Chapter 1

Business Logistics/Supply Chain—A Vital Subject

[redacted] way of saying

—PETER DRUCKER, 1969

INTRODUCTION

As far back as history records, the goods that people wanted were not produced where they wanted to consume them, or these goods were not accessible when people wanted to consume them. Food and other commodities were widely dispersed and were only available in abundance at certain times of the year. Early peoples had the choice of consuming goods at their immediate location or moving the goods to a preferred site and storing them for later use. However, because no well-developed transportation and storage systems yet existed, the movement of goods was limited to what an individual could personally move, and storage of perishable commodities was possible for only a short time. This limited movement-storage system generally constrained people to live close to the sources of production and to consume a rather narrow range of goods.

Even today, in some areas of the world consumption and production take place only within a very limited geographic region. Striking examples can still be observed in the developing nations of Asia, South America, Australia, and Africa, where some of the population live in small, self-sufficient villages, and most of the goods needed by the

[1]Peter F. Drucker, "Physical Distribution: The Frontier of Modern Management," in Donald J. Bowersox, Bernard J. LaLonde, and Edward Smykay (eds.), *Readings in Physical Distribution Management* (New York: Macmillan, 1969), p. 4.

residents are produced or acquired in the immediate vicinity. Few goods are imported from other areas. Therefore, production efficiency and the economic standard of living are generally low. In this type of economy, a well-developed and inexpensive logistics system would encourage an exchange of goods with other producing areas of the country, or even the world.

Example

Suppose that consumers in the United States and South Korea buy DVD recorders and computer software. In the coming year, about the same number of consumers will purchase a word processing program and a television set. Because of the differences in local labor costs, tariffs, transportation, and product quality, the effective price to the consumers differs, as shown in Table 1-1. A consumer in South Korea and one in the United States (in this case, the economy of both countries) must pay a total of $1,450.00 to fill their needs.

Now, if each economy trades with the other those goods with which it has a cost advantage, both consumers and their economies will be better off. South Korea has low labor costs for making DVD recorders, whereas the United States has an advantage in producing low-cost, high-quality software. With the availability of inexpensive and reliable transportation, there is an economic advantage to specializing in the product that can be produced most cheaply and buying the remaining product from the other country. With reasonable transportation costs, South Korea can place DVD recorders in the United States at a price below the locally produced and locally transported product. Conversely, the United States has the design and production cost advantage for software and can incur a reasonable transportation charge to place software in South Korea and at a price below what is available locally. The revised economic picture can be seen in Table 1-2. Both consumers in the countries save $1,450 – 1,200 = $250. Expensive transportation would preclude the countries from trading with each other and realizing their comparative economic advantages by making the landed price of imported products higher than those available locally.

As logistics systems improved, consumption and production began to separate geographically. Regions would specialize in those commodities that could be produced most efficiently. Excess production could be shipped economically to other producing (or consuming) areas, and

Table 1-1
Consumer Prices to Buy Only Locally Produced Products

Consumer in	DVD Recorder	Word Processing Software	Total
South Korea	$250.00	$500.00	$ 750.00
United States	400.00	300.00	700.00
The economies			$1,450.00

Table 1-2
The Benefits of Trading Products When Transportation Is Inexpensive

Consumer in	DVD Recorder	Word Processing Software	Total
South Korea	$250.00	$350.00[a]	$ 600.00
United States	300.00[b]	300.00	600.00
The economies			$1,200.00

[a] Imports from the United States
[b] Imports from South Korea

needed goods not produced locally were imported. This exchange process follows the *principle of comparative advantage.*

This same principle, when applied to world markets, helps to explain the high level of international trade that takes place today. Efficient logistics systems allow world businesses to take advantage of the fact that lands, and the people who occupy them, are not equally productive. Logistics is the very essence of trade. It contributes to a higher economic standard of living for us all.

To the individual firm operating in a high-level economy, good management of logistics activities is vital. Markets are often national or international in scope, whereas production may be concentrated at relatively few points. Logistics activities provide the bridge between production and market locations that are separated by time and distance. Effective management of these activities is the major concern of this book.

Business Logistics Defined

Business logistics is a relatively new field of integrated management study in comparison with the traditional fields of finance, marketing, and production. As previously noted, logistics activities have been carried out by individuals for many years. Businesses also have continually engaged in move-store (transportation-inventory) activities. The newness of the field results from the concept of *coordinated* management of the related activities, rather than the historical practice of managing them separately, and the concept that logistics adds value to products or services that are essential to customer satisfaction and sales. Although coordinated logistics management has not been generally practiced until recently, the idea of coordinated management can be traced back to at least 1844. In the writings of Jules Dupuit, a French engineer, the idea of trading one cost for another (transportation costs for inventory costs) was evident in the selection between road and water transport:

> The fact is that carriage by road being quicker, more reliable and less subject to loss or damage, it possesses advantage to which businessmen often attach a considerable value. However, it may well be that the saving of

> 0 fr.87 induces the merchant to use the canal; he can buy warehouses and increase his floating capital in order to have a sufficient supply of goods on hand to protect himself against slowness and irregularity of the canal, and if all told the saving of 0 fr.87 in transport gives him an advantage of a few centimes, he will decide in favor of the new route . . .[2]

The first textbook to suggest the benefits of coordinated logistics management appeared around 1961,[3] in part explaining why a generally accepted definition of business logistics is still emerging. Therefore, it is worthwhile to explore several definitions for the scope and content of the subject.

A dictionary definition of the term *logistics* is:

> The branch of military science having to do with procuring, maintaining, and transporting materiel, personnel, and facilities.[4]

This definition puts logistics into a military context. To the extent that business objectives and activities differ from those of the military, this definition does not capture the essence of business logistics management. A better representation of the field may be reflected in the definition promulgated by the Council of Logistics Management (CLM), a professional organization of logistics managers, educators, and practitioners formed in 1962 for the purposes of continuing education and fostering the interchange of ideas. Its definition:

> Logistics is that part of the supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, services, and related information from the point of origin to the point of consumption in order to meet customers' requirements.[5]

This is an excellent definition, conveying the idea that product flows are to be managed from the point where they exist as raw materials to the point where they are finally discarded. Logistics is also concerned with the flow of services as well as physical goods, an area of growing opportunity for improvement. It also suggests that logistics is a *process*, meaning that it includes all the activities that have an impact on making goods and services available to customers when and where they wish to acquire them. However, the definition implies that logistics is part of the supply chain process, not the entire process. So, what is the supply chain process or, more popularly, supply chain management?

Supply chain management (*SCM*) is a term that has emerged in recent years that captures the essence of integrated logistics and even goes beyond it. Supply chain

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[2]Jules Dupuit, "On the Measurement of the Utility of Public Works," reprinted in *International Economic Papers*, No. 2, translated from the French by R. H. Barback (London: Macmillan and Co., Ltd., 1952), p. 100.

