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سلايدات :

إدارة سلسلة التزويد و الخدمات اللوجستية

Supply Chain Management

للدكتور : أسامة المنيزل

اللجنة الأكاديمية لقسم الهندسة الصناعية

2023

Operation and Supply Chain Management

Dr. Osama Al Meanazel

Course Outline

Course Outline: Instructor Information

- Name: Dr. Osama T. Al Meanazel, Assistant Professor
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- Office: IE 3086

- Office Hours:
  - 10:00 – 11:00 Sunday, Tuesday and Thursday.
  - By appointment

Course Outline: Text Book

- Cecil B. Bozarth and Robert B. Handfield (2008) Introduction to Operations and Supply Chain Management, Pearson **(Required)**

Course Outline: Objectives

- The primary objectives of this course are to enhance the understanding of supply chain management and learn the tools and techniques required for better supply chain

Course Outline: Tentative Course Outline

1. Introduction to operation and supply chain management
2. Operation and supply chain strategies
3. Process Choice and Layout Decisions in Manufacturing and Services
4. Business Processes
5. Supply management
6. Logistics
7. Managing Inventory throughout the Supply Chain
8. Managing Production across the Supply Chain
9. JIT/Lean Production

Course Outline: Evaluation & Grading

- ❑ Coursework 30%
- ❑ Midterm Exam 30%
- ❑ Final Exam 40%

Course Outline: Exams

- Midterm: will be announced
- Final: Will be announced by the register

- The student is expected to notify the instructor in advance in the event an emergency occurs which prevents the student from taking an exam at the scheduled time, if possible.
- Make-up exams will ONLY be given for absence due to unavoidable situations.

Course Outline: Questions???

Operation and Supply Chain Management

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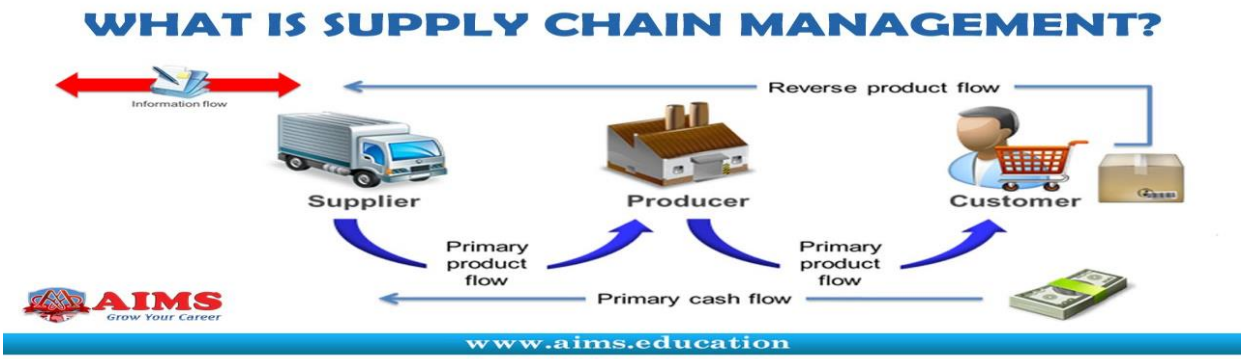
Lecture 1

Introduction to operation and supply chain management

What is the supply chain?



Why study Operations and Supply Chain Management?

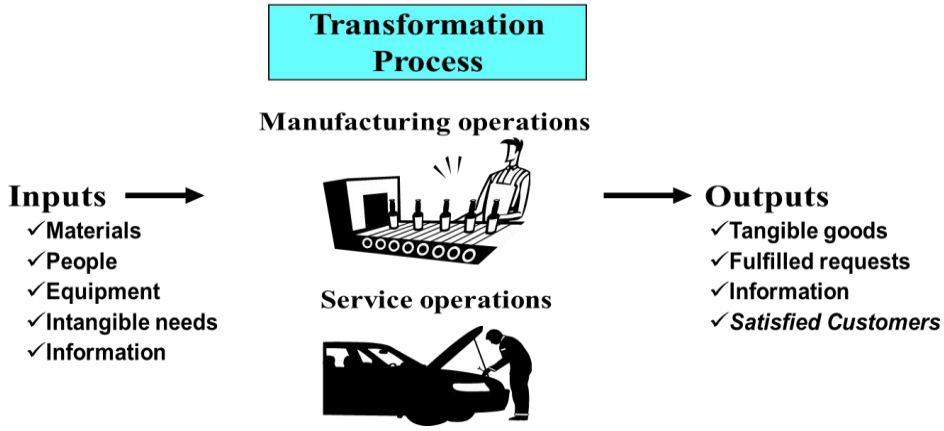
- Three basic truth
  - Pervasiveness
    - Every organization must make a product or provide a service that someone values
  - Interdependence
    - Most organizations function as part of a larger supply chain
  - Profitability and Survival
    - Organizations must carefully manage their operations and supply chains in order to prosper and, indeed, survive

Introduction

- ***Operations function:*** The collection of people, technology, and systems within an organization that has primary responsibility for providing the organization's products or services.
- ***Supply chain:*** A network of manufacturers and service providers that work together to create products or services needed by end users. These manufacturers and service providers are linked together through physical flows, information flows, and monetary flows.

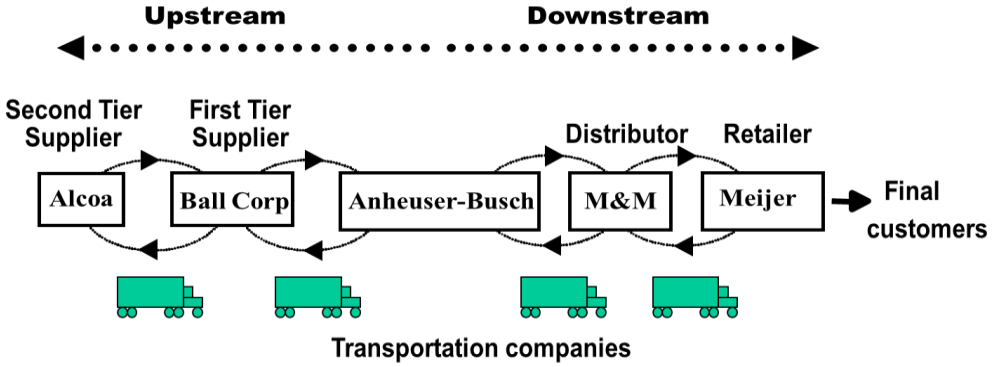
Operations Management

- The planning, scheduling, and control of the activities that transform inputs into finished goods and services



Supply Chain Management

- Active management of supply chain activities and relationships to maximize customer value and achieve a sustainable competitive advantage

