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Operations Management
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# Inventory management

# A definition

- **Inventory** or **stock** is defined as the *stored accumulation of resources in a transformation system.*
- Usually the term refers only to *transformed resources.*

# Inventory is created to compensate for the differences in timing between supply and demand

# Inventory related costs

- Cost of placing the order
- Price discount costs
- Stock-out costs
- Working capital costs
- Storage costs
- Obsolescence costs
- Operating inefficiency costs

* Consignment cost

# Reasons for keeping inventory

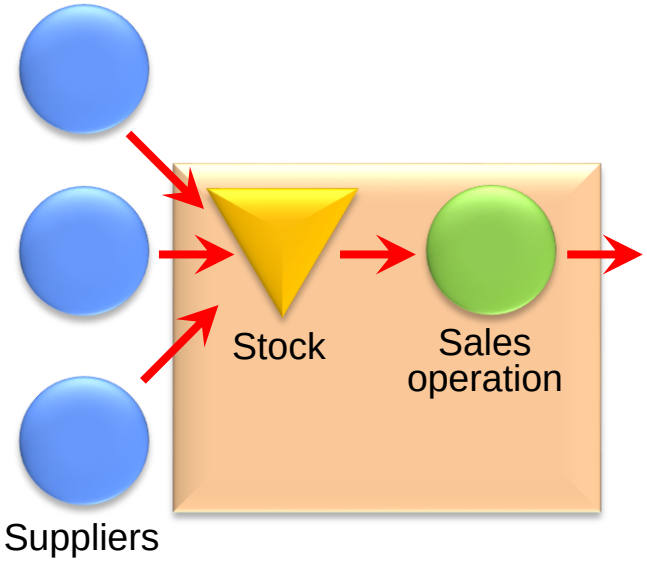
- There are five main reasons for keeping inventory:
  - To cope with random or unexpected interruptions in supply or demand (**buffer inventory or Safety inventory**)
  - To cope with an operation's inability to make all products simultaneously (**cycle inventory**)
  - To allow different stages of processing to operate at different speeds and with different schedules (**de-coupling inventory**)
  - To cope with planned fluctuations in supply or demand (**anticipation inventory**)
  - To cope with transportation delays in the supply network (**pipeline inventory**)

# Disadvantages of holding inventory

- Inventory **ties up money**, in the form of working capital, which is therefore unavailable for other uses
- Inventory **incurs storage costs** (leasing space, maintaining appropriate conditions etc.)
- Inventory **may become obsolete** as alternatives become available
- Inventory **can be damaged or deteriorate**
- Inventory **could be lost, or be expensive to retrieve**, as it gets hidden amongst other inventory
- Inventory **might be hazardous to store** (flammable solvents, explosives, chemicals and drugs etc.)
- Inventory **uses space that could be used to add value**
- Inventory **involves administrative and insurance costs**

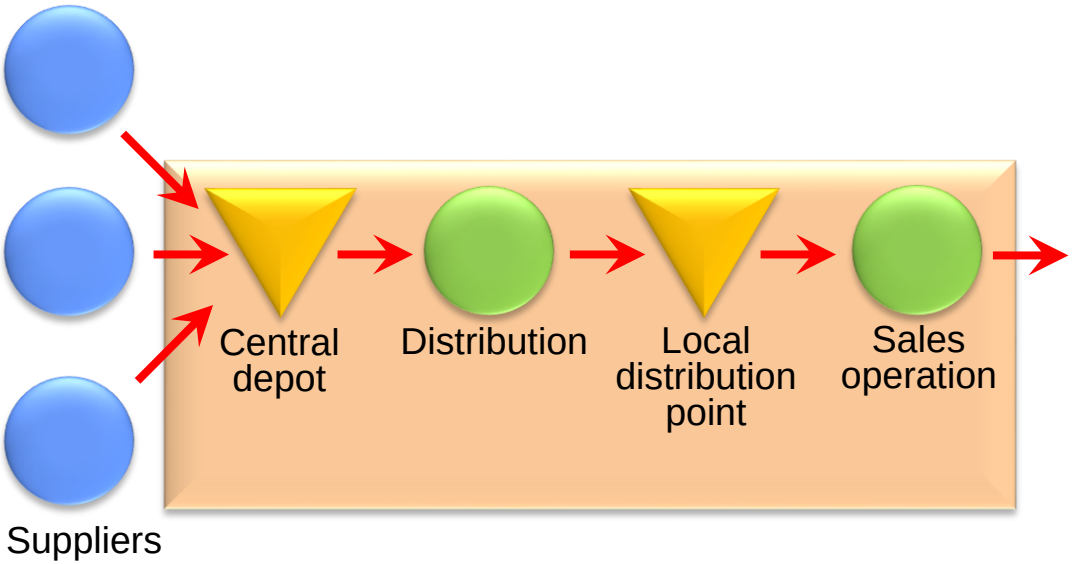
# Single-stage and two-stage inventory systems