[3]Edward W. Smykay, Donald J. Bowersox, and Frank H. Mossman, *Physical Distribution Management: Logistics Problems of the Firm* (New York: Macmillan, 1961).

[4]*Webster's New Encyclopedic Dictionary* (New York: Black Dog & Leventhal Publishers, 1993), p. 590.

[5]From the by laws of the *Council of Logistics Management*, accessed at CLM's Web site http://www.clm1.org.

management emphasizes the logistics interactions that take place *among* the functions of marketing, logistics, and production within a firm and those interactions that take place between the legally separate firms within the product-flow channel. Opportunities for cost or customer service improvement are achieved through *coordination* and *collaboration* among the channel members where some essential supply chain activities may not be under the direct control of the logistician. Although early definitions such as physical distribution, materials management, industrial logistics, channel management, and even rhocrematics, all terms used to describe logistics, have promoted this broad scope for logistics, there was little attempt to implement logistics beyond a company's own enterprise boundaries, or even beyond its own internal logistics function. Now, retail firms are showing success in sharing information with suppliers, which in turn agree to maintain and manage inventories on retailers' shelves. Channel inventories and product stockouts are lower. Manufacturing firms operating under just-in-time production scheduling build relationships with suppliers for the benefit of both companies by reducing inventories. Definitions of the supply chain and supply chain management reflecting this broader scope are:

> The *supply chain (SC)* encompasses all activities associated with the flow and transformation of goods from the raw materials stage (extraction), through to the end user, as well as the associated information flows. Materials and information flow both up and down the supply chain.
>
> *Supply chain management (SCM)* is the integration of these activities, through improved supply chain relationships, to achieve a sustainable competitive advantage.[6]

After careful study of the various definitions being offered, Mentzer et al. propose the broad and rather general definition as follows:

> Supply chain management is defined as the systematic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole.[7]

The supply chain management model in Figure 1-1 viewed as a pipeline shows the scope of this definition. It is important to note that supply chain management is about the coordination of product flows across functions and across companies to achieve competitive advantage and profitability for the individual companies in the supply chain and the supply chain members collectively.

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[6]Robert B. Handfield and Ernest L. Nichols Jr., *Introduction to Supply Chain Management* (Upper Saddle River, NJ: Prentice-Hall, 1999), p. 2.

[7]John T. Mentzer, William DeWitt, James S. Keebler, Soonhong Min, Nancy W. Nix, Carlo D. Smith, and Zach G. Zacharia, "Defining Supply Chain Management," *Journal of Business Logistics*, Vol. 22, No. 2 (2001), pp. 1–25.

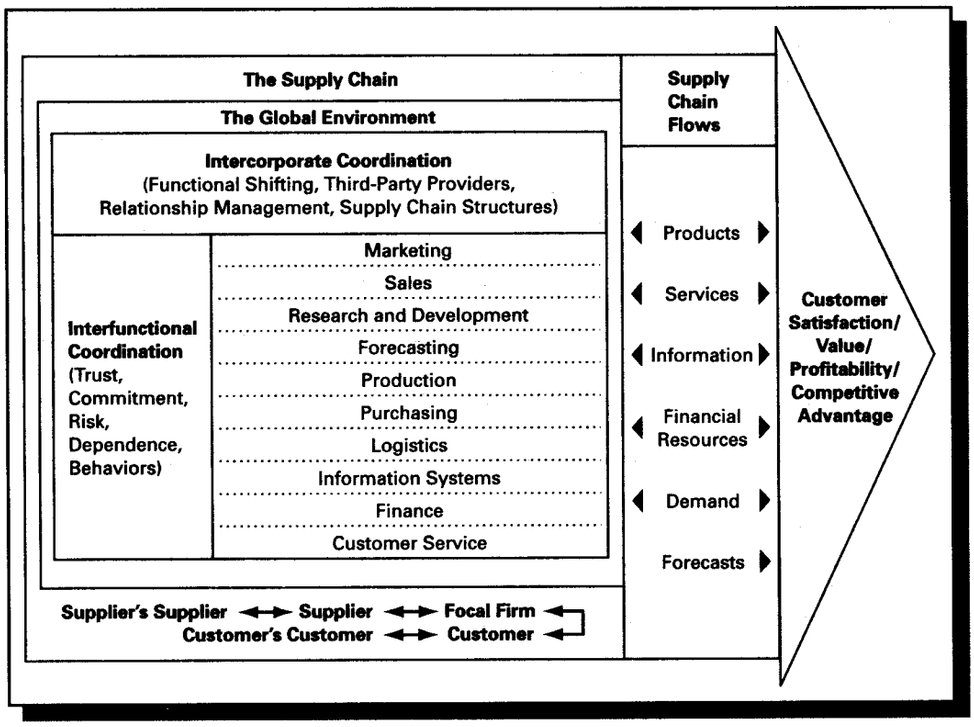

Figure 1-1 A Model of Supply Chain Management

Source: Mentzer et al., "Defining Supply Chain Management," *Journal of Business Logistics*, Vol. 22, No. 2 (2001), p. 19. Reproduced with permission of the Council of Logistics Management.

It is difficult, in a practical way, to separate business logistics management from supply chain management. In so many respects, they promote the same mission:

> 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.

Some claim that supply chain management is just another name for integrated business logistics management (IBLM) and that the broad scope of supply chain management has been promoted over the years. Conversely, others say that logistics is a subset of SCM, where SCM considers additional issues beyond those of product flow. For example, SCM may be concerned with product pricing and manufacturing quality. Although SCM promotes viewing the supply channel with the broadest scope, the reality is that firms do not practice this ideal. Fawcett and Magan found that companies that do practice supply chain integration limit their scope to one tier upstream and one tier downstream.[8] The focus seems to be concerned with creating

[8]Stanley E. Fawcett and Gregory M. Magan, "The Rhetoric and Reality of Supply Chain Integration," *International Journal of Physical Distribution & Logistics Management*, Vol. 32, No. 5 (2002), pp. 339–361.

seamless processes within their own companies and applying new information technologies to improve the quality of information and speed of its exchange among channel members. The boundary between the logistics and supply chain management terms is fuzzy. For the purposes of this text, integrated business logistics management and SCM will be referred to interchangeably. The focus will be on managing the product and service flows in the most efficient and effective manner, regardless of descriptive title. This includes integrating and coordinating with other channel members and service providers to improve supply chain performance when practical to do so.

THE SUPPLY CHAIN

Logistics/SC is a collection of functional activities (transportation, inventory control, etc.), which are repeated many times throughout the channel through which raw materials are converted into finished products and consumer value is added. Because raw material sources, plants, and selling points are not typically located at the same places and the channel represents a sequence of manufacturing steps, logistics activities recur many times before a product arrives in the marketplace. Even then, logistics activities are repeated once again as used products are recycled upstream in the logistics channel.