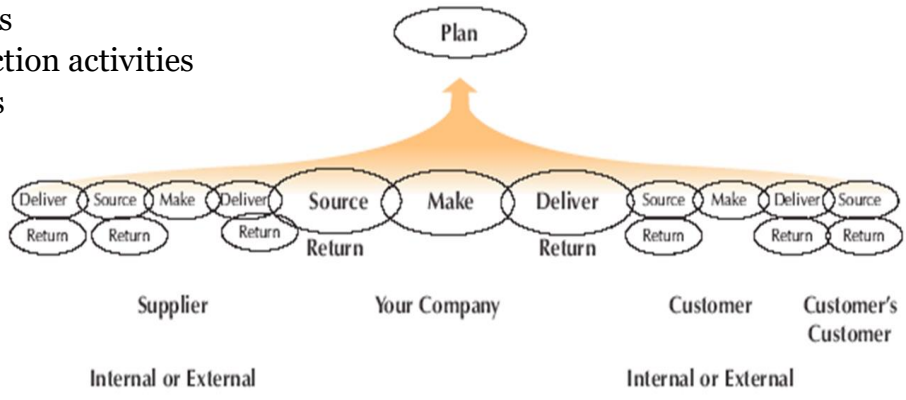


Supply Chain Issues

- Length of the chain
- Complexity
- Stability
- Physical, informational, and monetary flows

Supply-Chain Operations Reference (SCOR) Model

- Consists of:
  - Planning activities
  - Sourcing activities
  - "Make" or production activities
  - Delivery activities
  - Return activities



SCOR Model

- Planning activities
  - which seek to balance demand requirements against resources and communicate these plans to the various participants
- Sourcing activities
  - which include identifying, developing, and contracting with suppliers and scheduling the delivery of incoming goods and services
- "Make" or production activities
  - which cover the actual production of a good or service
- Delivery activities
  - which include everything from entering customer orders and determining delivery dates to storing and moving goods to their final destination
- Return activities
  - which include the activities necessary to return and process defective or excess products or materials

Operations and Supply Chain Management and You

- Some of the many career positions

✓ Analyst
✓ Commodity Manager
✓ Customer Service Manager
✓ International Logistics Manager
✓ Logistics Services Salesperson
✓ Production Manager
✓Sourcing Analyst
✓Logistics and Material Planner
✓Systems Support Manager (MIS)
✓Transportation Manager
✓Process Analyst
✓Scheduler
✓Purchasing Agent

Operations and Supply Chain Activities

- ❑ Process selection, design, and improvement
- ❑ Forecasting for decision making
- ❑ Capacity planning for capital investment and resource levels
- ❑ Inventory management for amount and location
- ❑ Planning and control for work scheduling and meeting demand
- ❑ Purchasing, managing supplier relationships
- ❑ Logistics or acquisition and distribution

Operation and Supply Chain Management

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Lecture 2

Operation and supply chain strategies

Business Elements

- ***Structural element:*** One of two major decision categories addressed by a strategy, includes tangible resources. Difficult to change:
  - Buildings
  - Equipment
  - Computer systems
  - Other capital assets

- ***Infrastructural element:*** One of two major decision categories addressed by a strategy. Relatively easy to change:
  - People
  - Policies
  - Decision rules
  - Organizational structure

Strategy

- ***Strategy:*** A mechanism by which a business coordinates its decisions regarding structural and infrastructural elements

- ***Business Strategy***
  - Long-term master plan for the company; establishes the general direction
- ***Functional Strategies***
  - Further develop the business strategy in segments of the business — must be aligned and coordinated
- ***Core Competencies***
  - Organizational strengths that provide focus and foundation for the company's strategies

A Top-Down Model of Strategy

Value Analysis

- A process for determining the best choice when there are no unambiguous formulas for doing so.
  - (also called a preference matrix).
- Helps maintain focus in gathering and assessing relevant data.
- **Value index** A measure that uses the performance and importance scores for various dimensions of performance for an item or a service to calculate a score that indicates the overall value of an item or a service to a customer

Value Index Determination

$$V = \sum_{n=1}^{N} I_n P_n$$

Where:

I_n = *Importance of value dimension (criteria) n*

P_n = *Performance of candidate with regard to dimension n*

N = *total number of value dimensions evaluated*

(Higher values represent higher importance or performance)

Value Analysis – Thoughts

- Requires definition of criteria and their importance beforehand to avoid bias
- It is useful if the importance or weighting values add up to 100%
- A threshold score can set by evaluating the current situation, if it exists, using the selected analysis criteria
- Requires careful definition of scoring values for performance assessment (highest value represents most desirable result)

Four Performance Dimensions

- Quality (performance, conformance, reliability)
- Time (delivery speed and reliability, development speed)
- Flexibility (mix, changeover, volume)
- Cost (labor, material, engineering, quality-related)

Quality

- The characteristics of a product or service that bear on its ability to satisfy stated or implied needs.

- ***Performance quality*** A subdimension of quality that addresses the basic operating characteristics of a product or service.
- ***Conformance quality*** A subdimension of quality that addresses whether a product was made or a service performed to specifications.
- ***Reliability quality*** A subdimension of quality that addresses whether a product will work for a long time without failing or requiring maintenance.

Time

- Time has two basic characteristics: speed and reliability

- ***Delivery speed*** A performance dimension that refers to how quickly the operations or supply chain function can fulfill a need once it has been identified.
- ***Delivery reliability*** A performance dimension that refers to the ability to deliver products or services when promised.
- ***Delivery window*** The acceptable time range in which deliveries can be made.

Flexibility

- A performance dimension that considers how quickly operations and supply chains can respond to the unique needs of customers.
- ***Mix flexibility*** The ability to produce a wide range of products or services.
- ***Changeover flexibility*** The ability to provide a new product with minimal delay.
- ***Volume flexibility*** The ability to produce whatever volume the customer needs.

Cost

- Covers such a wide range of activities that companies commonly categorize costs in order to focus their cost management efforts.
- Some typical cost categories include
  - Labor costs
  - Material costs
  - Engineering costs
  - Quality-related costs (including failure costs, appraisal costs, and prevention costs)

Order Winners and Order Qualifiers

- ***Order winner*** A performance dimension that differentiates a company's products and services from its competitors'. Firms win a customer's business by providing superior levels of performance on order winners.

- ***Order qualifier*** A performance dimension on which customers expect a minimum level of performance. Superior performance on an order qualifier will not, by itself, give a company a competitive advantage.

Stages of Alignment with the Business Strategy

- **Stage 1**—Internally neutral. In this stage, management seeks only to minimize any negative potential in the operations and supply chain areas. There is no effort made to link these areas with the business strategy.

- **Stage 2**—Externally neutral. Here industry practice is followed, based on the assumption that what works for competitors will work for the company. Still, there is no effort made to link the operations and supply chain areas with the overall business strategy.

- **Stage 3**—Internally supportive. At this stage, the operations and supply chain areas participate in the strategic debate. Management recognizes that the operations and supply chain structural and infrastructural elements must be aligned with the business strategy.

- **Stage 4**—Externally supportive. At this stage, the operations and supply areas do more than just support the business strategy: The business strategy actively seeks to exploit the core competencies found within these areas.