## Single-stage inventory system



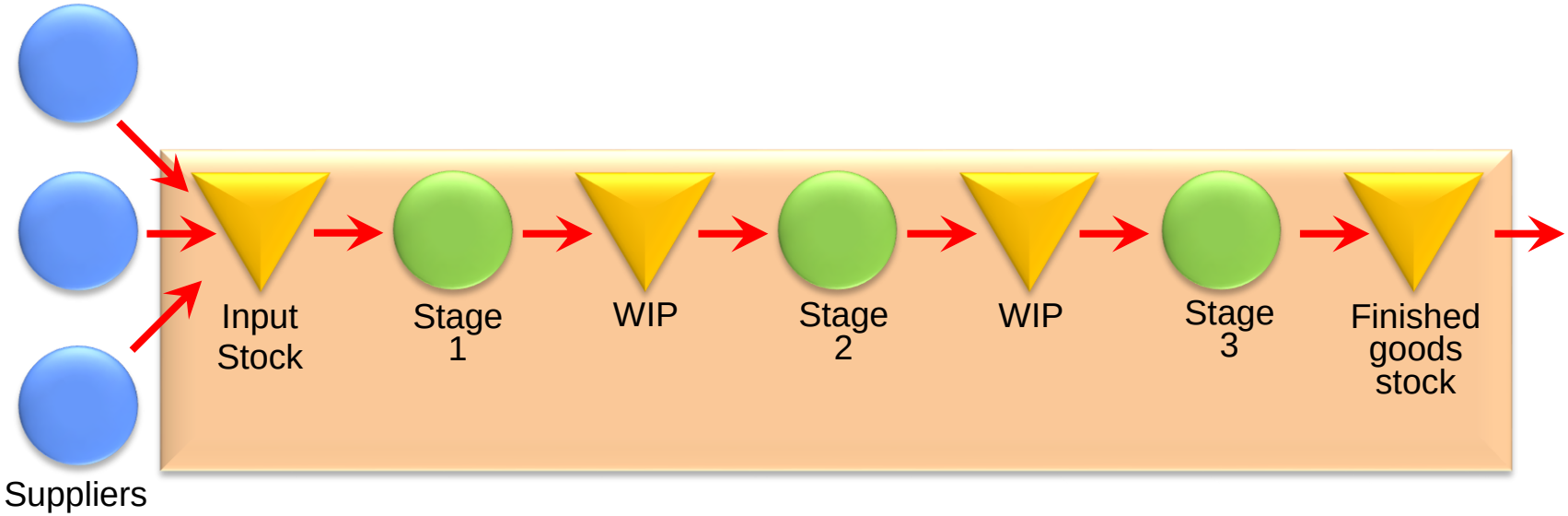

e.g. Local retail store

## Two-stage inventory system




e.g. Automotive parts distributor

# A Multi-stage inventory system




e.g. Television manufacturer

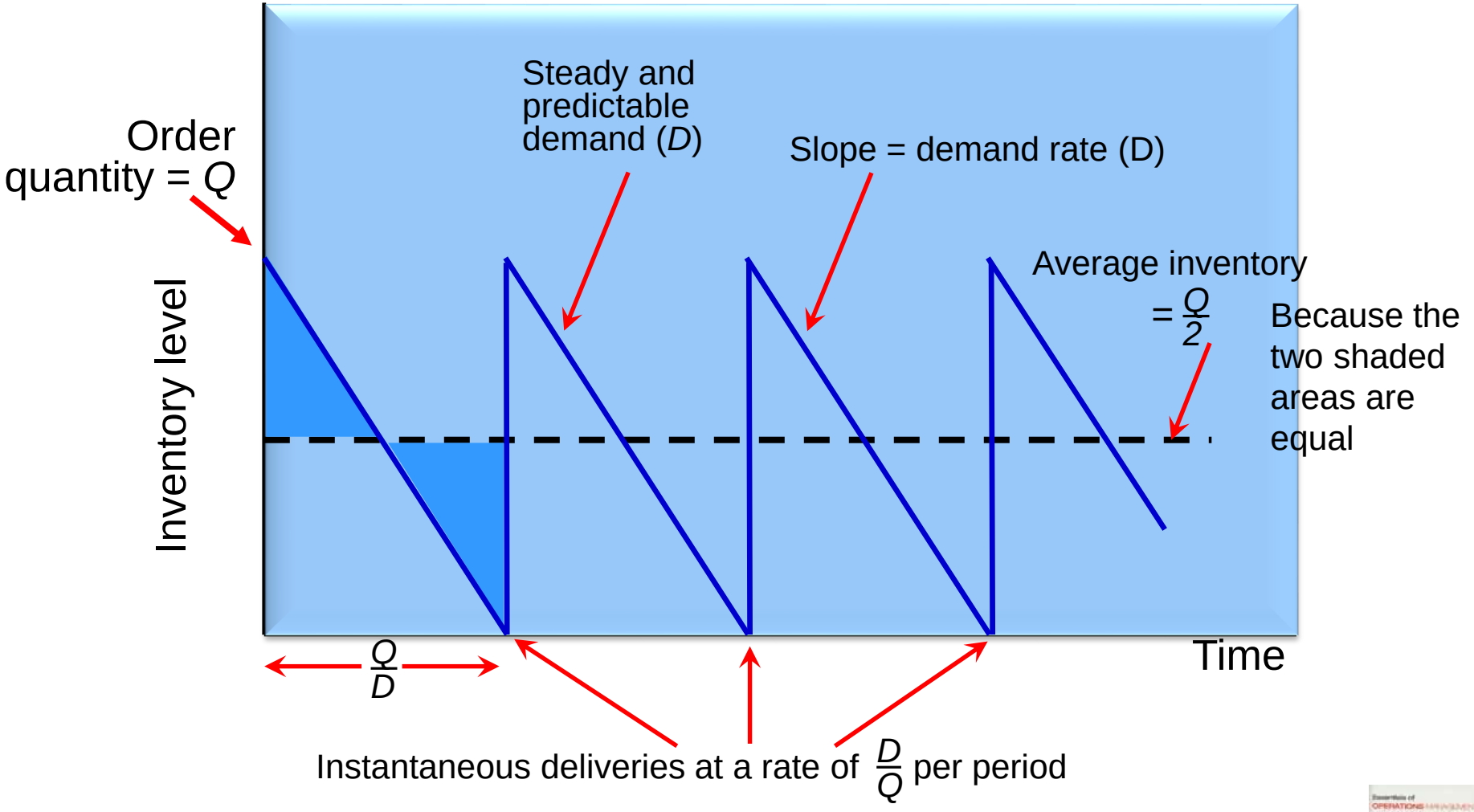
# Determining the amount of inventory

- The best-known approach to determining the amount of inventory to order is the **Economic Order Quantity (EOQ)** formula. The EOQ can be adapted to different types of inventory profile using different stock behaviour assumptions.
- Another approach for gradual replacement of the inventory is the Economic Batch Quantity (EBQ).

