Managing Inventory

Why inventory is kept at all?

- In-transit inventory: inventories appear when goods (WIP or finished foods) are moved from one place to another and hence some amount is blocked in transit
- Decoupling inventory: inventory to decouple different stages in the production process so that they can work independently
- Safety stock: Caution against unanticipated fluctuations in supply or in demand
- Anticipation inventory: on the contrary, sellers may anticipate surge in demand and keep inventory
- Cycle stock or lot size inventory: amount of inventory directly proportional with the batch size
- Inventory accounts for nearly 40% of current assets of typical manufacturing and 50-60% of the current assets in wholesaling and retailing industries.

Metrics for inventory management

- Customer service: ensuring right product at the right place at the right time
- Operational performance: ensuring no unanticipated downtime in production because of low availability of raw material/WIP or excess final product
  - Annual Inventory Turns: (Annual COGS)/(Average inventory at cost)
  - Days of inventory = (Average Inventory / COGS)*365
    = 365 / (Annual Inventory Turns)
- Operational costs: inventory holding cost, opportunity cost and their tradeoff with cost of lost sales
- Defining metrics separately for three sources of inventory: raw material, work in process and finished goods

Metrics for inventory management

- Cash to Cash Cycle = Days of Inventory + Days of Receivable – Days of Payable
- Days of inventory = (Average Inventory / COGS)*365
- Days of receivable = (Accounts receivable / Revenue)*365
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Cash-to-Cash Cycle Averages			
Industry Sector	2000 - 2003	2004-2007	2008-2011
Athletic Apparel	119	110	94
Automotive	100	89	87
Chemical	82	78	77
Consumer Products	44	21	18
Food & Beverage	32	37	40
Hard-Disk Drives	19	19	15
High-Tech & Electronics	25	14	5
Medical Devices	275	269	309
Retail	23	18	13
Pharmaceutical	161	168	182
Semiconductors	93	98	92

Cost of inventory

- Inventory carrying cost:
  - Cost of capital: Weighted Average Cost of Capital (WACC)
  - Obsolescence cost
  - Handling cost
  - Occupancy cost
  - Miscellaneous costs
    - Theft, security, damage, tax, insurance

ABC Classification of Inventory

- Each item in inventory is classified as either an A part, a B part, or a C part, often by ranking the items based on annual dollar sales.
- It is not unusual for 10 percent of the items that are classified as A to account for 60 percent of the total-dollar value.
- A business would be advised to pay much more attention in terms of analysis and control to the A items than the others. This ABC classification is sometimes referred to as a Pareto Analysis or the 80–20 Rule.

Inventory Driven Costs (IDC)

- Component devaluation costs: Costs incurred on the price drop of the unsold inventory (of short lifecycle products) placed at various phases of the supply chain
- Price protection costs: If the company dropped the market price of a product after units had already been shipped to a sales channel, it had to reimburse its channel partners for the difference for any units that had not yet sold, so the channel partner didn't have to sell at a loss.
- Product return costs: Product return costs are simply 100% price protection costs; distributors can simply return unsold goods to the manufacturer for a full refund.