A single firm generally is not able to control its entire product flow channel from raw material source to points of the final consumption, although this is an emerging opportunity. For practical purposes, the business logistics for the individual firm has a narrower scope. Usually, the maximal managerial control that can be expected is over the immediate physical supply and physical distribution channels, as shown in Figure 1-2. The *physical supply channel* refers to the time and space gap between a firm's immediate material sources and its processing points. Similarly, the *physical distribution channel* refers to the time and space gap between the firm's processing points and its customers. Due to the similarities in the activities between the two channels, physical supply (more commonly referred to as materials management) and physical distribution comprise those activities that are integrated into business logistics. Business logistics management is now popularly referred to as supply chain management.[9] Others have used terms such as *value nets, value stream,* and *lean logistics* to describe a similar scope and purpose. The evolution of the management of product flows toward SCM is captured in Figure 1-3.

Although it is easy to think of logistics as managing the flow of products from the points of raw material acquisition to end customers, for many firms there is a *reverse logistics channel* that must be managed as well. The life of a product, from a logistics viewpoint, does not end with delivery to the customer. Products become obsolete, damaged, or nonfunctioning and are returned to their source points for repair or disposition. Packaging materials may be returned to the shipper due to

[9]Some proponents of supply chain management include pricing within its scope. Business logistics management rarely does this.

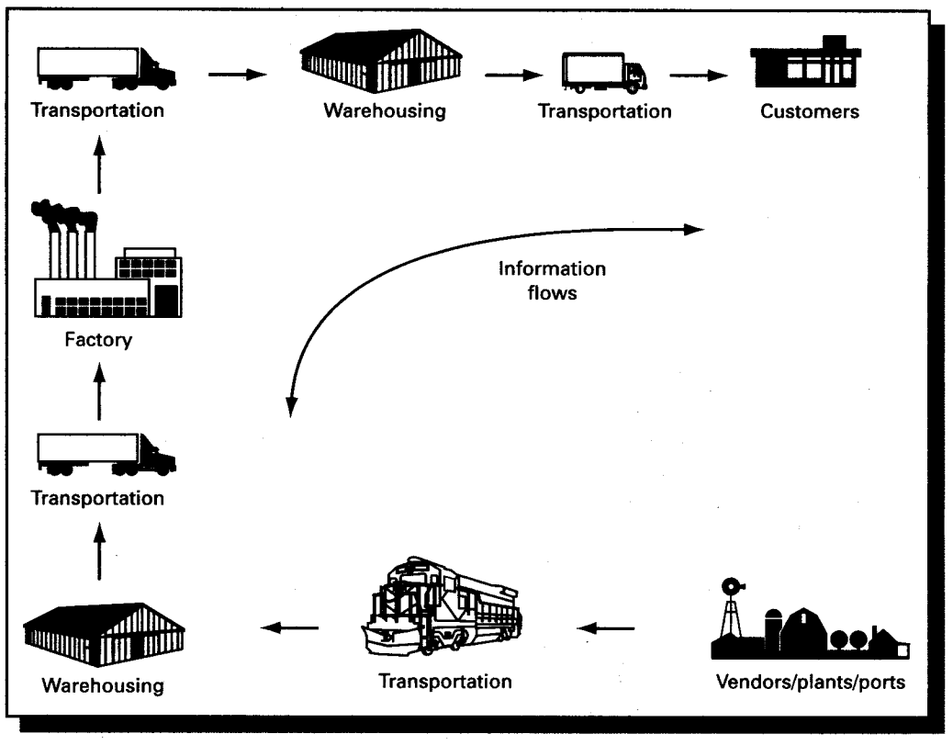

Figure 1-2 The Immediate Supply Chain for an Individual Firm

environmental regulations or because it makes good economic sense to reuse them. The reverse logistics channel may utilize all or a portion of the forward logistics channel or it may require a separate design. The supply chain terminates with the final disposition of a product. The reverse channel must be considered to be within the scope of logistics planning and control.

Example

The reverse logistics channel comes into play when a customer buys a toaster from a retailer. The customer takes the toaster home and finds it defective. The customer returns it to the retailer, who gladly refunds the purchase price. The retailer now has a defective toaster in in-store inventory. The retailer sends it to a central return center. Upon receipt, the toaster's Universal Product Code (UPC) is scanned for identification in the return center's database. The database determines that the toaster has a return-to-vendor disposition. The database credits the store inventory for the toaster and creates a charge back to the manufacturer for the cost of the toaster. The toaster is shipped back to the manufacturer. The retailer has made a cost recovery for this

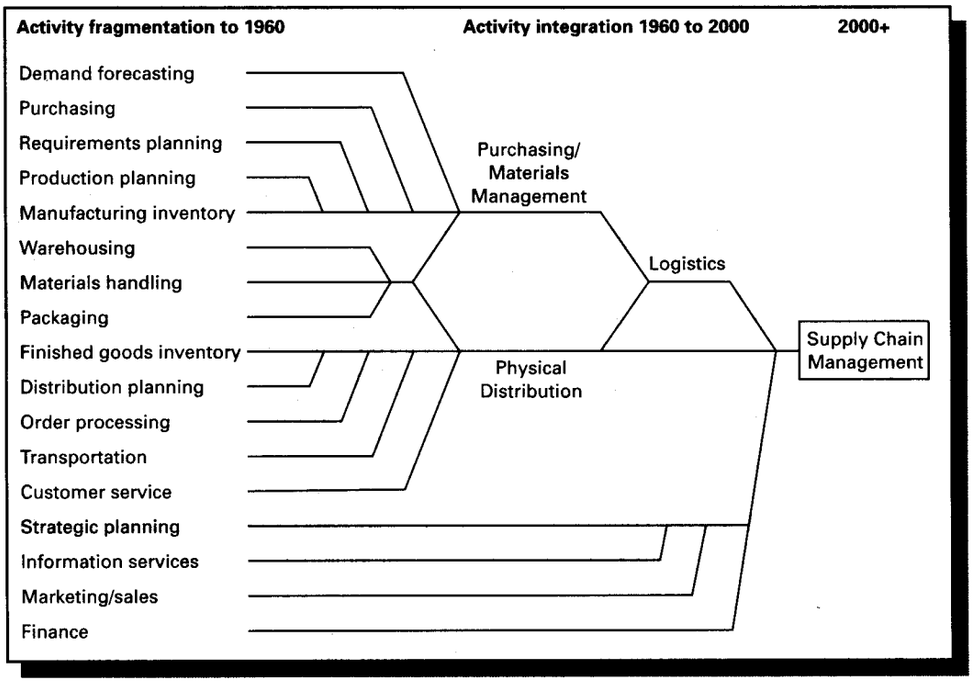

Figure 1-3 Evolution of Logistics Toward Supply Chain

Source: John Yuva, "Collaborative Logistics: Building a United Network," *Inside Supply Management*, Vol. 13, No. 5 (May 2002), p. 50 (with modification).