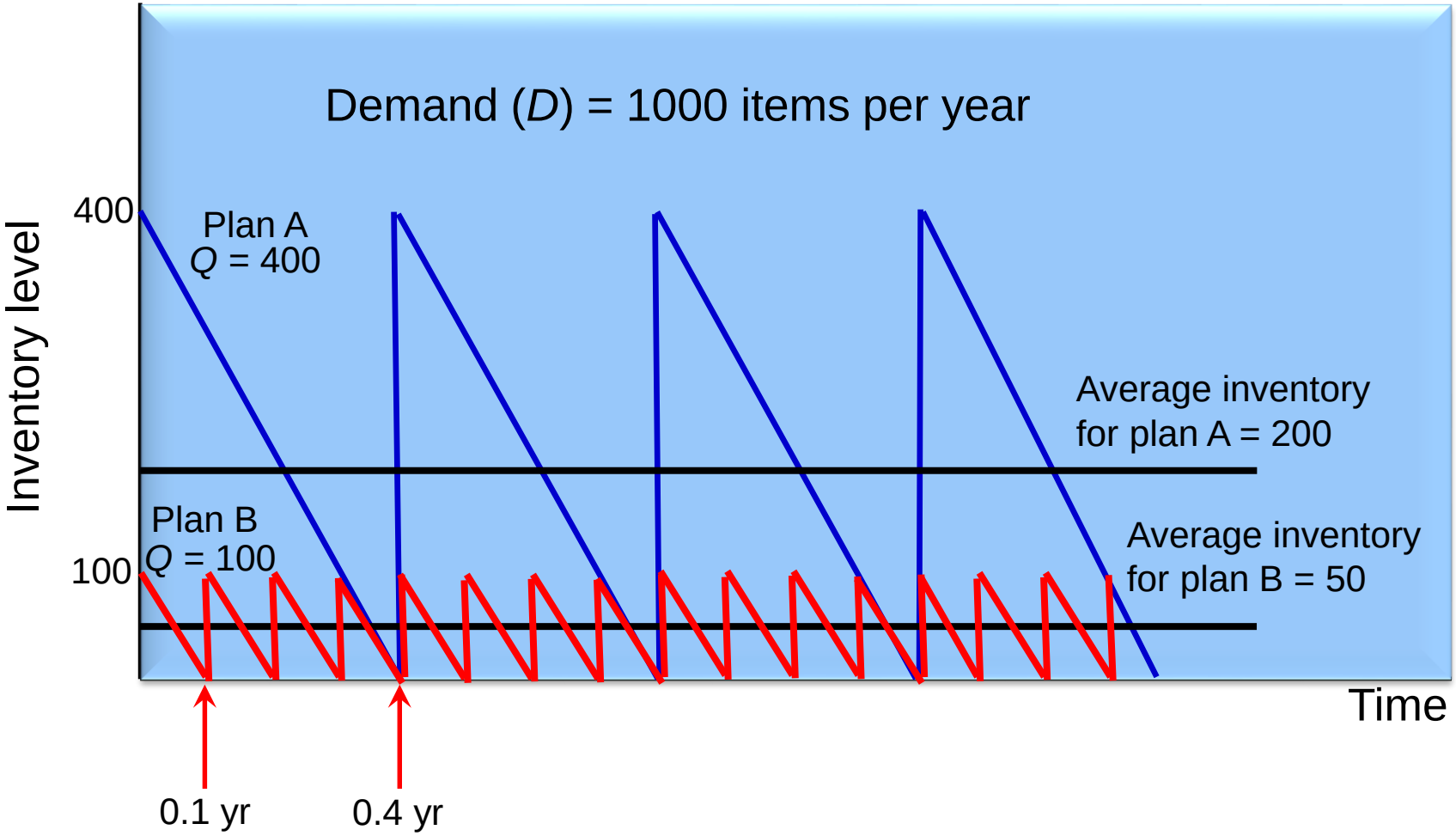
# Defining things

- Order quantity = Q
- Steady and predictable demand = D
- Average inventory = Q/2
- Time interval between deliveries = Q/D
- Frequency of deliveries = D/Q

# Inventory profiles chart the variation in inventory level



# Two alternative inventory plans with different order quantities (*Q*)




- **$C_h$** : Total cost of holding a unit for a period of time
  - Working capital costs
  - Storage costs
  - Obsolescence risk costs
- **$C_o$** : The total cost of placing an order
  - Cost of placing the order (eg. Transportation)
  - Price discount costs

