Logistics

Business Logistics: An area of management that has been observed to absorb more than 30% of the sales dollar for some firms, that is an essential element in meeting customer goals, and that can be essential to a firms competitive strategy.

It has been called by many names, including *Physical Distribution, Materials Management, and Supply Chain Management.*

The activities to be managed may include all or part of the following:

Transportation
Inventory maintenance
Order processing
Purchasing
Warehousing
Materials handling
Packaging
Customer service standards, and
Product scheduling

A **dictionary definition of logistics is**

The branch of military science having to do with procuring, maintaining, and transporting material, personnel, and facilities.

Definition of the Council of Logistics Management (CLM)

Logistics is the process of planning, implementing, and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory, finished goods and related information from point of origin to point of consumption for the purpose of conforming to customer requirements.

The mission of logistics is to get the right goods or services to the right place, at the right time, and in the desired condition, while making the greatest contribution to the firm.

Customer Service standards set the level of output and degree of readiness to which the logistics system must respond. Logistics costs increase in proportion to the level of customer service provided. Setting very high service requirements can force logistics costs to exceedingly high levels.

Transportation and inventories are the primary cost-absorbing logistics activities. Experience has shown that each will represent one-half to two-thirds of total logistics costs.
It is *Transportation* **that adds place value to the products and services,** whereas *Inventory* **adds time value.**

Transportation is essential because no modern firm can operate without providing for the movement of its raw materials and/or finished products

Inventories are essential to logistics management because it is usually not possible or practical to provide instant production or sure delivery times to the customers. They serve as buffers between supply and demand so that needed product availability may be maintained for customers while providing flexibility for production and logistics to seek more efficient methods for manufacturing and distributing the products

Logistics is about creating value – value for customers and suppliers of the firm, and value for the firm's stakeholders. Value in logistics is expressed in terms of *time and place.*

Products and services have no value unless they are in the possession of the customers when (time) and where (place) they wish to consume them.

Logistics revolves around a primary decision triangle of ***Location, Inventory,*** and ***Transportation***, with ***Customer Service*** being the result of these decisions.

Customer Service Goals
Low levels of service allow centralized inventories at few locations and the use of less expensive forms of transport. High service levels generally require just the opposite. However, when service levels are pressed to their upper limits, logistics costs rise at a rate disproportionate to the service level.

Customer service broadly includes inventory availability, speed of delivery, and order filling speed and accuracy. The cost associated with these factors increase at a higher rate as customer service levels is raised.

Reformulating the logistics strategy is usually needed when service levels are changed due to competitive forces, policy revisions, or arbitrary service goals different from those on which the logistics strategy was based originally.

Facility Location Strategy
The geographic placement of the stocking points and their sourcing points create an outline for the logistics plan. Fixing the number, location, and size of the facilities and assigning market demand to them determines the path through which products are directed to the market place. The proper scope for the facility location problem is to include all product movements and associated costs as they take place from plant,

vendor, or port location through the intermediate stocking points and to the customer locations.

Assigning customer demand to be served directly from plants, vendors, or ports, or directing it through selected stocking points, affects total distribution costs.
Finding the lowest cost assignments, or alternatively the maximum profit assignments is the essence of facility location strategy.

Inventory Decisions
Refer to the manner in which inventories are managed. Allocating (pushing) inventories to the stocking points versus pulling them into stocking points through inventory replenishment rules represents two strategies.
Selective location of various items in the product line in plant, regional or field warehouses or managing inventory levels by various methods or inventory control are others.

Transportation Decisions
Transport decisions can involve mode selection, shipment size, and routing or scheduling. These decisions are influenced by the proximity of warehouses to customers and plants, which in turn, influence warehouse location. Inventory levels also respond to transport decisions through shipment size.

Customer service levels, facility location, inventory, and transportation are major planning areas because of the impact that decisions in these areas have on the profitability, cash flow, and return on investment of the firm.

