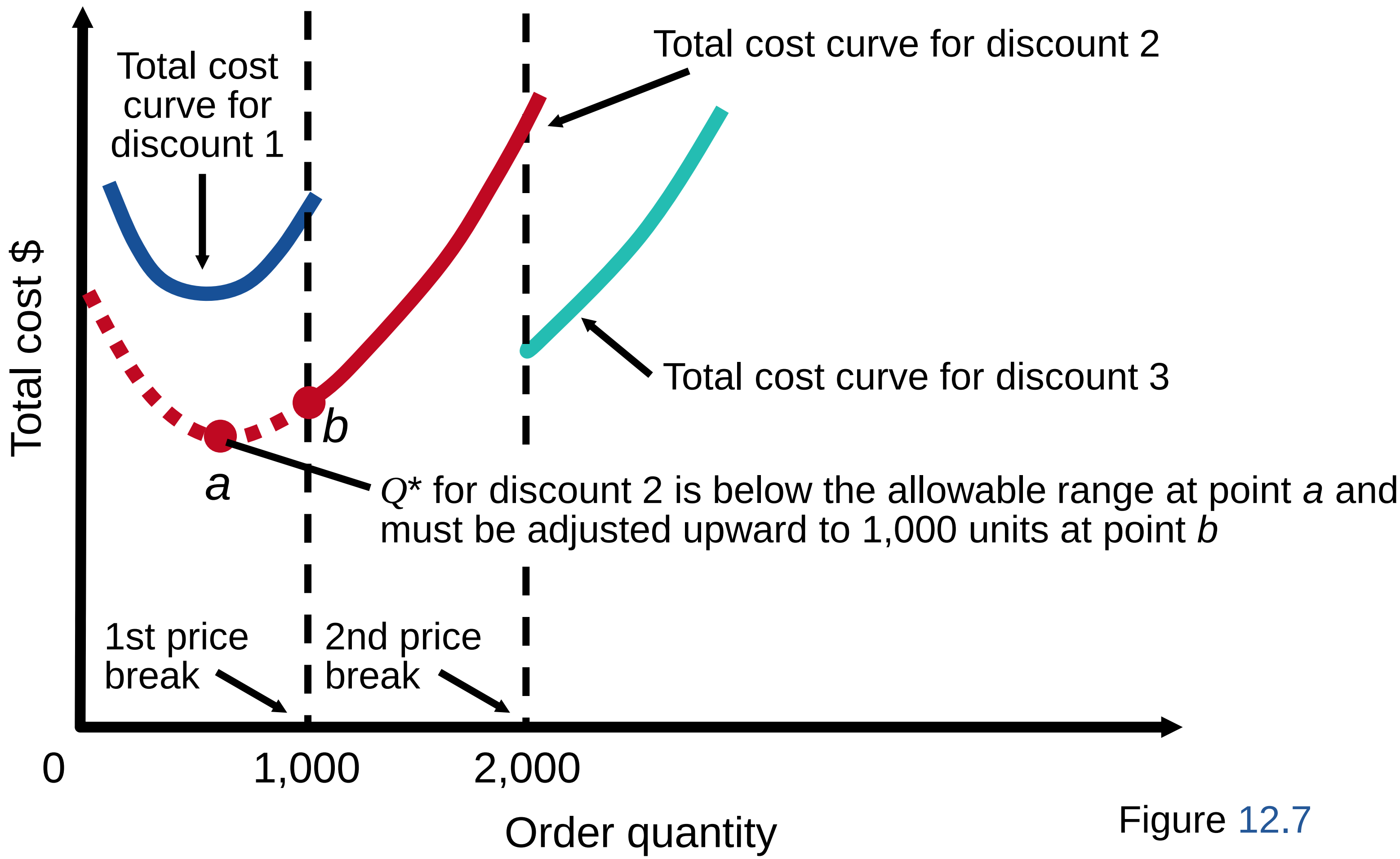


Figure 12.7

Quantity Discount Models (Example)

Calculate Q^* for every discount

$$Q^* = \sqrt{\frac{2DS}{IP}}$$

$$Q_1^* = \sqrt{\frac{2(5{,}000)(49)}{(.2)(5.00)}} = 700 \text{ cars/order}$$

$$Q_2^* = \sqrt{\frac{2(5{,}000)(49)}{(.2)(4.80)}} = 714 \text{ cars/order}$$

$$Q_3^* = \sqrt{\frac{2(5{,}000)(49)}{(.2)(4.75)}} = 718 \text{ cars/order}$$

Quantity Discount Models (Example)

Calculate Q^* for every discount

$$Q^* = \sqrt{\frac{2DS}{IP}}$$

$$Q_1^* = \sqrt{\frac{2(5{,}000)(49)}{(.2)(5.00)}} = 700 \text{ cars/order}$$

$$Q_2^* = \sqrt{\frac{2(5{,}000)(49)}{(.2)(4.80)}} = \text{~~714~~ cars/order}$$

1,000 — adjusted

$$Q_3^* = \sqrt{\frac{2(5{,}000)(49)}{(.2)(4.75)}} = \text{~~718~~ cars/order}$$

2,000 — adjusted

Quantity Discount Models (Example)

TABLE 12.3	Total Cost Computations for Wohl's Discount Store					
DISCOUNT NUMBER	UNIT PRICE	ORDER QUANTITY	ANNUAL PRODUCT COST	ANNUAL ORDERING COST	ANNUAL HOLDING COST	TOTAL
1	$5.00	700	$25,000	$350	$350	$25,700
2	$4.80	1,000	$24,000	$245	$480	$24,725
3	$4.75	2,000	$23.750	$122.50	$950	$24,822.50

Choose the price and quantity that gives the lowest total cost

Buy 1,000 units at $4.80 per unit

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