- Holding costs = holding cost/unit x average inventory

  **= $C_h$ x Q/2**

- Ordering costs = ordering cost x number of orders per period

  **= $C_o$ x D/Q**

- Total costs = Holding costs + Ordering costs

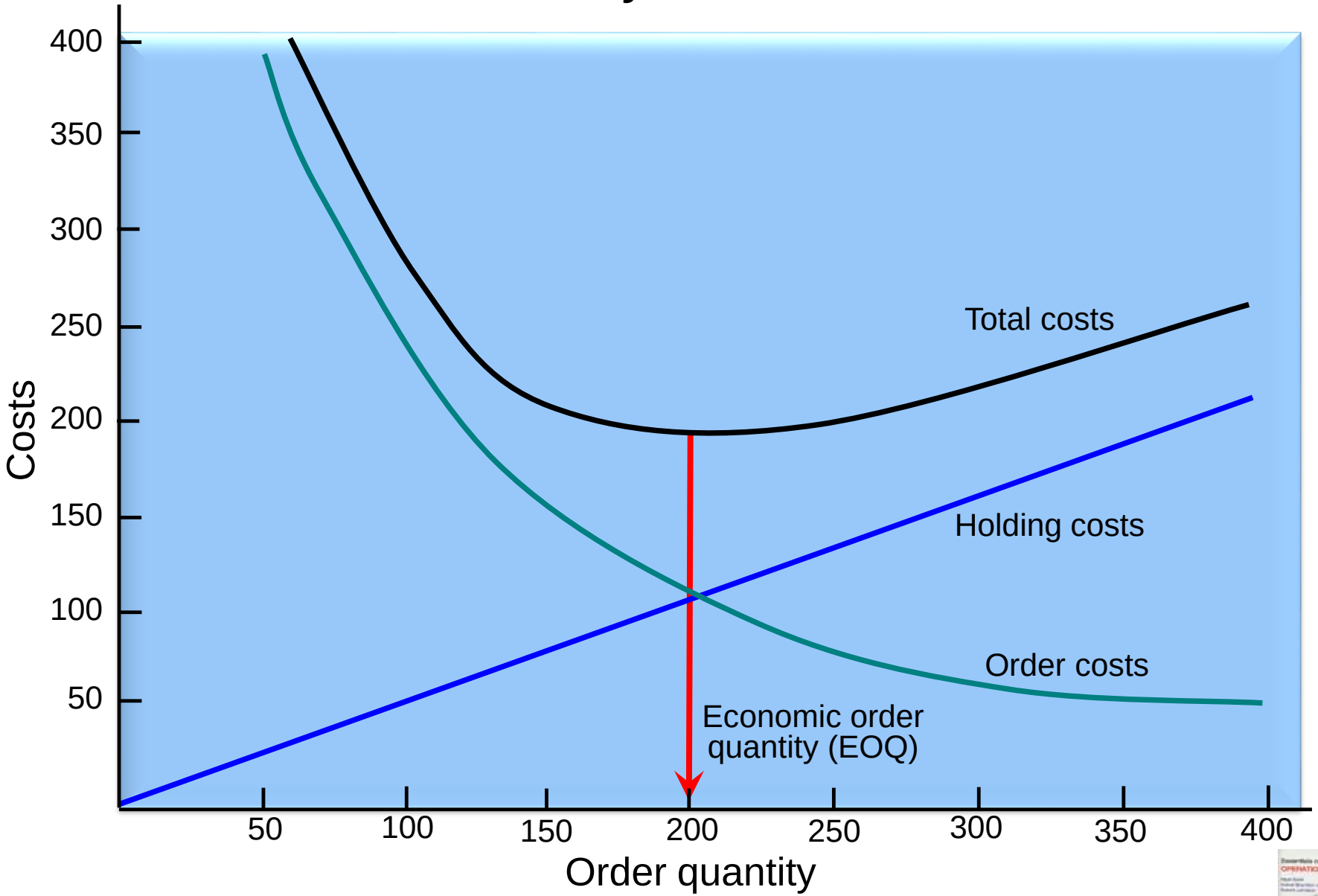
  **$C_t = C_hQ/2 + C_oD/Q$**

# EOQ

- The optimum order quantity that minimizes the total costs is called *Economic Order Quantity (EOQ)*
- For Q = EOQ the holding costs are equal to order costs