Another way to look at logistics planning problem is to view it in the abstract as a network of links and nodes, as shown in.
The links of the network represent the movement of goods between various inventory storage points. These storage points – retail stores, warehouses, factories, or vendors – are the nodes. There may be several links between any pair of nodes, to represent alternative forms of transportation service, different routes, and different products. Nodes represent points where the flow of inventories is temporarily stopped, for example, at a warehouse, before moving onto a retail store and to the final customer.
In addition there is a flow of information flows. Information is derived from sales revenues, product costs, inventory levels, warehouse utilization, forecasts, transportation rates and the like. Links in the information network usually consists of the mail or electronic methods for transmitting information from one geographical point to another. Nodes are the data collection and processing points, such as a clerk who handles order processing and prepares bills of laden or computer that updates inventory records.
A major difference in the network is that product mainly flows “down” the distribution channel (toward the final customer), whereas information mainly, but not entirely, flows “up” the channel (toward raw material sources).

Product Characteristics

Logistics costs are sensitive to such characteristics as product ***weight***, ***volume*** (cube), ***value***, and ***risk***.

In the logistics channel, these characteristics can be altered through package design or finished state of the product during shipment and storage. For example, shipping a product in a knocked-down form can considerably affect the weight-bulk ratio of the product and the associated transportation and storage costs.

A firm producing high valued goods (such as machine tools and computers) with logistics costs being a fraction of total costs will likely give little attention to the optimality of logistics strategy.

However, when logistics costs are high, as they can be in the case of packaged industrial chemicals and food products, logistics strategy is a key concern.

Classifying Products

Consumer Products are those that are directed to ultimate consumers.

A three-fold consumer classification has been suggested

Convenience Products are those goods and services that consumers purchase frequently, immediately, and with limited comparative shopping. Typical products are banking services, tobacco items, and many foodstuffs.

These products generally require wide distribution through many outlets. Distribution costs are typically high but more than justified by the increased sales potential that is brought about by this wide and extensive distribution.

Customer service levels are expressed in terms of product availability and accessibility. (Examples are vending machines for Pepsi-cola etc., and telephone kiosks all over the place).

Shopping Products are those for which customers are willing to seek and compare: shopping many locations, comparing price and quality, performance, and making a purchase only after careful deliberation. Typical products in this category are fashion clothes, automobiles, and home furnishings.

Because of the customer's willingness to shop around, the number of stocking points is substantially reduced as compared with convenience goods and services. Distribution costs for such suppliers are somewhat lower than convenience goods.

Specialty Products are those for which buyers are willing to expend a substantial effort and often to wait a significant amount of time in order to require them. Buyers seek out particular types and brands of goods and services. Examples can be almost any type of good ranging from fine foods to custom made automobiles or a service such as management consultancy advice. Because buyers insist on particular brands, distribution is centralized and customer service levels are not as high as for convenience and shopping products. Physical distribution costs can be the lowest of any product category. Because of this, many firms will attempt to create a brand preference for their product line.

Industrial Products are those that are directed to individuals or organizations that use them to produce other goods or services. Their classification is quite different from consumer products.
Traditionally, industrial goods and services have been classified according to the extent to which they enter the production process. For example, there are goods that are part of the finished product, such as raw materials and component parts; there are goods that are used in the manufacturing process, such as buildings and equipment; and there are goods that do not enter the process directly, such as supplies and business services. Although this classification is valuable in preparing a selling strategy, it is not clear if it is useful in planning a physical distribution strategy.
Industrial buyers do not seem to show preferences for different service levels for different product classes. This simply means that traditional product classification for industrial products may not be useful for identifying typical logistics channels, as is the classification of consumer products.

The Product Life Cycle
Products do not generate their maximum sales volume immediately after being introduced, nor do they maintain their peak sales volume indefinitely. The physical distribution strategy differs for each stage. During the introductory stage, the strategy is a cautious one, with stocking restricted to relatively few locations. Product availability is limited.
If the product receives market acceptance, sales are likely to increase rapidly. Physical distribution is particularly difficult at this stage. Often there is not much of a sales history that can guide inventory levels at stocking points or even the number of stocking points to use.
The growth stage may be fairly short, followed by a longer stage called maturity. Sales growth is slow or stabilized at a peak level. The product volume is no longer undergoing rapid change, and therefore can be assimilated into the distribution pattern of similar existing products. At this time the product has its widest distribution. Many stocking points are used with good control over product availability throughout the market place.
Eventually the sales volume declines for most products as a result of technological change, competition, or waning consumer interest. To maintain efficient distribution, patterns of product movement and inventory deployment have to be adjusted. The number of stocking points is likely to be decreased and the product stocking reduced to fewer, and more centralized location.