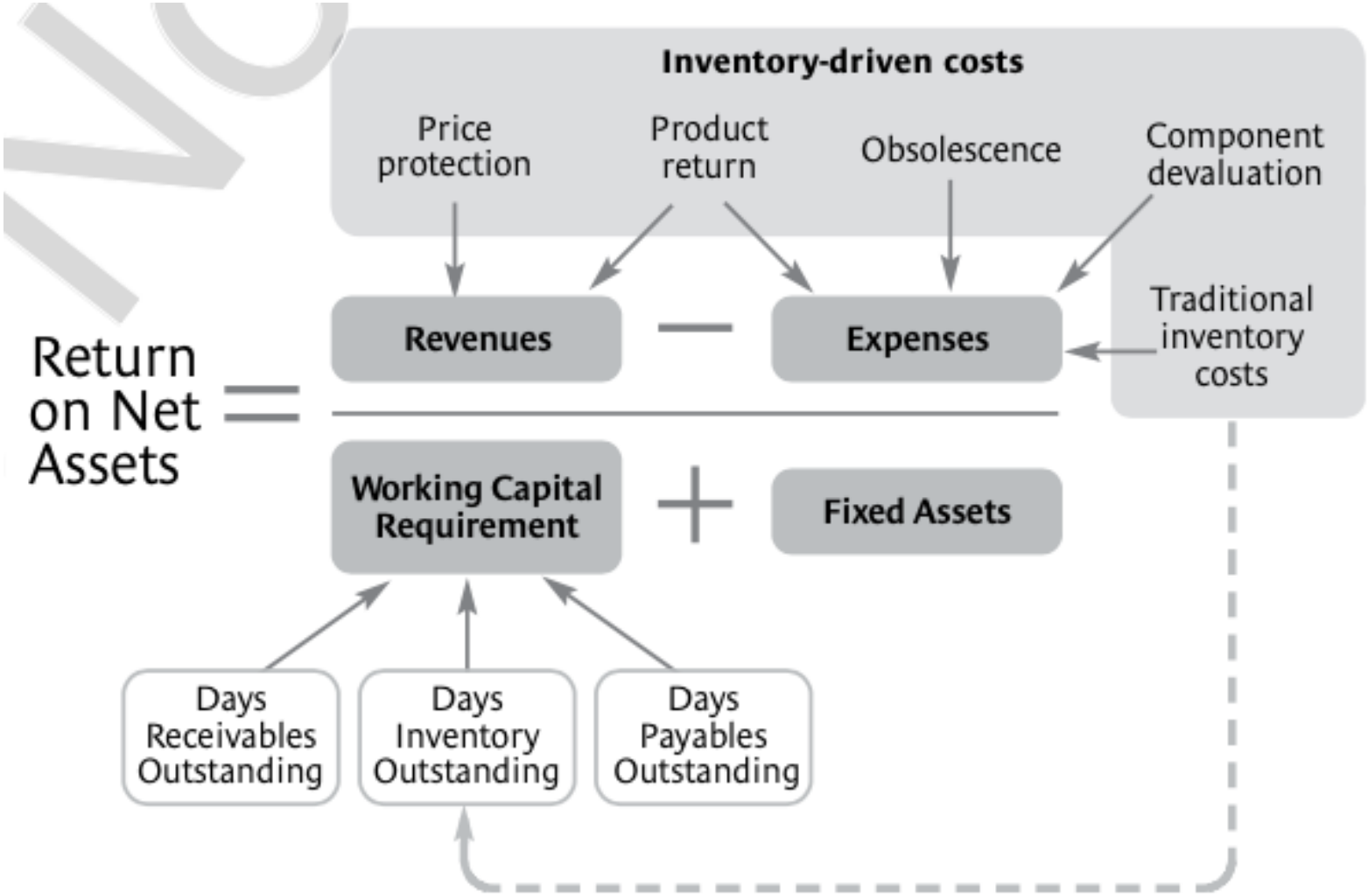
Inventory Driven Costs (IDC)

- Obsolescence Costs: End of lifecycle write-off costs because inappropriate demand forecasting
  - Marketing effort needed to release end of lifecycle products

Inventory Driven Costs (IDC) – A Snapshot

Inventory-Driven Cost	IDC as a Percentage of Revenues		
	Product A	Product B	Product C
Component Devaluation	2.10	4.20	2.20
Price Protection	7.15	2.30	0.80
Product Return	1.15	0.60	0.60
Obsolescence	2.55	0.65	0.40
Holding Cost of Inventory	1.30	1.10	0.80
Total	14.25%	8.85%	4.80%

Linking IDC to Financial Performance



Managing Supply Chain Inventory: Some Pitfalls

1. No supply chain metric: Each site is managed autonomously. Conflicting objectives are decided independently. For example, some companies use inventory turns for all supply chain inventories as the main performance measure. Yet they do not measure their response time or service fill rates to customers.

2. Inadequate definition of customer service: Overall order fill rate is an appropriate performance measure, but measuring it will not help the firm identify which divisions are slowing down order completion.

    - Total response time to an order; average backorder levels or backorder profile; average lateness or earliness of orders relative to customer due dates;

Managing Supply Chain Inventory: Some Pitfalls

3. Inaccurate delivery status data: Companies should track delivery performance and track inventory till it reaches the final customers. It helps to keep a track of exact WIP and when the WIP will be handed over to the customer. Customer anxiety also reduces because of it.