defective asset. The toaster is received at the manufacturer's return center. The manufacturer scans the toaster into its database and determines that it has a refurbish disposition. The toaster is repaired and sent for resale on the secondary market. The manufacturer has now gained value for this defective asset.[10]

THE ACTIVITY MIX

The activities to be managed that make up business logistics (supply chain process) vary from firm to firm, depending on a firm's particular organizational structure, management's honest differences of opinion about what constitutes the supply chain for its business, and the importance of individual activities to its operations. Follow

[10]Jerry A. Davis, Jerome G. Lawrence, Peter Rector, and Herbert S. Shear, "Reverse Logistics Pipeline," *Annual Conference Proceedings* (San Diego, CA: Council of Logistics Management, October 8–11, 1995), p. 427.

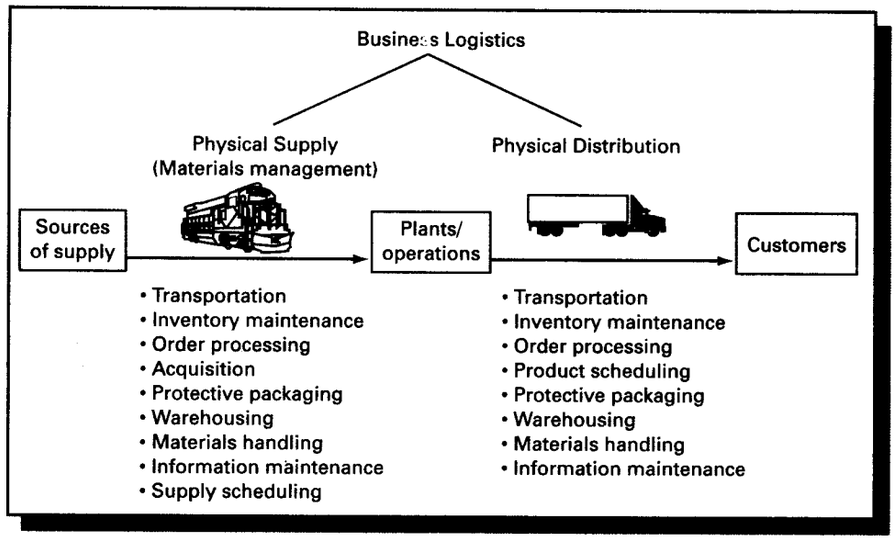

Figure 1-4 Logistics Activities in a Firm's Immediate Supply Chain

along the supply chain as shown in Figure 1-2 and note the important activities that take place. Again, according to the CLM:

> The components of a typical logistics system are: customer service, demand forecasting, distribution communications, inventory control, material handling, order processing, parts and service support, plant and warehouse site selection (location analysis), purchasing, packaging, return goods handling, salvage and scrap disposal, traffic and transportation, and warehousing and storage.[11]

Figure 1-4 organizes these components, or activities, according to where they are most likely to take place in the supply channel. The list is further divided into key and support activities, along with some of the decisions associated with each activity.

Key Activities

1. Customer service standards cooperate with marketing to:
   a. Determine customer needs and wants for logistics customer service
   b. Determine customer response to service
   c. Set customer service levels
2. Transportation
   a. Mode and transport service selection
   b. Freight consolidation
   c. Carrier routing

[11] *Careers in Logistics* (Oak Brook, IL: Council of Logistics Management), p. 3.

d. Vehicle scheduling
e. Equipment selection
f. Claims processing
g. Rate auditing

3. Inventory management
   a. Raw materials and finished goods stocking policies
   b. Short-term sales forecasting
   c. Product mix at stocking points
   d. Number, size, and location of stocking points
   e. Just-in-time, push, and pull strategies
4. Information flows and order processing
   a. Sales order-inventory interface procedures
   b. Order information transmittal methods
   c. Ordering rules

Support Activities

1. Warehousing
   a. Space determination
   b. Stock layout and dock design
   c. Warehouse configuration
   d. Stock placement
2. Materials handling
   a. Equipment selection
   b. Equipment replacement policies
   c. Order-picking procedures
   d. Stock storage and retrieval
3. Purchasing
   a. Supply source selection
   b. Purchase timing
   c. Purchase quantities
4. Protective packaging designed for:
   a. Handling
   b. Storage
   c. Protection from loss and damage
5. Cooperate with production/operations to:
   a. Specify aggregate quantities
   b. Sequence and time production output
   c. Schedule supplies for production/operations
6. Information maintenance
   a. Information collection, storage, and manipulation
   b. Data analysis
   c. Control procedures

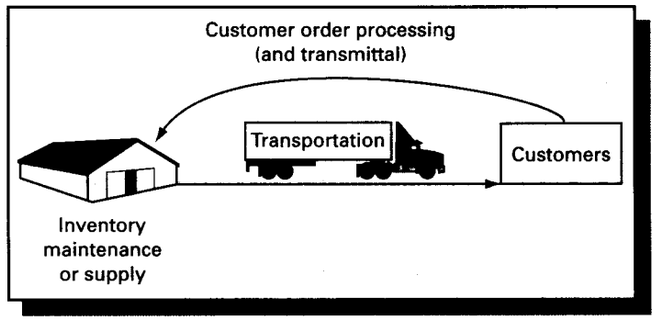

Figure 1-5
The Critical Customer Service Loop

Key and support activities are separated because certain activities will generally take place in every logistics channel, whereas others will take place, depending on the circumstances, within a particular firm. The key activities are on the "critical" loop within a firm's immediate physical distribution channel, as shown in Figure 1-5. They contribute most to the total cost of logistics or they are essential to the effective coordination and completion of the logistics task.

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, such that setting the standards for service also affects the logistics costs to support that level of service. Setting very high service requirements can force logistics costs to exceedingly high levels.

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

Transportation is essential because no modern firm can operate without providing for the movement of its raw materials or its finished products. This importance is underscored by the financial strains placed on many firms by such disasters as a national railroad strike or independent truckers' refusal to move goods because of rate disputes. In these circumstances, markets cannot be served, and products back up in the logistics pipeline to deteriorate or become obsolete.

Inventories are also essential to logistics management because it is usually not possible or practical to provide instant production or ensure delivery times to 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 in seeking efficient methods for manufacture and distribution of the product.

Order processing is the final key activity. Its costs usually are minor compared to transportation or inventory maintenance costs. Nevertheless, order processing is an important element in the total time that it takes for a customer to receive goods or services. It is the activity triggering product movement and service delivery.