Operation and Supply Chain Management

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Lecture 3

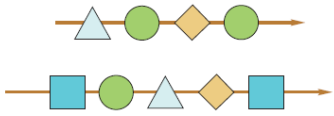
Process Choice and Layout Decisions in Manufacturing and Services

Manufacturing Processes

- Many customers are demanding smaller quantities, more frequent shipments, and shorter lead times with lower prices
- ***Flexible manufacturing systems (FMSs):*** Highly automated batch processes that can reduce the cost of making groups of similar products.
- Five classic manufacturing processes:
  1. Production lines
  2. Continuous flow processes
  3. Job shops
  4. Batch manufacturing
  5. Fixed-position layout

Production Line

- **Production line:** A type of manufacturing process used to produce a narrow range of standard items with identical or highly similar designs.
- **Product-based layout:** A type of layout where resources are arranged sequentially, according to the steps required to make a product.



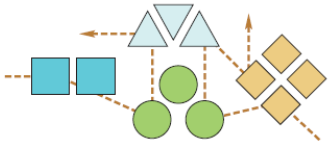
- **Cycle time:** For a line process, the actual time between completions of successive units on a production line.

Continuous Flow Processes

- **Continuous flow process:** A type of manufacturing process that closely resembles a production line process. The main difference is the form of the product, which usually cannot be broken into discrete units. Examples include yarns and fabric, food products, and chemical products such as oil or gas.
- Continuous flow process is even less flexible than a production line

Job Shop

- **Job shop:** A type of manufacturing process used to make a wide variety of highly customized products in quantities as small as one. Job shops are characterized by general-purpose equipment and workers who are broadly skilled.



- **Functional layout:** A type of layout where resources are physically grouped by function.

Batch Manufacturing and Fixed-Position Layout

- **Batch manufacturing:** A type of manufacturing process where items are moved through the different manufacturing steps in groups, or batches.

- **Fixed-position layout:** A type of manufacturing process in which the position of the product is fixed. Materials, equipment, and workers are transported to and from the product.

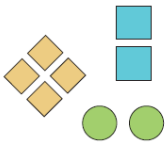
Hybrid Manufacturing Processes

- **Hybrid manufacturing:** process A general term referring to a manufacturing process that seeks to combine the characteristics, and hence advantages, of more than one of the classic processes. Examples include flexible manufacturing systems, machining centers, and group technology.

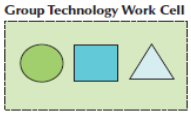
- Two Common Layout:
  - Machining center
  - Group technology

Hybrid Manufacturing Processes

- **Machining center:** A type of manufacturing process that completes several manufacturing steps without removing an item from the process.



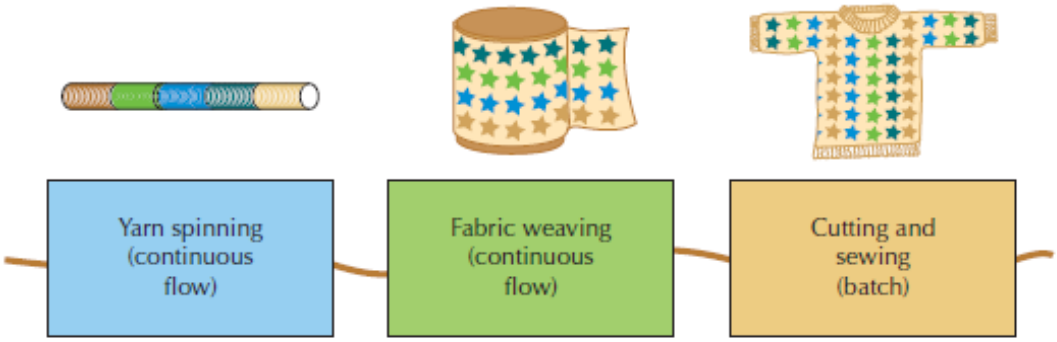
- **Group technology:** A type of manufacturing process that seeks to achieve the efficiencies of a line process in a batch environment by dedicating equipment and personnel to the manufacture of products with similar manufacturing characteristics.



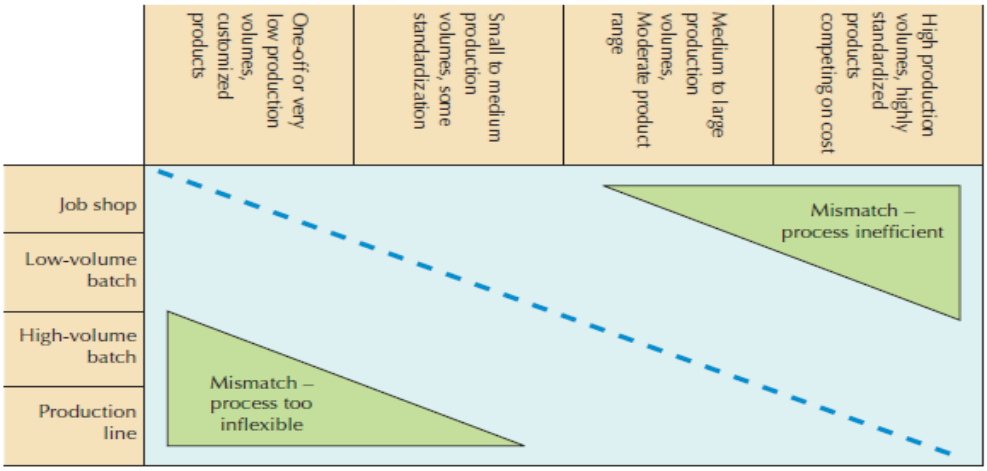
Group Technology

- Group technology cells typically follow a cellular layout
- **Cellular layout:** A type of layout typically used in group technology settings in which resources are physically arranged according to the dominant flow of activities for the product family.
- **Product family:** In group technology, a set of products with very similar manufacturing requirements.

Linking Manufacturing Processes across the Supply Chain



The Product-Process Matrix

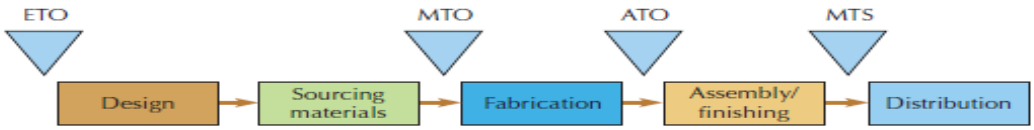


Product Customization Within The Supply Chain

- Four Levels of Customization:
  1. Make-to-stock (MTS) products
     - Products that require no customization. They are typically generic products and are produced in large enough volumes to justify keeping a finished goods inventory.
  2. Assemble-to-order (ATO) or finish-to-order products
     - Products that are customized only at the very end of the manufacturing process.
  3. Make-to-order (MTO) products
     - Products that use standard components but have customer-specific final configuration of those components.
  4. Engineer-to-order (ETO) products
     - Products that are designed and produced from the start to meet unusual customer needs or requirements. They represent the highest level of customization.

The Customization Point

- **Upstream activities:** In the context of manufacturing customization, activities that occur prior to the point of customization.
- **Downstream activities:** In the context of manufacturing customization, activities that occur at or after the point of customization.