- $EOQ = \sqrt{2C_oD/C_h}$

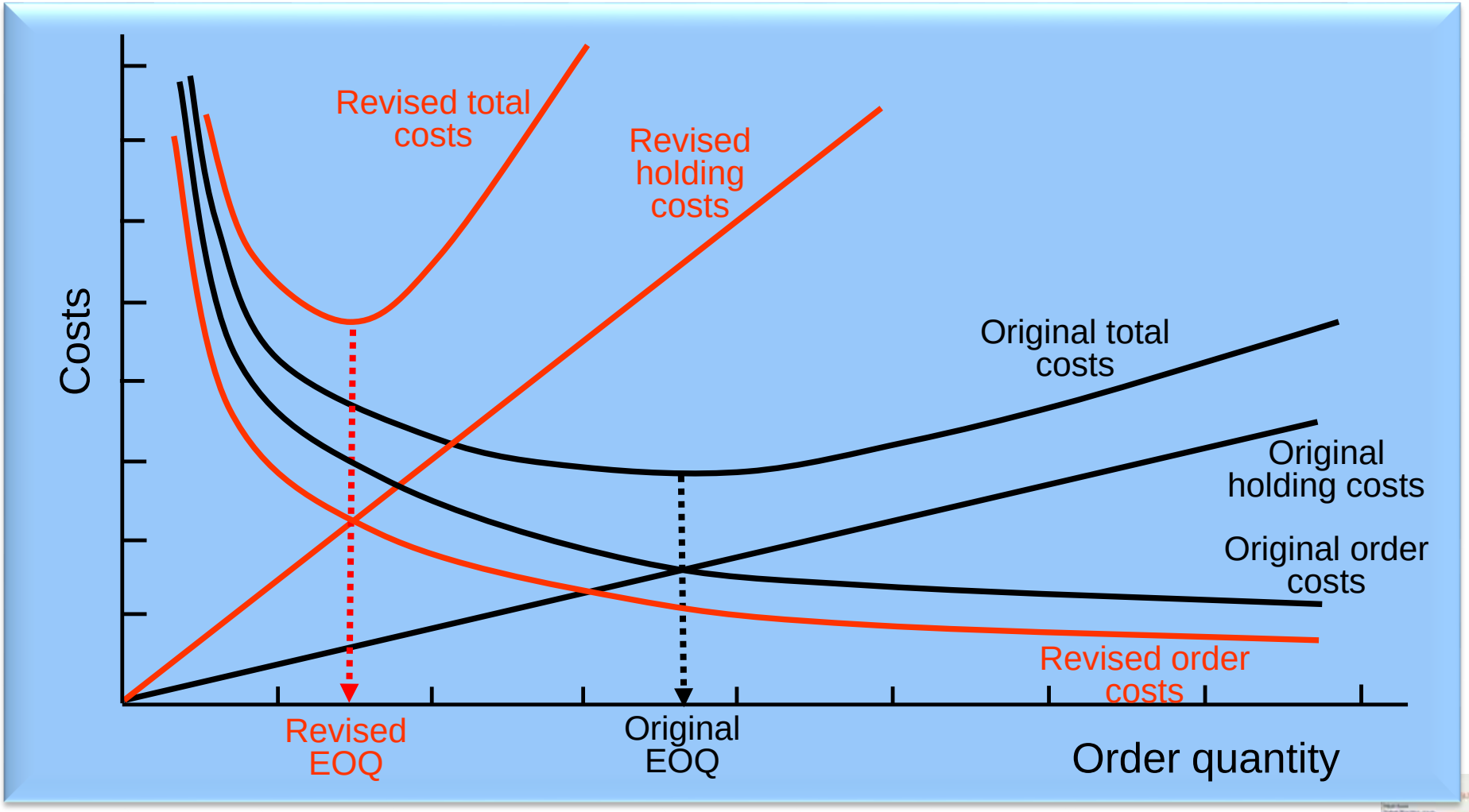
# Traditional view of inventory-related costs