Although support activities may be as critical as the key activities in any particular circumstance, they are considered here as contributing to the logistics mission. In addition, one or more of the support activities may not be a part of the logistics activity

mix for every firm. For example, products such as finished automobiles or commodities such as coal, iron ore, or gravel not needing the weather and security protection of warehousing will not require the warehousing activity, even though inventories are maintained. However, warehousing and materials handling are typically conducted wherever products are temporarily halted in their movement to the marketplace.

Protective packaging is a support activity of transportation and inventory maintenance as well as of warehousing and materials handling because it contributes to the efficiency with which these other activities are carried out. Purchasing and product scheduling often may be considered more a concern of production than of logistics. However, they also affect the overall logistics effort, and specifically they affect the efficiency of transportation and inventory management. Finally, information maintenance supports all other logistics activities in that it provides the needed information for planning and control.

The *extended supply chain* refers to those members of the supply channel beyond the firm's immediate suppliers or customers. They may be suppliers to the immediate suppliers or customers of the immediate customers and so on until raw material source points or end customers are reached. It is important to plan and control the previously noted activities and information flows if they affect the logistics customer service that can be provided and the costs of supplying this service. Management of the extended supply chain has the potential of improving logistics performance beyond that of just managing the activities within the immediate supply chain.

Importance of Logistics/ Supply Chain

Logistics is about creating *value*—value for customers and suppliers of the firm, and value for the firm's stakeholders. Value in logistics is primarily 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. For example, concessions at a sports event have no value to consumers if they are not available at the time and place that the event is occurring, or if inadequate inventories don't meet the demands of the sports fans. Good logistics management views each activity in the supply chain as contributing to the process of adding value. If little value can be added, it is questionable whether the activity should exist. However, value is added when customers are willing to pay more for a product or service than the cost to place it in their hands. To many firms throughout the world, logistics has become an increasingly important value-adding process for a number of reasons.

Costs Are Significant

Over the years, several studies have been conducted to determine the costs of logistics for the whole economy and for the individual firm. There are widely varying estimates of the cost levels. According to the International Monetary Fund (IMF), logistics costs average about 12 percent of the world's gross domestic product.

Table 1-3
Recent Average Physical Distribution Costs in Percent of Sales and $/cwt.[a]

CATEGORY	PERCENT OF SALES	$/CWT.
Transportation	3.34%	$26.52
Warehousing	2.02	18.06
Customer service/order entry	0.43	4.58
Administration	0.41	2.79
Inventory carrying cost @ 18%/year.	1.72	22.25
Total distribution cost[b]	7.65%	$67.71

[a] The statistics are for all firm types; however, they most closely represent manufacturing firms since they dominate the database.

[b] The authors of this survey claim the totals do not match the sum of the individual statistics due to a different number of data entries in each category.

Source: Herbert W. Davis and William H. Drumm, "Logistics Costs and Service Database—2002," *Annual Conference Proceedings* (San Francisco, CA: Council of Logistics Management, 2002) at www.clm1.org.

Robert Delaney, who has tracked logistics costs for more than two decades, estimates that logistics costs for the U.S. economy are 9.9 percent of the U.S. gross domestic product (GDP), or $921 billion.[12] On the other hand, India spends about Rs. 260 billion on logistics, which is approximately 1 percent of its GDP.[13] However, overall supply chain and logistics spend in India is approximately 13 percent of its GDP.[14] For U.S. firms, logistics costs have ranged from 4 percent to over 30 percent of sales.[15] The results from a cost survey of individual firms are shown in Table 1-3. Although the results show physical distribution costs at about 8 percent of sales, this survey does not include physical supply costs. Probably another one-third may be added to this total to represent average logistics costs for the firm at about 11 percent of sales. Over the last decade, physical distribution costs have ranged between 7 percent and 9 percent of sales. There may be a trend of increasing costs for individual firms, although Wilson and Delaney show over the same period that logistics costs as a percent of U.S. GDP have declined by about 10 percent.[16] Logistics costs, substantial for most firms, rank second only to the cost of goods sold (purchase costs) that are about 50 percent to 60 percent of sales for the average manufacturing firm. Value is added by minimizing these costs and by passing the benefits on to customers and to the firm's shareholders.

Table 1-4 shows the SCM Spend as a percentage of net sales in nine major Indian manufacturing industries for the last four years.[17] Despite continuous increase in

[12]Rosalyn Wilson and Robert V. Delaney, "11th Annual State of Logistics Report," *Cass Information Systems and ProLogis* (Washington, DC: National Press Club, June 5, 2000).
[13]*Project Monitor* (December 19, 2005), p. 3.
[14]*Prowess Software* (Centre for Monitoring Indian Economy, 2006).
[15]For a history of these costs estimates, see Bernard J. LaLonde and Paul H. Zinszer, *Customer Service: Meaning and Measurement* (Chicago: National Council of Physical Distribution Management, 1976); Richard E. Snyder, "Physical Distribution Costs: A Two-Year Analysis," *Distribution Age* Vol. 62 (January 1963), pp. 50–51; and Wendall M. Stewart, "Physical Distribution: Key to Improved Volume and Profits," *Journal of Marketing* Vol. 29 (January 1965), p. 67.
[16]Wilson and Delaney, op. cit.
[17]Centre for Monitoring Indian Economy, 2006.

Table 1-4 SCM Spend as a Percenge of Net Sales

SCM Spend Indicator	2001–02	2002–03	2003–04	2004–05
Inbound transportation costs as percentage of net sales	1.5%	1.4%	1.3%	1.4%
Inventory-related costs as percentage of net sales	13.3	13.9	13.1	13.1
Distribution expenses as percentage of net sales	3.0	2.8	2.8	2.7
Total SCM Spend as percentage of net sales	17.8%	18.1%	17.2%	17.2%

Source: Centre for Monitoring Indian Economy.

Standard Product Measures		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Total order cycle Time, days		8	7	7	6	9	8	7	8	8	7	8
Product availability	percent orders	84	84	86	87	87	87	85	85	86	87	88
	percent line items	92	92	92	92	94	94	93	90	92	93	95

Source: Herbert W. Davis and William H. Drumm, "Logistics Costs and Service Database—2002," *Annual Conference Proceedings* (San Francisco, CA: Council of Logistics Management, 2002) at www.clml.org.

Table 1-5 Average Customer Service Performance Measures for All Firms, Survey Years 1992–2002

fuel prices, the industries have been able to reduce SCM spend slightly, the major gain coming from distribution due to improvements in infrastructure and better SCM practices.