Customization Important Notes

- **Early Customization in the supply chain:**
  - Flexibility in response to unique customer needs will be greater.
  - Lead times to the customer will tend to be longer.
  - Products will tend to be more costly.
- **Late Customization in the supply chain:**
  - Flexibility in response to unique customer needs will be limited.
  - Lead times to the customer will tend to be shorter.
  - Products will tend to be less costly.

Layout Decision Models

- **Line balancing:** The technique works by assigning tasks to a series of linked workstations in a manner that minimizes the number of workstations and minimizes the total amount of idle time at all stations for a given output level

- **Assigning department locations in functional layouts:** the objective here is to arrange the different functional areas, or departments, in such a way that departments that should be close to one another (such as packaging and shipping) are, while departments that don't need to be or shouldn't be near one another aren't

Line Balancing – Steps

1. Identify all the process steps required, including the time for each task, the immediate predecessor for each task, and the total time for all tasks.
2. Draw a precedence diagram based on the information gathered in step1.
3. Determine the takt time for the line.
4. Compute the theoretical minimum number of workstations needed.
5. Working on one workstation at a time, use a decision rule to assign tasks to the workstation.
6. Evaluate the performance of the proposed line by calculating some basic performance measures.

Line Balancing

- Takt time: In a production line setting, the available production time divided by the required output rate. Takt time sets the maximum allowable cycle time for a line.

$$\text{Takt time} = \frac{\text{available production time}}{\text{required output rate}}$$

- The theoretical minimum number of workstations is defined as:

$$W_{Min} = \frac{\sum_{i=1}^{I} T_i}{\text{takt time}}$$

- some basic performance measures
  - Idle time $= IT = W_{Actual}CT - \sum_{i=1}^{I} T_i$
  - Percent idle time $= PI = 100\%\left[\frac{IT}{W_{Actual}CT}\right]$
  - Efficiency delay $= ED = 100\% - PI$

Assigning Department Locations In Functional Layouts

1. Identify the potential department locations and distances between the various locations.
2. For each department, identify the expected number of trips between the department and all other departments (interdepartmental trips).
3. Attempt to assign department locations in such a way as to minimize the total distance traveled.
   a. If a particular department can be assigned only to a certain location, do this first.
   b. Rank order department pairings by number of interdepartmental trips and attempt to locate departments with the most interdepartmental trips next to one another.
   c. Centrally locate departments that have significant interactions with multiple departments.
   d. See if the solution can be improved by swapping pairs of departments.

Operation and Supply Chain Management

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Lecture 4
Business Processes

Business Processes

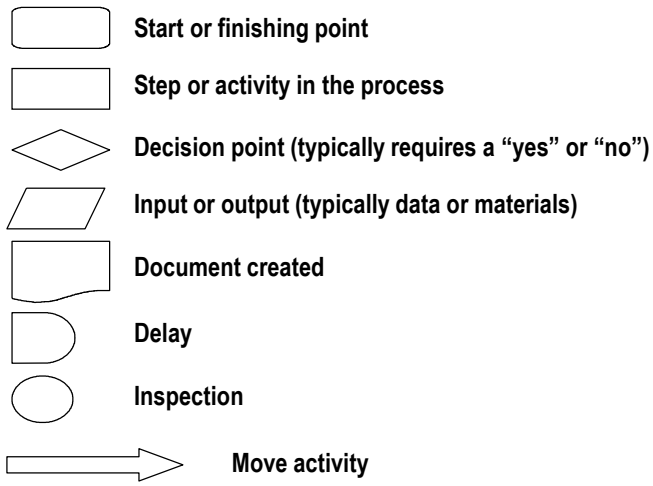
- Process: According to APICS, "A set of logically related tasks or activities performed to achieve a defined business outcome."
  - *Primary:* A process that addresses the main value-added activities of an Organization.
  - *Support:* A process that performs necessary, though not value added, activities
  - *Development:* A process that seeks to improve the performance of primary and support processes.

PRIMARY PROCESSES	SUPPORT PROCESSES	DEVELOPMENT PROCESSES
Providing a service	Evaluating suppliers	Developing new products
Educating customers	Recruiting new workers	Performing basic research
Manufacturing	Developing a sales and operations plan (S&OP)	Training new workers

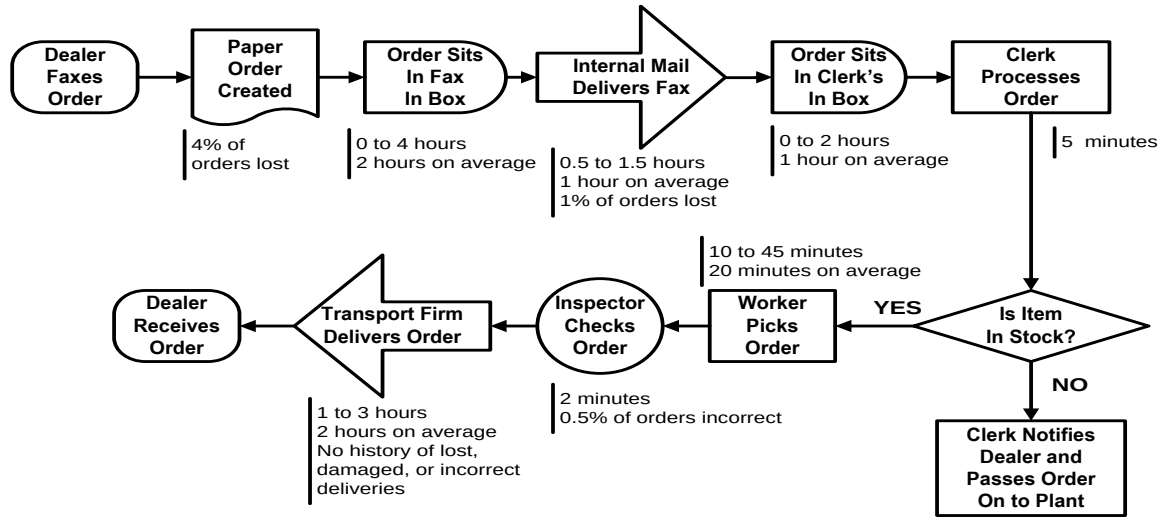
Mapping Business Processes

- Mapping: The process of developing graphic representations of the organizational relationships and/or activities that make up a business process.
- Process maps: A detailed map that identifies the specific activities that make up the informational, physical, and/or monetary flow of a process.
- 'Swim Lane' process maps: A process map that graphically arranges the process steps so that the user can see who is responsible for each step.

