# Storage and Warehousing System

# Storage & Warehouse Fundamentals

## Reasons for Storage

1. To reduce transportation-production cost
2. To coordinate supply and demand
3. To assist in the production process
4. To assist marketing process

## Transportation-Production Cost Reduction

- Warehousing (including inventory) activities are added expenses.
- It can be traded off with the improvement of efficiency in transportation and production
- Using warehouses appears to be an attractive option when the increased warehousing expense is more than offset with reduced production and transportation expenses.

| | Ship Direct from Plant | Ship Trough 35 Warehouses | Change in Costs |
|---|---|---|---|
| Production costs | $500,000 | $425,000 | $500,000 |
| Transportation costs: | | | |
| To warehouses | 0 | 50,000 | +50,000 |
| To local area | 250,000 | 100,000 | -150,000 |
| Warehouse costs | 0 | 75,000 | +75,000 |
| **Total** | **$750,000** | **$650,000** | **$-100,000** |

## Coordination of Supply and Demand

- Warehousing is needed whenever it becomes too expensive to precisely coordinate supply and demand:
  - Uncertainty (seasonal) supply / production: vegetable and fruits
  - Uncertainty (short selling season) demand: raincoat, room air conditioners
- Warehousing is needed for materials and products that experience wide swings in price from one time to another.
  - Copper, steel, oil
  - The cost of warehousing can be offset with the better price obtained for the commodities.

## Production Needs

- Warehousing may be part of the production process.
  - Warehouse is used to place products which require time for aging (cheeses, wines, liquors, tempe)
  - Warehouse is used to secure or bond the product until the time of sale. It can be related to paying taxes
  - Warehouse performs some "value-added" services: packaging, private labeling, and custom product preparation.

## Marketing Considerations

- Warehouse is used to facilitate the level of readily available the product to the marketplace.
- Reduce delivery time
- Improve customer service
- Increase sales

## Storage System Functions

The primary functions of storage facilities:

1. holding
2. consolidation
3. break-bulk
4. mixing

Warehouse design and layout reflect the particular emphasis on satisfying one or more of these needs.

## Storage System Functions

1. Holding
   - To provide protection and the orderly holding of inventories
   - **The length of time** holding goods and **the requirements for storage** dictate the **facility's configuration and layout**
   - Types of facilities:
     - Longterm, seasonal holding of goods, to temporary holding of goods
     - Specialized storage to general purpose merchandise storage
   - Types of goods:
     - Finished goods (ready for market), semimanufactured goods (awaiting for assembly ot future process), and raw materials

## Storage System Functions

2. Consolidation
   - Distribution warehouse used to consolidate small inbound shipments into larger outbound shipments
     - Reduce overall transportation costs
     - Defined by place of holding activities.
     - It has most of it space allocated to temporary storage
     - Defined by time goods are stored
     - More attention is given to speed and ease of product flow
   - Cross dock / pool points: a warehouse focus only on receiving and shipping activities, eliminating storage and order picking activities. The transfer is typically completed in less than 24 hours

## Storage System Functions

3. Break-Bulk
   - The opposite of consolidate shipments
   - When inbound transportation rates per unit < outbound rates per unit
   - When customer order in < vehicle load quantities
   - When distance between manufacture and customer are great.
   - Pool point / Cross dock / Terminal system

4. Mixing
   - A mixing point permits volume shipments of portions of the product line to be collected at a single point and then assembled into orders and reshipped to customers
   - Pool point / Cross dock / Terminal

## Storage Alternatives

Considerations of storage alternatives: Financial and Legal arrangements

The basic alternatives:

1. Space ownership
   - Advantages: less expensive warehousing, a higher degree of control to ensure efficient warehousing and a high level of service, suitable for product requires specialized personnel and equipment (chemical products), the benefit that accrue real estate ownership, the space may be converted to other uses at a future time, the space may sever as a base for a sale, private truck fleet, traffic department, or purchasing department

2. Rented space
   - 3PL
   - Mostly are categorized as public warehouse

## Storage Alternatives

3. Leased space
   - Intermediate choice between short-term space rental and long-term commitment of private warehouse
   - Lower rate
   - The user may also have control over the storage space and the associated operations

4. Storage in transit
   - The time that goods remain in the transportation equipment during delivery
   - Different transportation choices mean different transit time

## Types of Warehouses

- Private Warehouses
- Public Warehouses

## Types of Warehouses

Classifications of public warehouses:
1. Commodity warehouses

2. Bulk storage warehouses

3. Temperature-controlled warehouses

4. Household goods warehouses

5. General merchandise warehouses

6. Miniwarehouses

## Storage System Costs and Rates

- Public Warehousing
  - All-variable-cost storage system
  - Flexibility and improved customer service
- Leased Warehousing, Manual Handling
  - Leased cost is a variable cost (charge of leased divided by warehouse throughput,
  - Labor cost tend to be substantial
- Private Warehousing, Pallet and Forklift Handling
  - Depend on warehouse utilization and the diseconomies caused form fluctuating warehouse throughput
- Private Warehousing, Automated Handling
  - High level of fixed investment
  - Very high warehouse throughput levels
  - Cost components: storage, handling, clerical costs

## Virtual Warehousing

Satisfy customer requests from alternative inventories in a company's logistic system

Not all item for sale are stocked in a company's warehouse

Example: AMAZON, ALIBABA, LAZADA

Sharing critical information with vendors

# Storage & Warehouse Decisions

## Site Selection

Facility location decision:

**Classification of Location Problems:**

- Driving force
  - Economic factor
  - Accessibility factor
- Number of facilities
  - Single facility
  - Multi Facility
- Discreteness of the choices
  - Continuous location methods
  - Discrete location methods
- Degree of data aggregation
  - Size of area
- Time horizon
  - Static. Find location based on data for a single period.
  - Dynamic. Handle multiperiod location planning.

## Site Selection: Facility Location

A Historical Perspective on Location

- Bid-Rent Curve
  - Consider the difference between the price for goods in the marketplace and the cost of transporting the goods to marketplace
- Weber's Classification of Industries
  - Effect on process location of product weights before and after processing
- Hoover's Trapped Transportation Rates
  - Minimize inbound and outbound transportation costs (inbound costs: cost from source of material; outbound costs: cost to the market)

## Site Selection: Facility Location

Single Facility Location

- Center of gravity
- Graphical techniques
- Nonlinear approximation method

Multiple Facility Location

- Exact method:
  - Multiple center-of-gravity approach
  - Mixed integer programming
  - Simulation Methods
- Heuristic method:
  - Selective evaluation
  - Guided linear programming
  - Simulated Annealing
  - Genetic Algorithm

## Site Selection: Facility Location

Dynamic Warehouse Location:

- Consider current conditions and projected some future year
- Evaluate new configuration each year. Facility that work with actual data not forecasted
- Optimal configuration can be found over time that will precisely show **when** a change to a new configuration is needed and should be made

## Site Selection: Facility Location

- Retail / service location
- Other location problems
  - Hub and Spoke (FedEx , UPS)
  - Obnoxious Facilities (dangerous facilities: waste dumps, water treatment plants, chemical reclamation plants, prison)
  - Microlocation (require precise data)
  - Depo for emergency or disaster handling equipment

## Planning for Design and Operation

**SIZING FACILITY**

**The No-Trend Sizing Problem**

**Sizing with Trend**

## Planning for Design and Operation

**Appraisal of the Sizing Method**

## Warehouse Decisions

- Selecting the type of materials handling system
- Material handling equipment replacement
- Product layout decisions
- Order-Picking Operations