Logistics Customer Service Expectations Are Increasing

The Internet, just-in-time operating procedures, and continuous replenishment of inventories have all contributed to customers expecting rapid processing of their requests, quick delivery, and a high degree of product availability. According to the Davis survey of hundreds of companies over the last decade, world-class competitors have average order cycle times (the time between when an order is placed and when it is received) of seven to eight days and line item fill rates of 90 percent to 94 percent.[18] LogFac summarizes world-class logistics performance for domestic companies as:

- Error rates of less than one per 1,000 orders shipped
- Logistics costs of well under 5 percent of sales
- Finished goods inventory turnover of 20 or more times per year
- Total order cycle time of five working days

[18]Herbert W. Davis and William H. Drumm, "Logistics Costs and Service 2001," *Annual Conference Proceedings*, (Kansas City, MO: Council of Logistics Management, 2001).

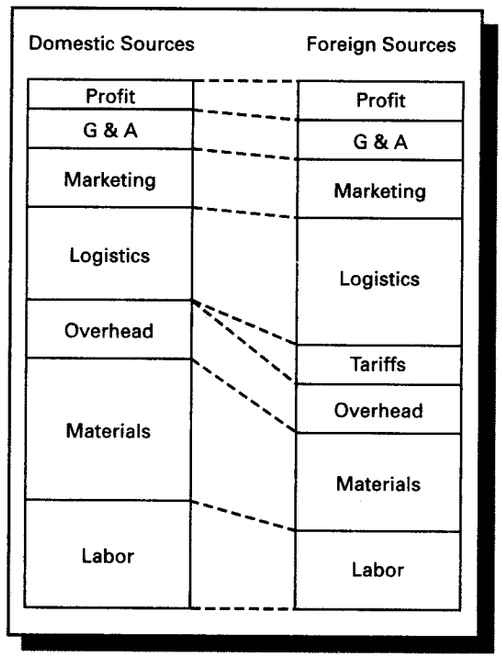

Figure 1-6
Economic Benefit of Sourcing from Low-Cost Offshore Locations Rather Than from Higher-Cost Local Suppliers

Source: "International Logistics: Battleground of the '90s" (Chicago: A. T. Kearney, 1988).

- Transportation cost of one percent of sales revenue or less, if products sold are over $5 per pound[19]

As might be expected, the average company performs below these cost and customer service benchmarks, when compared with the statistics in Tables 1-3 and 1-5.

Supply and Distribution Lines Are Lengthening with Greater Complexity

The trend is toward an integrated world economy. Firms are seeking, or have developed, global strategies by designing their products for a world market and producing them wherever the low-cost raw materials, components, and labor can be found (e.g., Ford's Focus automobile), Contract Manufacturers manufacturing for big pharmaceutical giants like *Glaxo Smithkline Beecham (GSK), Ranbaxy,* and *Dr. Reddy's Laboratories (DRL)* in India or they simply produce locally and sell internationally. (*e.g., Maruti Udyog Limited* producing Suzuki cars for European market. In fact, the Government of India (GoI) has initiated a number of initiatives to encourage development of export oriented units (EOU) through various incentives to such enterprises.) In either case, supply and distribution lines are stretched, as compared with the producer who wishes to manufacture and sell only locally. Not only has the trend occurred naturally by firms seeking to cut costs or expand markets, but it is also

[19]"Logistics Rules of Thumb III," *LogFac*, www.logfac.com (2001).

being encouraged by political arrangements that promote trade. Examples of the latter are the European Union, the North America Free Trade Agreement (NAFTA) between Canada, the United States, and Mexico, and the economic trade agreement among several countries of South America (MERCOSUR). Similarly, South Asia Free Trade Agreement (SAFTA) envisages leading toward customs union, common market, and economic union. It promises to have a positive impact on economic growth and development in the South Asian region.

Globalization and internationalization of industries everywhere will depend heavily on logistics performance and costs, as companies take more of a worldview of their operations. As this happens, logistics takes on increased importance within the firm since its costs, especially transportation, become a larger part of the total cost structure. For example, if a firm seeks foreign suppliers for the raw materials that make up its final product or foreign locations to build its product, the motivation is to increase profit. Material and labor costs may be reduced, but logistics costs are likely to increase due to increased transportation and inventory costs. The tradeoff, as shown in Figure 1-6, may lead to higher profit by reducing materials, labor, and overhead costs at the expense of logistics costs and tariffs. Further, it can serve as a means of acquiring new capabilities and bringing about fundamental strategic and structural change.[20]

Today, offshore global outsourcing has gained widespread acceptance as a crucial aspect of business strategy. With the availability of highly educated, technically skilled, and low-cost talent, India has emerged as one of the major global offshoring and outsourcing destinations. Outsourcing adds value, but it requires careful management of logistics costs and product-flow times in the supply channel.

Example

Toyota has 35 manufacturing plants in 25 countries (excluding Japan) at which it produces nearly 900,000 vehicles annually. While exports were down by 9 percent in 1993, overseas production was up by 16 percent. In the case of Georgetown, Kentucky, where Camrys are built, Toyota uses the just-in-time concept to supply parts from across the Pacific. The parts are loaded into ocean containers in Japan, shipped across the Pacific, and transferred to trains on the West Coast of the United States for relay to Georgetown, where they feed an assembly line that turns out 1,000 Camrys a day. Deliveries are scheduled to the minute in order to keep inventories low. Due to the long supply lines and the associated uncertainties, supply channels must be more carefully managed than if all production were local.[21]

Logistics/SC Is Important to Strategy

Firms spend a great deal of time finding ways to differentiate their product offerings from those of their competitors. When management recognizes that logistics/SC

[20] Jane C. Linder, "Transformational Outsourcing," *MIT Sloan Management Review* (Winter 2004), pp. 52–58.
[21] Joseph Bonney, "Toyota's Global Conveyor Belts," *American Shipper* (September 1994), pp. 50–58.

affects a significant portion of a firm's costs and that the result of decisions made about the supply chain processes yields different levels of customer service, it is in a position to use this effectively to penetrate new markets, to increase market share, and to increase profits. That is, good supply chain management can generate sales, not just reduce costs. Consider how Wal-Mart used logistics as the core of its competitive strategy to become the world's number one merchandise retailer.

Example

Wal-Mart Wins with Logistics Kmart and Wal-Mart are two retail merchandise chains that, a few years back, looked alike, sold the same products, sought the same customers, and even had similar names. When the race began, people were quite familiar with the "big red K," whose stores dotted metropolitan areas, but few had heard of Wal-Mart, whose stores were in rural settings. Considering the similarity of the stores and their mission, analysts attribute the fates of the two chains primarily to differing management philosophies.

In 1987, Kmart was far ahead, with twice as many stores and sales of $26 billion, compared to $16 billion for Wal-Mart. With its urban presence and a focus on advertising, Kmart had more visibility. In contrast, Wal-Mart began in stand-alone stores outside small towns, luring customers away from the mom-and-pop stores in aging downtowns. But so rapidly did Wal-Mart multiply over the rural landscape that an invasion of urban America—and a confrontation with Kmart—was inevitable.