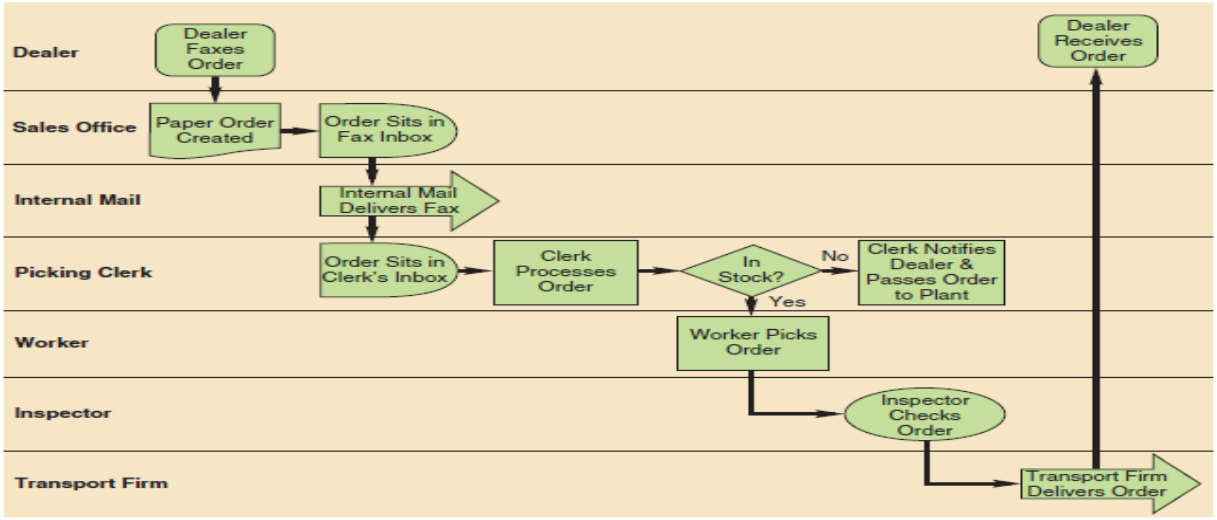
Process Maps



Process Maps



'Swim Lane' Process Maps



Process Measures

- **Productivity:** A measure of process performance; the ratio of outputs to inputs.
- **Efficiency:** A measure of process performance; the ratio of actual outputs to standard outputs. Usually expressed in percentage terms.
- **Cycle Time:** The total elapsed time needed to complete a business process. Also called throughput time.
- **Benchmarking:** According to Cook, "The process of identifying, understanding, and adapting outstanding practices from within the same organization or from other businesses to help improve performance."

Process Measures – Productivity

$$\text{Productivity} = \text{outputs}/\text{inputs}$$

- **Single-factor productivity:** A productivity score that measures output levels relative to single input.

(Number of customer calls handled)/(support staff hours)

(Number of items produced)/(machine hours)

- **Multifactor productivity:** A productivity score that measures output levels relative to more than one input.

(Sales dollars generated)/(labor, material, and machine costs)

Process Measures – Efficiency

$$\text{Efficiency} = 100\% \left(\text{actual outputs} / \text{standard outputs} \right)$$

- **Standard output:** An estimate of what should be produced, given a certain level of resources.
- Usually expressed as a percentage
- Standard is an estimate of what should be produced based on studies or historical results
- Efficiency = 100%(actual rate / standard rate)
- OR: Efficiency = 100%(standard time/actual time) for one unit

Process Measures – Cycle Time

- The percent of cycle time spent on value-added activities is a measure of process effectiveness.

- Causes that increase cycle time are:
  - Waiting times
  - Unneeded steps
  - Rework
  - Unnecessary controls or testing
  - Outmoded technology
  - Lack of information or training

Process Measures – Benchmarking

- **Competitive benchmarking:** The comparison of an organization's processes with those of competing organizations.
- **Process benchmarking:** The comparison of an organization's processes with those of noncompetitors that have been identified as superior processes.

Some other Measures

- Cost
  - Materials
  - Labor
  - Shipping
  - etc.
- Quality
  - Defects per million (ppm)
  - Number of returns
  - Time between failures (MTBF, reliability)
- Speed
  - Lead time to customer
  - Percent orders late
- Flexibility
  - Changeover time
  - Volume to meet changes in demand

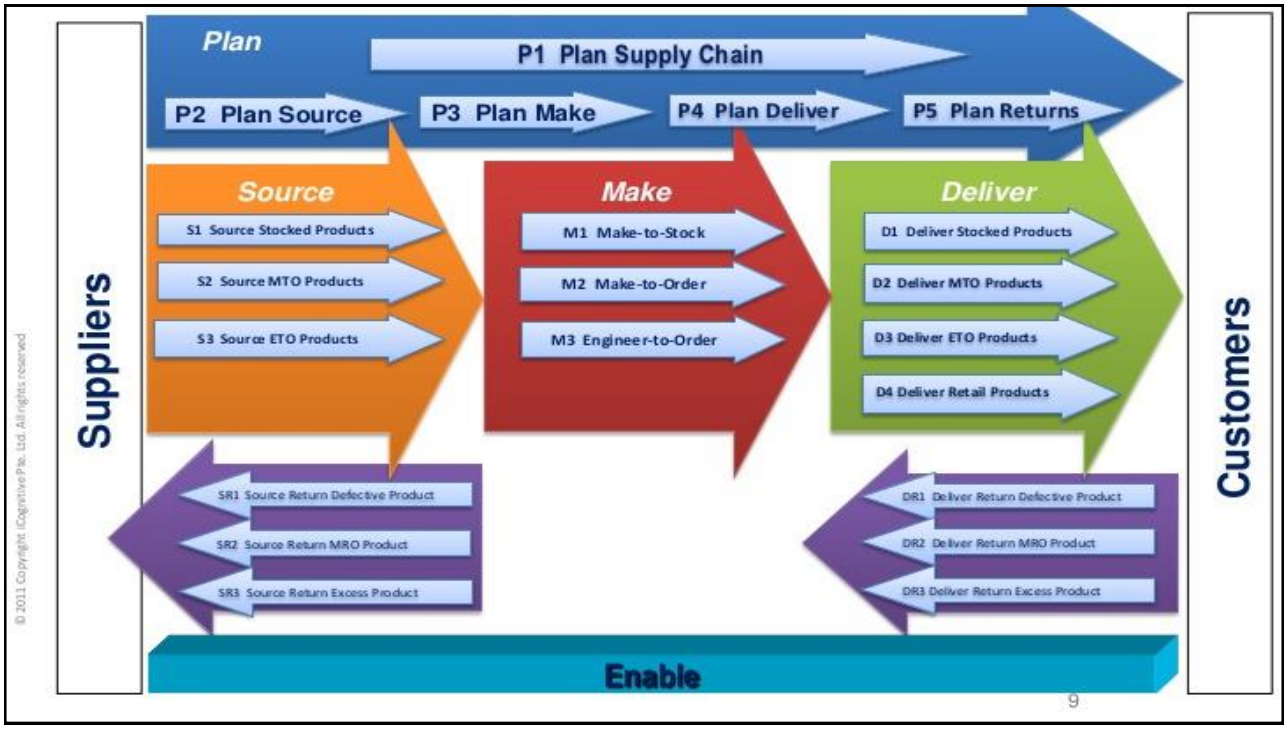
Supply-Chain Operations Reference (SCOR) Model

- SCOR: A comprehensive model of the core management processes and individual process types that, together, define the domain of supply chain management.