The 80 –20 Curve
The product line of a typical firm is made up of individual products at different stages of their respective life cycles and with different degrees of sales success. At any point in time, this creates a product phenomenon known as the 80- 20 curve.
The bulk of the sales are generated from relatively few products in the product line and from the principle known as Pareto´s law. That is, 80 percent of a firm's sales are generated by 20 percent of the product line items. Each category of items could be distributed differently. For example, A items might receive wide geographical

distribution through many warehouses and high levels of stock availability, where C items might be distributed from a single stocking point (e.g. the plant) with lower total stocking levels than for A items. B items would have an intermediate distribution strategy where a few regional warehouses are used.

Product Characteristics

The most important characteristics of the product that can influence logistics strategy are the attributes of the product itself – weight, volume, value, perishability, flammability, and substitutability. When observed in various combinations, they are an indication of the need for warehousing, inventories, materials handling, and order processing.

Weight–Bulk Ratio The ratio of weight to bulk (volume) is a particularly meaningful measure, as transportation and storage costs are directly related to them. Products that are dense, i.e. have a high weight-bulk ratio (rolled steel, printed materials, and canned foods) show good utilization of transportation equipment and storage facilities, with the costs of both tending to be low. However, for products with low density (inflated beach balls, boats, potato chips, and lamp shades), the bulk capacity of transportation equipment is not fully realized before the weight-carrying limit is reached. Also the handling and space costs, which are weight-based, tend to be high relative to the product's sales price.

Value-Weight Ratio Storage costs are particularly sensitive to value. When value is expressed as a ratio to weight, some of the obvious cost trade-offs emerge that are useful in planning the logistics system.

Products that have low value-weight ratios (coal ore, and sand) have low storage costs but high movement costs as a percentage of their sales price.
Inventory carrying costs are computed as a percentage of the product's value. Low product value means low storage cost because inventory-carrying cost is the dominant factor in storage cost.
Transportation costs on the other hand, are pegged to weight. When the value of the product is low, transportation costs represent a high proportion of the sales value.

High value- weight ratio products (electronic equipment, jewelry, and musical instruments) show the opposite pattern with higher storage and lower transport costs.
If the product has a high value-weight ratio, minimize the amount of inventory maintained is a typical reaction.

Risk Characteristics Product risk characteristics refer to such patterns as perishability, flammability, value, tendency to explode, and ease of being stolen. When a product shows high risk in one or more of these features, it simply forces more restrictions on the distribution system. Both transport and storage costs are higher in absolute dollars and as a percentage of the sales price.

Logistics Customer Service

Customers view the offerings of any company in terms of price, quality, and service, and they respond with their patronage.

Logistics customer service for many firms is *the speed and dependability with which items ordered by customers can be made available.*

Transportation Fundamentals

Transportation usually represents the most important single element in logistics costs in most firms. Freight movement has been observed to absorb between one-third and two-thirds of total logistics costs.

Service Choices and Their Characteristics

The user of transportation has a wide range of services at his disposal, all revolving around the five basic modes water, rail, truck, air, and pipeline).

Transportation service may be viewed in terms of characteristics that are basic to all services: *price, average transit time, transit time variability, and loss and damage*

Price (cost) of transport service to a shipper is simply the line-haul rate for transporting goods plus any accessorial or terminal charges for additional services.

Transit time and Variability Average delivery time and delivery time variability rank at the top as important transportation performance characteristics.
Delivery (transit) time is usually referred to as the average time it takes for a shipment to move from its point of origin to its destination.
For purposes of comparing carrier performance, it is best to measure transit time door to door, even if more than one mode is involved.

Variability refers to the usual differences that occur between shipments by various modes.
Transit time variability is a measure of uncertainty in carrier performance.

Single-Service Choices

Rail the railroad is basically a long hauler and slow mover of raw materials (coal, lumber, chemicals) and of low valued manufactured products (food, paper, and wood products) and prefers to move shipment sizes of at least a full carload.

Truck trucking is a transportation service of semi finished and finished products. Trucking moves freight with smaller average shipment sizes than rail. The inherent advantage of trucking is its door-to-door service such that no loading and unloading is required between origin and destination.

Air Air-service dependability can be rated as good under normal operating conditions, and air transport has a distinct advantage in terms of loss and damage.