Kmart executives focused on marketing and merchandising, even using Hollywood star Jaclyn Smith to promote her clothing line. By contrast, Sam Walton, Wal-Mart's founder, was obsessed with operations. He invested millions of dollars in a company-wide computer system linking cash registers to headquarters, enabling him to quickly restock goods. He also invested heavily in trucks and modern distribution centers. Besides enhancing his control of the supply chain, these moves sharply reduced costs. While Kmart tried to improve its image and cultivate store loyalty, Walton kept lowering costs, betting that price would prove more important than any other factor in attracting customers. Wal-Mart's incredibly sophisticated distribution, inventory, and scanner systems meant that customers almost never encountered depleted shelves or price-check delays.

Meanwhile, Kmart's woes mounted, as distribution horror stories abounded. Employees lacked the training and skill to plan and control inventory properly, and Kmart's cash registers often did not have up-to-date information and would scan items and enter incorrect prices. This led to a lawsuit in California, and Kmart settled for $985,000 for overcharging its customers.

Over the years, it has been Wal-Mart's focus on logistical matters that enables it to keep its prices low and its customers happy and returning often. Today, Wal-Mart is nearly six times the size of Kmart![22]

[22]"Loss Leader: How Wal-Mart Outdid a Once-Touted Kmart in Discount Store Race," *Wall Street Journal*, March 24, 1995, and revenue data for 2000 from Wal-Mart and Kmart financial reports found online at http:/finance.yahoo.com

Kmart continued its focus on ad circulars and promotional pricing into the twenty-first century, whereas Wal-Mart continued to focus more on supply chain efficiencies and less on advertising, with the results that selling, administrative, and overhead costs were 17.3 percent for Wal-Mart and Kmart's were 22.7 percent. Wal-Mart was able to achieve prices that average 3.8 percent below Kmart's and even 3.2 percent below Target's. In 2002, Kmart went into bankruptcy and reorganization.[23]

Logistics/SC Adds Significant Customer Value

A product, or service, is of little value if it is not available to customers at the time and place that they wish to consume it. When a firm incurs the cost of moving the product toward the customer or making an inventory available in a timely manner, for the customer value has been created that was not there previously. It is value as surely as that created through the production of a quality product or through a low price.

It is generally recognized that business creates four types of value in products or services. These are: form, time, place, and possession. Logistics creates two out of these four values. Manufacturing creates *form* value as inputs are converted to outputs, that is raw materials are transformed into finished goods. Logistics controls the *time* and *place* values in products, mainly through transportation, information flows, and inventories. *Possession* value is often considered the responsibility of marketing, engineering, and finance, where the value is created by helping customers acquire the product through such mechanisms as advertising (information), technical support, and terms of sale (pricing and credit availability). To the extent that SCM includes production, three out of the four values may be the responsibility of the logistics/supply chain manager.

Example

Reliance Industries Limited (RIL), the largest business conglomerate in India, is going for entire gamut of retail formats, from hypermarkets to convenience stores in over 700 cities in India.[24] Plans are to launch over 1,000 or more of these formats. This calls for a massive investment, planning, and logistical support. Here, the key to successful pan-India retail will remain logistics, the physical movement of goods to stores from vendors or other stores/distribution centers, and return flows to vendors and stores. The scale of the plans means that there are opportunities for warehousing players, express logistics, vehicle owners and drivers, brokers and truckers.

When discount houses selling computer software through Web sites, catalogs, and magazine advertisements wished to compete with local retailers, they had a price advantage due to the economies of scale that they could achieve. Operations

[23]Amy Merrick, "Expensive Ad Circulars Help Precipitate Kmart President's Dep. . .are," *Wall Street Journal*, January 18, 2002, B1ff.
[24]Available at http://www.ril.com.

were centralized at one location where lower-cost warehouse space rather than higher-cost retail space could be used. Their staff was predominately telephone order takers and warehouse order-fillers and packagers. Inventories were minimized relative to sales through centralization, but these discount operations also offered substantial variety and high levels of product availability. Conversely, retailers had the advantage of immediate availability for the anxious customer that would offset any price disadvantage of the local retailer. To counter this possible delivery advantage of retailers in their local markets, the discount houses made sure that customer orders could be placed using toll-free telephone numbers or through a Web site, that these orders were filled the *same day*, and that they were shipped overnight using priority air delivery. Many customers find this nearly as fast and, in many cases, a lot more convenient than traditional shopping! Value has been created for the busy customer through logistics.

Similarly, Indian Railway Catering and Tourism Corporation (IRCTC), which provides a host of services to railway passengers, in India, offers two options to its customers for safe and convenient ways to book railway tickets.[25] Initially, it started with the Internet Ticket (I-ticket) option that allowed the customers to book their tickets online and get the same by courier through "Overnite Express" within three days. The company charges a nominal fee for this service. The second option, Electronic Ticket (E-ticket) was started in 2006. Here, the customers can book their tickets on-line and print the same. This offers the option of booking tickets up to 4 hours prior to the departure of the train. Further, the fee is lower due to no courier activity in the process. These options are gaining wide popularity and the queues at reservation counters are gradually decreasing. In fact, Indian Railways has registered more than 100 percent growth in ticket sales through Internet (12.8 lakh tickets in 2004–2005 to 25.7 lakh tickets in 2005–2006). IRCTC's revenues from online ticketing have increased by 43 percent in 2005–2006.

Customers Increasingly Want Quick, Customized Response

Fast food retailers, automatic teller machines, overnight package delivery, and electronic mail on the Internet have led us as consumers to expect that products and services can be made available in increasingly shorter times. In addition, improved information systems and flexible manufacturing processes have led the marketplace toward mass customization. Rather than consumers having to accept the "one size fits all" philosophy in their purchases, suppliers are increasingly offering products that meet individual customer needs.