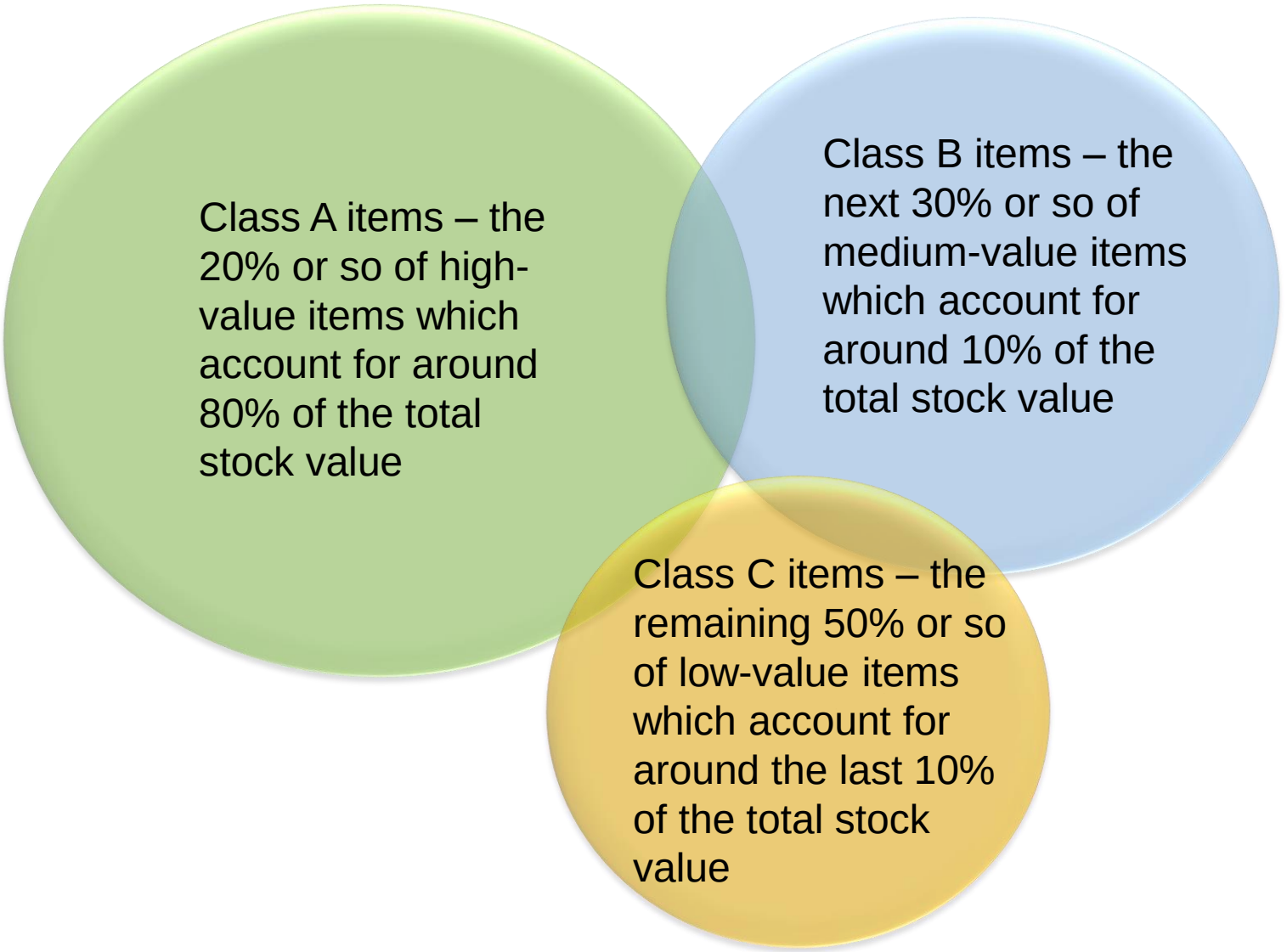
# Criticisms to EOQ

- The criticisms fall in four broad categories:
  - The assumptions included in the EOQ models are simplistic
  - The real costs of stock in operations are not as assumed in EOQ models
  - The models are really descriptive, and should not be used as prescriptive devices
  - Cost minimization is not an appropriate objective for inventory management

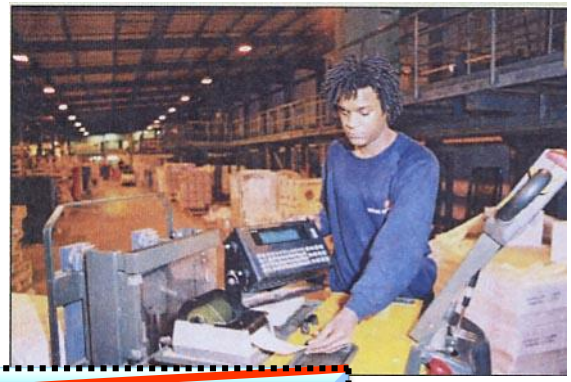
If the true costs of stock holding are taken into account, and if the cost of ordering (or changeover) is reduced, the economic order quantity ( EOQ) is much smaller