Supply-Chain Operations Reference (SCOR) Model

- Five core processes for Level 1
  1. **Source:** Processes that procure goods and services to meet planned or actual demand.
  2. **Make:** Processes that transform product to a finished state to meet planned or actual demand.
  3. **Deliver:** Processes that provide finished goods and services to meet planned or actual demand.
  4. **Return:** Processes associated with returning or receiving returned products for any reason.
  5. **Plan:** Processes that balance aggregate resources with requirements.

- Three expanded processes for Level 2
  1. **Planning**
  2. **Execution**
  3. **Enable**


Plan
P1 Plan Supply Chain
P2 Plan Source
P3 Plan Make
P4 Plan Deliver
P5 Plan Returns
Suppliers
Source
S1 Source Stocked Products
S2 Source MTO Products
S3 Source ETO Products
Make
M1 Make-to-Stock
M2 Make-to-Order
M3 Engineer-to-Order
Deliver
D1 Deliver Stocked Products
D2 Deliver MTO Products
D3 Deliver ETO Products
D4 Deliver Retail Products
Customers
SR1 Source Return Defective Product
SR2 Source Return MRO Product
SR3 Source Return Excess Product
DR1 Deliver Return Defective Product
DR2 Deliver Return MRO Product
DR3 Deliver Return Excess Product
Enable
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9

Operation and Supply Chain Management

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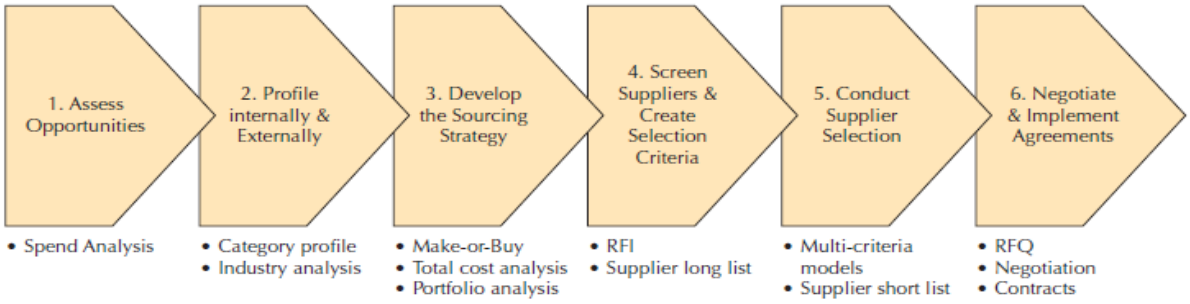
Lecture 5
Supply Chain Management

Strategic Sourcing

- Strategic sourcing is concerned with identifying ways to improve long-term business performance by better understanding sourcing needs, developing long-term sourcing strategies, selecting suppliers, and managing the supply base.



Step 1: Assess Opportunities

- **Spend analysis:** The application of quantitative techniques to purchasing data in an effort to better understand spending patterns and identify opportunities for improvement.

- It help to answer:
  - What categories of products or services make up the bulk of company spending?
  - How much are we spending with various suppliers?
  - What are our spending patterns like across different locations?

Step 2: Profile Internally and Externally

- Two approaches that sourcing managers use to create internal and external need profiles:
  - Category profiles
  - Industry analysis

- Category profiles: The main objective of a category profile is to understand all aspects of a particular sourcing category that could ultimately have an impact on the sourcing strategy

- Industry analysis: Profiles the major forces and trends that are impacting an industry, including pricing, competition, regulatory forces, substitution, technology changes, and supply/demand trends.

Step 3: Develop the Sourcing Strategy

- Contain three main steps:

1. **The make-or-buy decision:** A high-level, often strategic, decision regarding which products or services will be provided internally and which will be provided by external supply chain partners.
2. **Total cost analysis:** A process by which a firm seeks to identify and quantify all of the major costs associated with various sourcing options.
3. **Portfolio analysis:** A structured approach used by decision makers to develop a sourcing strategy for a product or service, based on the value potential and the relative complexity or risk represented by a sourcing opportunity.

Step 3: Insourcing Vs Outsourcing

Insourcing	
ADVANTAGES	DISADVANTAGES
High degree of control	Reduced strategic flexibility
Ability to oversee the entire process	Required high investment
Economies of scale and/or scope	Potential suppliers may offer superior products and services
Outsourcing	
ADVANTAGES	DISADVANTAGES
High strategic flexibility	Possibility of choosing a bad supplier
Low investment risk	Loss of control over the process and core technologies
Improved cash flow	Communication/coordination challenges
Access to state-of-the-art products and services	"Hollowing out" of the corporation
	Increased risk of supply chain disruption

Step 3: Cost Analysis

	INSOURCING	OUTSOURCING
Direct Costs	Direct material	Price (from invoice)
	Direct labor	Freight costs
	Freight costs	
	Variable overhead	
Indirect Costs	Supervision	Purchasing
	Administrative support	
	Supplies	Receiving
	Maintenance costs	Quality control
	Equipment depreciation	
	Utilities	
	Building lease	
	Fixed overhead	

Step 3: Portfolio Analysis

- **Single sourcing:** A sourcing strategy in which the buying firm depends on a single company for all or nearly all of a particular item or service.
- **Multiple sourcing:** A sourcing strategy in which the buying firm shares its business across multiple suppliers.
- **Cross sourcing:** A sourcing strategy in which a company uses a single supplier for one particular part or service and another supplier with the same capabilities for a different part or service, with the understanding that each supplier can act as a backup for the other supplier.
- **Dual sourcing:** A sourcing strategy in which two suppliers are used for the same purchased product or service.

Step 4: Screen Suppliers and Create Selection Criteria

- Qualitative criteria that a company might use to evaluate suppliers:
  1. Process and design capabilities
  2. Management capability
  3. Financial condition and cost structure
  4. Longer-term relationship potential

- **Request for information (RFI):** An inquiry to a potential supplier about that supplier's products or services for potential use in the business. The inquiry can provide certain business requirements or be of a more exploratory nature.

Step 5: Conduct Supplier Selection

- **Multicriteria decision models:** Models that allow decision makers to evaluate various alternatives across multiple decision criteria.

- **The Weighted-point Evaluation System:** In this model, the user is asked up front to assign weights to the performance measures (W_Y), and rate the performance of each supplier with regard to each dimension ($Performance_{XY}$).

Step 6: Negotiate and Implement Agreements

- **Request for quotation (RFQ):** A formal request for the suppliers to prepare bids, based on the terms and conditions set by the buyer.
- **Description by brand:** A description method that is used when a product or service is proprietary or when there is a perceived advantage to using a particular supplier's products or services.
- **Description by market grade/industry standard:** A description method that is used when the requirements are well understood and there is common agreement between supply chain partners about what certain terms mean.
- **Description by specification:** A description method that is used when an organization needs to provide very detailed descriptions of the characteristics of an item or a service.
- **Description by performance characteristics:** A description method that focuses attention on the outcomes the customer wants rather than on the precise configuration of the product or service.