Water transportation is limited in scope for several reasons. Domestic water service is confined to the inland waterway system, which requires shippers to be located on the waterways or to use another transportation mode in combination with water.

Availability and dependability of water service are greatly influenced by weather.

Pipeline to date, pipeline transportation offers a very limited range of services and capabilities.
The most economically feasible products to move by pipeline are crude oil and refined petroleum products. However, there is some experimentation with moving solid products suspended in liquids, called ”slurry”, or containing the solid products in cylinders that in turn move in a liquid.
Product movement by pipeline is very slow, only about 3 or 4 miles per hour. This slowness is tempered by the fact that products move 24 hours a day and 7 days a week.

Cost of service, average transit time (speed), and transit-time variability (dependability) can serve as the basis for modal choice.

Vehicle Routing
Because transportation costs typically range between 1/3 and 2/3 of total logistics costs, improving efficiency through the maximum utilization of transportation equipment and personnel is a major concern. The length of time that goods are in transit reflects on the number of shipments that can be made with a vehicle within a given period of time and on the total transportation costs for all shipments. To reduce transportation costs and also to improve customer service, finding the best paths that a vehicle should follow through a network of roads, rail lines, shipping lanes, or air navigational routes that will minimize time or distance is a frequent decision problem.

Although there are many variations of routing problems, they can be reduced to a few basic types.
There is the problem of finding a path through a network where the origin point is different from the destination point.
There is a similar problem where there are multiple origin and destination points.
And there is the problem of routing when origin and destination points are the same.

Separate and Single Origin and Destination Points
Perhaps the simplest and most straight forward of routing a vehicle through a network is the *shortest route method.*

Multiple Origin and Destination
When there are multiple source points that may serve multiple destination points, there is a problem off assigning destinations to sources as well as finding the best routes between them. This problem occurs when there is more than one vender, plant or warehouse to serve more than one customer for the same product. It is further complicated when the source points are restricted in amount of total customer demand that can be supplied from each location. This type of problem is frequently solved by a special class of linear programming algorithm known as the *transportation method.*

Vehicle Routing and Scheduling

This is an extension of the vehicle routing problem. More realistic restrictions are now included such as:

1. Each stop may have a volume to be picked out as well as delivered.
2. Multiple vehicles may be used having different capacity limitations to both weight and cube.
3. A maximum total driving time is allowed on a route before a rest period of at least 8 hours.
4. Stops may permit pickup and/or deliveries at certain times of the day (called time windows).
5. Pickup may be permitted on route only after deliveries are made.
6. Drivers may be allowed to take short rests or lunch breaks at certain times of the day.

These restrictions add a great deal of complexity to the problem and make it very difficult to find an optimal solution. However good solution can be found using *heuristic procedures*.

Inventory Strategy

The Storage and Handling System

In contrast with transportation, storage and handling of product takes place primarily at the nodal points in the supply chain network. Storage has been referred to as transportation at zero miles per hour. The costs of warehousing and materials-handling activities absorb 26 percent of a firm's logistics dollar.

Need for a Storage System

If demand for a firm's products were known for sure and products could be supplied instantaneously to meet the demand, theoretically, storage would not be required since no inventories would be held. However, it is neither practical nor economical to operate a firm in this manner since demand usually cannot be predicted exactly.

Even to approach perfect supply and demand coordination, production would have to be instantly responsive, and transportation would have to be perfectly reliable with zero delivery time. This is not available to a firm at any reasonable cost. Therefore, firms use inventories to improve supply-demand coordination and lower overall costs.

It follows that maintaining inventories produces the need for warehousing and handling as well; storage becomes an economic convenience rather than a necessity.

The costs of warehousing and materials handling are justified because they can be traded off with transportation and production-purchasing costs. That is, by warehousing some inventory, a firm can often lower production costs through economical production lot sizing and sequencing.

By this means, a firm avoids the wide fluctuations in output levels due to uncertainties and variations in demand patterns. Also, the warehousing of these inventories can lead to lower transportation costs through the shipment of larger, more economical quantities.

Storage System Functions

The storage system can be separated into two important functions:

- Inventory holding (storage)
- Materials handling

Materials handling refers to those activities of loading and unloading, moving the product to and from various locations within the warehouse, and order picking.
Storage is simply the accumulation of inventory for a period of time. Different locations in the warehouse are chosen, depending on the purpose of storage.