# ABC classification




# Pareto curve for stocked items



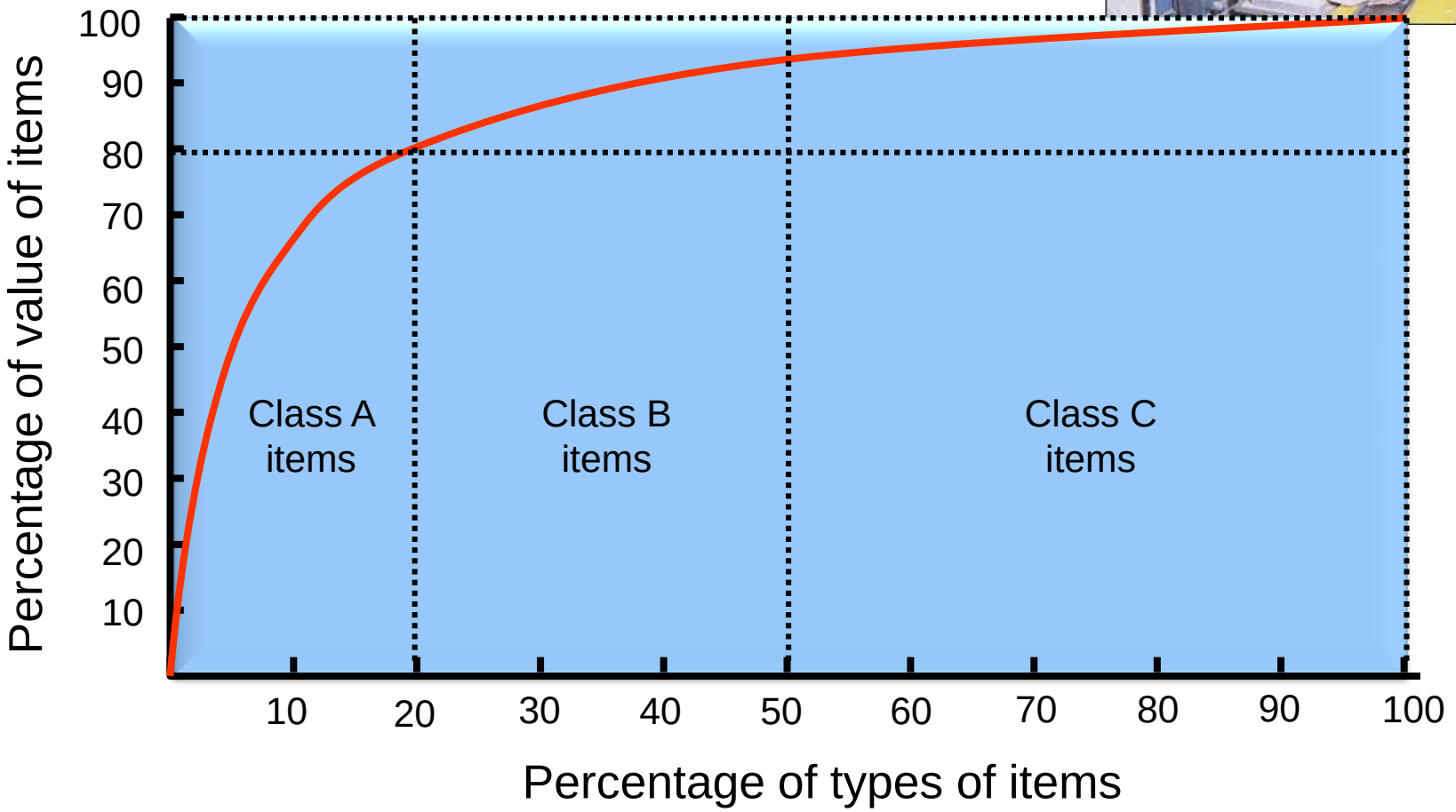



**Table 12.5** Warehouse items ranked by usage value

| *Stock no.* | *Usage (items/year)* | *Cost (£/item)* | *Usage value (£000/year)* | *% of total value* | *Cumulative % of total value* |
|---|---|---|---|---|---|
| A/703 | 700 | 2.00 | 1,400 | 25.14 | 25.14 |
| D/012 | 450 | 2.75 | 1,238 | 22.23 | 47.37 |
| A/135 | 1,000 | 0.90 | 900 | 16.16 | 63.53 |
| C/732 | 95 | 8.50 | 808 | 14.51 | 78.04 |
| C/375 | 520 | 0.54 | 281 | 5.05 | 83.09 |
| A/500 | 73 | 2.30 | 168 | 3.02 | 86.11 |
| D/111 | 520 | 0.22 | 114 | 2.05 | 88.16 |
| D/231 | 170 | 0.65 | 111 | 1.99 | 90.15 |
| E/781 | 250 | 0.34 | 85 | 1.53 | 91.68 |
| A/138 | 250 | 0.30 | 75 | 1.34 | 93.02 |
| D/175 | 400 | 0.14 | 56 | 1.01 | 94.03 |
| E/001 | 80 | 0.63 | 50 | 0.89 | 94.92 |
| C/150 | 230 | 0.21 | 48 | 0.86 | 95.78 |
| F/030 | 400 | 0.12 | 48 | 0.86 | 96.64 |
| D/703 | 500 | 0.09 | 45 | 0.81 | 97.45 |
| D/535 | 50 | 0.88 | 44 | 0.79 | 98.24 |
| C/541 | 70 | 0.57 | 40 | 0.71 | 98.95 |
| A/260 | 50 | 0.64 | 32 | 0.57 | 99.52 |
| B/141 | 50 | 0.32 | 16 | 0.28 | 99.80 |
| D/021 | 20 | 0.50 | 10 | 0.20 | 100.00 |
| Total | | | 5,569 | 100.00 | |

# Critical commentary on Pareto/ABC classification

- Many managers point out that the Pareto law is often misquoted.
- It is not that 80% of SKUs (stock-keeping units) account for only 20% of the value, it is that slow moving items, although only accounting for 20% of sales account for 80%  of inventory usage, as they require a large part of the total investment in stock.

# Critical commentary on Pareto/ABC classification (cont.)

- If errors in forecasting or ordering result in excess stock of "A class" fast moving items, it is relatively unimportant as the excess stock can be sold quickly.
- A items can be left to look after themselves, B and even more C items need controlling.