Contracting

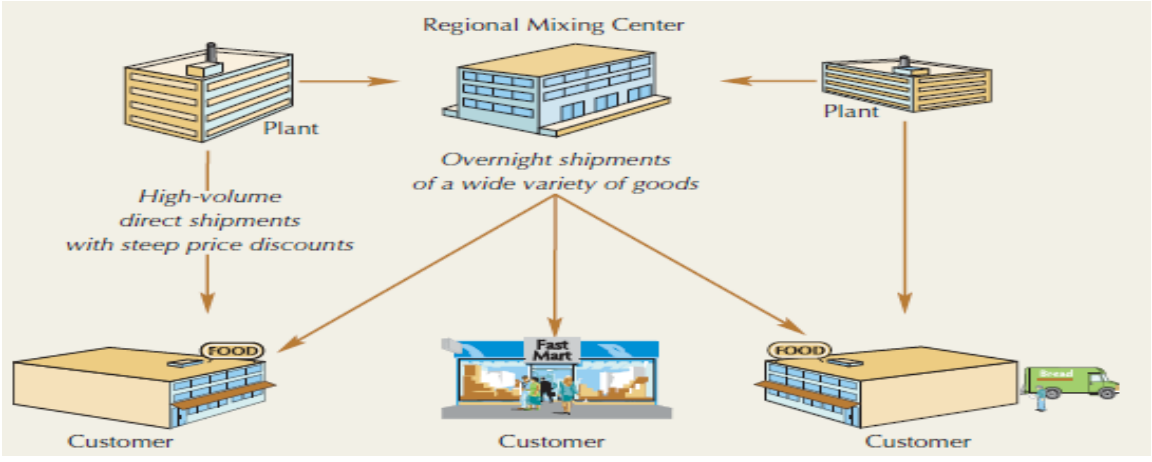
- **Fixed-price contract:** A type of purchasing contract in which the stated price does not change, regardless of fluctuations in general overall economic conditions, industry competition, levels of supply, market prices, or other environmental changes.
- **Cost-based contract:** A type of purchasing contract in which the price of a good or service is tied to the cost of some key input(s) or other economic factors, such as interest rates.

Operation and Supply Chain Management

Dr. Osama Al Meanazel

Lecture 6
Logistics

Logistics Management



Logistics Management

- According to the Council of Supply Chain Management Professionals (CSCMP), "that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements."

- Logistics covers a wide range of business activities:
  - Transportation
  - Warehousing
  - Material handling
  - Packaging
  - Inventory management
  - Logistics information systems

Logistics Management – Transportation

TRANSPORTATION MODE	STRENGTHS	WEAKNESSES
Highway	Flexibility to deliver where and when needed. Often the best balance among cost, flexibility, and reliability/speed of delivery.	Neither the fastest nor the cheapest option.
Water	Highly cost-effective for bulky items.	Limited locations.
	Most effective when linked to a multimodal system.	Relatively poor delivery reliability/speed.
Rail	Highly cost-effective for bulky items.	Limited locations, although less so than with water.
	Can be most effective when linked to a multimodal system.	Not as fast as highway, but improving over time.
Air	Quickest mode of delivery. Flexible, especially when linked to the highway mode.	Often the most expensive mode on a per-pound basis

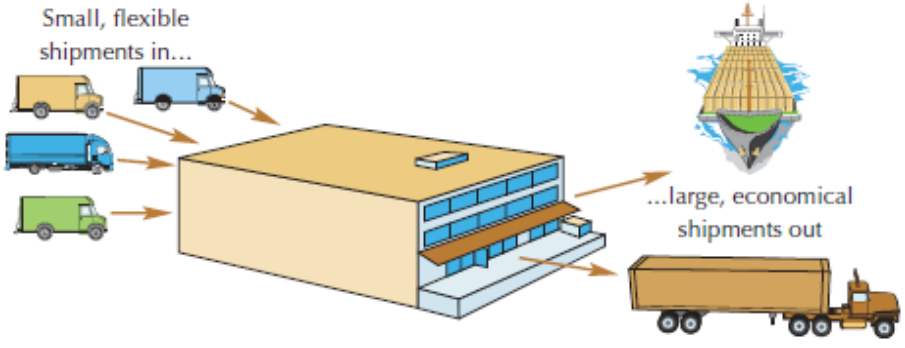
Logistics Management – Warehousing

- **Warehousing:** Any operation that stores, repackages, stages, sorts, or centralizes goods or materials. Organizations use warehousing to reduce transportation costs, improve operational flexibility, shorten customer lead times, and lower inventory costs.

- Different forms of warehousing:
  - Consolidation
  - Cross-docking
  - Break-bulk
  - Hub-and-spoke system
  - Postponement
  - Assortment
  - Spot stock

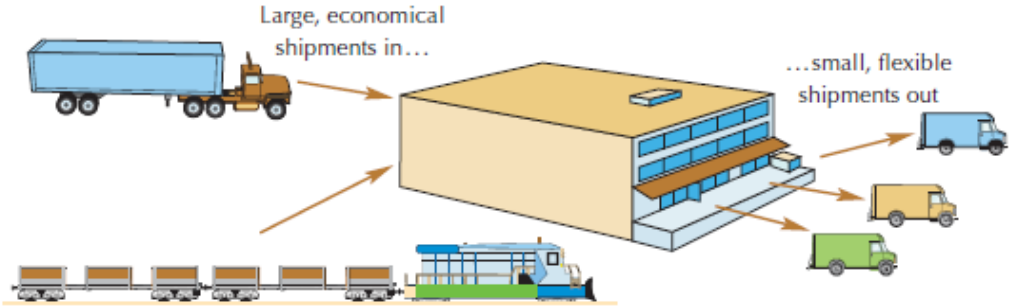
Consolidation Warehousing

- A form of warehousing that pulls together shipments from a number of sources (often plants) in the same geographic area and combines them into larger—and hence more economical— shipping loads.



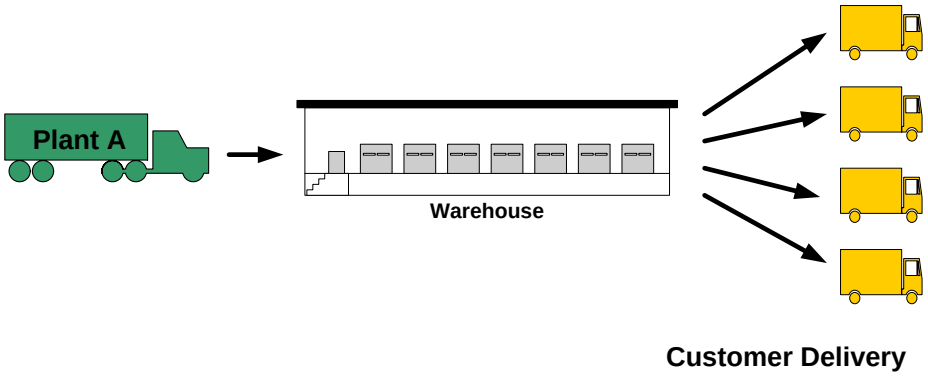
Cross-Docking Warehousing

- A form of warehousing in which large incoming shipments are received and then broken down into smaller outgoing shipments to demand points in a geographic area. Cross-docking combines the economies of large incoming shipments with the flexibility of smaller local shipments.