4. Insufficient information systems: The databases at different operating sites that describe system environment, inventory/backlog status, future production plans, and so on, are usually not linked. For example, when manufacturer develops a production plan, it has to retrieve information on order forecasts, current backlogs, inventory status, shipability profile of orders (i.e., when shipments are due for the orders), and production capacities from databases at a number of sites and functions

Managing Supply Chain Inventory: Some Pitfalls

5. Ignoring the impact of uncertainties: Sources of uncertainties are supplier lead time and delivery performance, quality of incoming materials, manufacturing process time (including machine downtimes, process yields, and reworks), transit times, and demand. Those variables are not tracked and hence their impacts are undermined.

6. Simplistic inventory stocking policies: Dynamic inventory policy with changing sources of uncertainties should be recognized and updated. The classification of items by transaction volume does not necessarily reflect the magnitude of uncertainties in supply and demand.

Managing Supply Chain Inventory: Some Pitfalls

7. Discrimination against internal customers: Although customer service for internal customers is not tracked, it is common knowledge that it is much poorer than for external customers. Discriminating against internal customers has a profound impact on the overall supply chain.

8. Poor coordination: Products with multiple components carry a higher information asymmetry and chance of poor coordination. Inventory pileup is evident at the merging centre.

9. Incomplete shipment methods analysis: Changing the transportation lead time may have significant impact on inventory planning but typically transportation decisions are made on cost.

Managing Supply Chain Inventory: Some Pitfalls

10. Incorrect assessment of inventory costs

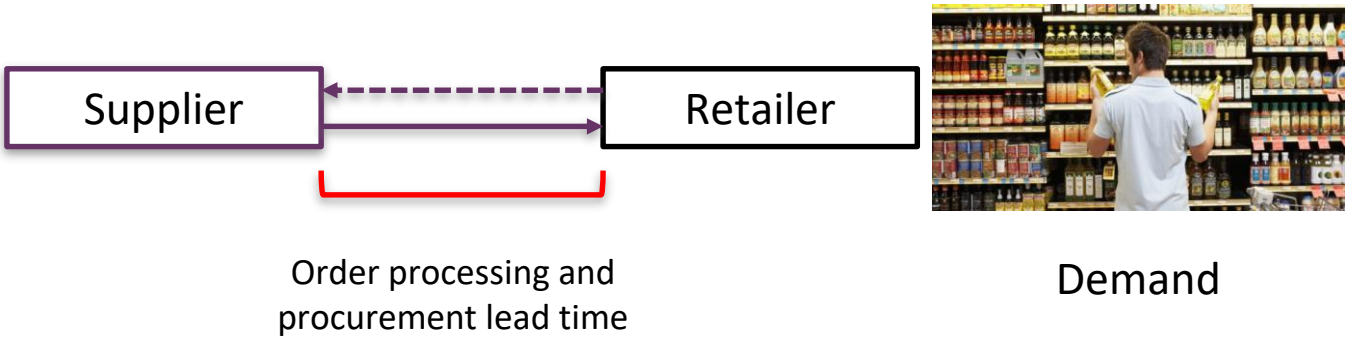
11. Organizational barriers (Decentralization): Entities of a supply chain belong to different organizations within a company, each organization having its own performance measures and evaluation responsibilities.

12. Product process design without supply chain consideration: Product introduction without proper supply chain planning can create problems like product unavailability, excessively long delivery lead times, and unnecessary expediting costs, which may ultimately affect the product's success. On the contrary, an expensive design leading to greater supply chain flexibility may be desired.

Managing Supply Chain Inventory: Opportunities

- Design for supply chain
- Integrate database throughout supply chain
- Integrate control and planning support systems
- Redesign organizational incentives
- Link supply chain metric, incentive and responsibility throughout the supply chain
- Expand view of supply chain

Problem Context



Single Period vs. Multi-Period

Deterministic vs. Stochastic Lead time

Deterministic vs. Stochastic Demand

Summary of inventory models

Problem Characteristics	Decision Variables
Single-period Deterministic Inventory Problem	No decision variable
Single-period Inventory Problem with uncertain demand	How much to order (Q*)
Multi-period Deterministic Inventory Problem	How much to order (EOQ) and When to order (ROP)
Multi-period Deterministic Inventory Problem with lead time	How much to order (EOQ) and When to order (ROP)
Multi-period Inventory Problem with lead time and with uncertain demand	How much to order (EOQ) and When to order (ROP) considering Safety Stock (SS)
Multi-period Inventory Problem with uncertain lead time and demand	How much to order (EOQ) and When to order (ROP) considering Safety Stock (SS)