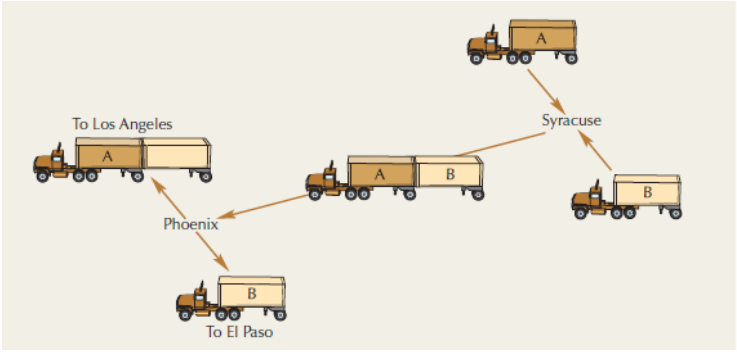
Break-bulk warehousing

- A specialized form of cross-docking in which the incoming shipments are from a single source or manufacturer.



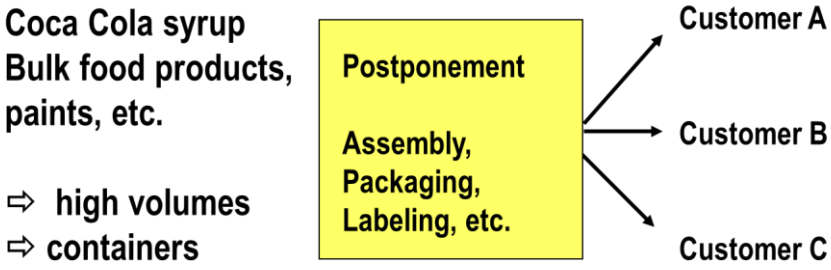
Hub-and-Spoke warehousing Systems

- A form of warehousing in which strategically placed hubs are used as sorting or transfer facilities. The hubs are typically located at convenient, high-traffic locations. The "spokes" refer to the routes serving the destinations associated with the hubs.



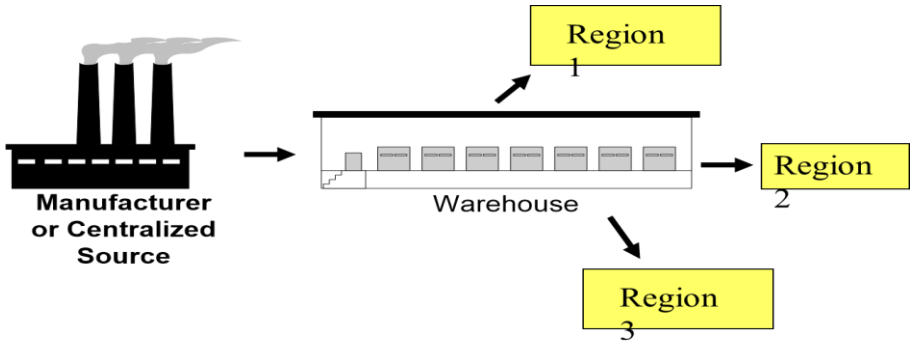
Postponement Warehousing

- A form of warehousing that combines classic warehouse operations with light manufacturing and packaging duties to allow firms to put off final assembly or packaging of goods until the last possible moment.



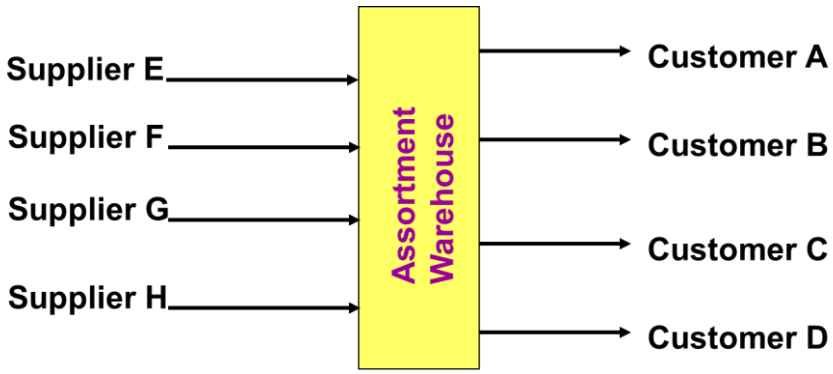
Spot Stock Warehousing

- A form of warehousing that attempts to position seasonal goods close to the marketplace. At the end of each season, the goods are either liquidated or moved back to a more centralized location.



Assortment Warehousing

- A form of warehousing in which a wide array of goods is held close to the source of demand in order to assure short customer lead times.



Information Systems

- Decision support tools
  - Real-time simulation and optimization
  - Location selection
  - Cost estimations
- Precise coordination of multimodal solutions
- Execution systems
  - Global positioning systems
  - Bar-coding applications
  - RFID on the horizon as replacement

Logistics Management – Material Handling and Packaging

- **Material handling system:** A system that includes the equipment and procedures needed to move goods *within* a facility, *between* a facility and a transportation mode, and *between* different transportation modes (e.g., ship-to-truck transfers).
- **Packaging:** From a logistics perspective, the way goods and materials are packed in order to facilitate physical, informational, and monetary flows through the supply chain.

Logistics Strategy Choices

PERFORMANCE DIMENSION	TRANSPORTATION MODE	WAREHOUSING SYSTEM
Delivery reliability—Deliver on time consistently	Highway Air	None (direct ship) Assortment Spot stock
Delivery speed—Minimal time from order to delivery	Air Highway	None (direct ship) Assortment Spot stock
Mix flexibility—Support a wide range of different products/delivery needs	Highway Air Rail	Assortment Spot stock
Design flexibility—Support design changes/unique customer needs	Highway Air	Postponement
Volume flexibility—Provide products/delivery services in whatever volume the customer needs	Highway Air	None (direct ship) Assortment Spot stock
Cost—Minimize the cost of transportation	Rail Water Pipeline Highway	Consolidation Cross-docking Hub-and-spoke

Measuring Logistics Performance

- Perfect Order: A term used to refer to the timely, error-free provision of a product or service in good condition.
  - Delivered on time
  - Shipped complete
  - Invoiced correctly
  - Undamaged in transit
- Landed Costs: The cost of a product plus all costs driven by logistics activities, such as transportation, warehousing, handling, customs fees, and the like.
  - Packing
  - Insurance
  - Customs, other fees
  - Warehousing
  - Transportation
  - Documentation

Reverse Logistics Systems

- Customer returns
  - Warranty failures
  - Incorrect or damaged orders
- Repair and remanufacture process support
- Recycling (increasing importance!)
- Generally independent systems because of low volume and mix complexity

Logistics Decision Models

- Weighted Center of Gravity Method: A logistics decision modeling technique that attempts to identify the "best" location for a single warehouse, store, or plant, given multiple demand points that differ in location and importance.
- Optimization: A type of mathematical model used when the user seeks to optimize some objective function subject to some constraints.
- Assignment Problem: A specialized form of an optimization model that attempts to assign limited capacity to various demand points in a way that minimizes costs.