One such initiative that achieved tremendous success in India during the last decade was the Asian Paints Shades Palette Card. It started as an exclusive concept offered at selected Asian Paints retail stores. It featured a visual array of Asian Paints shades to help the customer make the right shade decision. It had eight color families of purples, blues, greens, grays, creams, beiges, peaches, and pinks. Each color family featured a collection of popular Asian Paints shades in it. The customer could get the color of his choice. To meet this customized demand, the company innovatively

[25]Available at http://www.irctc.co.in.

developed a cheap and easy-to-use color mixing machine and provided it to each retail store. This not only led to offering customized colors but also to drastic reduction in supply chain inventories. Additionally, it helped the company to go for larger production runs and more cost-effective color sequencing at its paint manufacturing units. Creative advertising and fulfilling the promise helped the company to attain market leadership position in India.[26]

Observations

- Dell, a desktop computer company, will configure a PC to a customer's exact hardware requirements, and even install requested software.
- L. L. Bean sells clothes and other items through its catalog and Web site. In addition, some of the clothes may be altered to a customer's exact measurements. Moreover, L. L. Bean will ensure fast delivery by shipping via Federal Express at no additional charge (if the customer charges the order to an L. L. Bean Visa charge card).
- National Bicycle Industrial Co., a subsidiary of the Japanese electronics giant Matsushita, builds bicycles using *flexible* manufacturing techniques, those that allow switching from the production of one product to another with minimal setup cost. Rather than mass-producing in standard sizes and building inventories for retail sales, National Bicycle builds the bicycles to precise customer specifications in over 11 million variations on 18 models of road, racing, and mountain bikes. Although it takes three hours to produce a bicycle using flexible manufacturing as compared to 90 minutes for mass production, the company is able to charge more than twice the price by pleasing customers with unique bikes built to their individual specifications.
- Project Bespoke was a unique initiative by Arvind Mills in 2004 to deliver customized Arrow brand shirts to customers within a short lead-time. The customer is offered 250 options at a time and the backorder is processed within 24 hours and shirts are delivered to the customer within 2 days.

Companies too have been applying the concept of quick response to their internal operations in order to meet the service requirements of their own marketing efforts. The quick response philosophy has been used to create a marketing advantage. Saks Fifth Avenue applied it, even though big profits are made through big margins and not on cost reductions that might be achieved from good logistics management. Supply chain costs may even rise, although the advantage is to more than cover these costs through increased profits.

Application

Retailers go out of business at an alarming rate. To Saks Fifth Avenue, this fear alone may have been adequate motivation for management to integrate merchandising

[26]Available at http://www.apaints.com.

and logistics. The benefits are obvious when merchandising relies on manufacturers that might cut cloth in Bangladesh and finish garments in Italy before shipping them to a ritzy selling floor in the United States. The difference between profit and loss on hot-selling items may be as little as seven to ten days, so good logistics performance requires that such items be on the selling floor *precisely* when needed most. How does Saks do it?

The company's 69 stores are served by just two distribution centers. One is in Yonkers, New York, close by Saks' flagship store on New York City's 5th Avenue. The second is in Ontario, California, well situated to serve the trendy southern California market. Rapid movement through the supply channel is key to profitability. Items are processed by the centers in a 24-hour turnaround. About 80 percent of Saks' imported items arrive by airfreight—those from Europe are handled by Yonkers and those from the Far East by Ontario. Items are exchanged between the centers by airfreight, with a dedicated flight between New York and Los Angeles every business day. Distribution centers then serve their local stores with a combination of airfreight and trucking.[27]

Logistics/SC in Nonmanufacturing Areas

It is perhaps easiest to think of logistics/SC in terms of moving and storing a physical product in a manufacturing setting. This is too narrow a view and can lead to many missed business opportunities. The logistics/SC principles and concepts learned over the years can be applied to such areas as service industries, the military, and even environment management.

Service Industry

The service sector of industrialized countries is large and growing. In the United States, over 70 percent of all jobs are in what the federal government classifies as the service sector. The size of this sector alone forces us to ask if logistics concepts are not equally applicable here as they are to the manufacturing sector. If they are, there is a tremendous untapped opportunity yet to be fulfilled. The service sector in India accounts for more than 54 percent of total output[28] —an unusually large share for a developing country—and its growth has been consistently strong. It grew by 9.9 percent in the second half of 2005–06.

Many companies designated as service firms in fact produce a product. Examples include: McDonald's Corporation (fast foods); Café Coffee Day (beverages); Dow Jones & Co., Inc.; The Times of India (newspaper publishing); and Sears, Roebuck and Co. (merchandise retailing). These companies carry out all the typical supply chain activities of any manufacturing firm. However, for service companies such as Bank One ICICI Bank (retail banking), Marriott Corporation (lodging), and Consolidated Edison (electric power), supply chain activities, especially those associated with physical distribution, are not as obvious.

[27]Bruce Vail, "Logistics, Fifth Avenue Style," *American Shipper* (August 1994), pp. 49–51.
[28]*Businessline* (March 1, 2006), p. 2.

Even though many service-oriented companies may be distributing an intangible, nonphysical product, they do engage in many physical distribution activities and decisions. A hospital may want to extend emergency medical care throughout the community and must make decisions as to the locations of the centers. United Parcel Service and Federal Express must locate terminals and route pickup and delivery trucks. The East Ohio Gas Company inventories natural gas in underground wells during the off-season in the region where demand will occur. Bank One must locate and have cash inventory on hand for its ATMs. The Federal Reserve Bank must select the methods of transportation to move canceled checks among member banks. The Catholic Church must decide the number, location, and size of the churches needed to meet shifts in size and location of congregations, as well as to plan the inventory of its pastoral staff. Xerox's repair service for copying equipment is also a good example of the logistics decisions encountered in a service operation.

Examples

- Promise Keepers is a Christian men's ministry that conducts 23 major events around the United States—with attendance ranging from 50 to 80,000. Promise Keepers must rely on good logistics management to assure that their crusades can be conducted on time. The operation is large enough to involve a major motor carrier that handles the event logistics. Using the concept of *time definite delivery*, the carrier coordinates the receipt of supplies such as Bibles from Chicago, hats from Kansas City, in addition to trailer loads of stage equipment. The materials must be assembled and delivered to an event site and delivered precisely on time. Since events are held at stadiums, speedways, and the like, there are other events (ball games, races, etc.) also scheduled on the same weekend. There may be as many as 30 truckloads that must be coordinated to arrive precisely on time and leave just as precisely to avoid congestion with the logistics of the other events. Computer technology is used to track trailer movements and ensure that the extremely close coordination can be achieved.[29]
- During the time span of one week, there were three major stories that drew the largest TV audience in history: England's Princess Diana was killed in an automobile crash in Paris, India's Mother Teresa died of heart failure in Calcutta, and there was a major bombing incident in Jerusalem. Suddenly, the media had major logistical problems with covering three major news stories in three corners of the world. For example, CNN diverted a reporter from Paris to the Middle East, while other networks sent their Hong Kong correspondents to Calcutta. Then, there were the logistical problems of allocating airtime to the three stories.[30]

[29]Roger Morton, "Direct Response Shipping," *Transportation & Distribution* (April 1996), pp. 32–36.
[30]Kyle Pope, "For the Media, Diana's Funeral Prompts Debate," *Wall Street Journal* September 8, 1997, B1.

The techniques, concepts, and methods discussed throughout this text should be as applicable to the service sector as they are to the manufacturing sector. The key, according to Theodore Levitt, may be in transforming an intangible service into a tangible product.[31] Problems will remain in carefully identifying the costs associated with the distribution of an intangible product. Perhaps because of this, few service firms or organizations have a physical distribution manager on their staff, although they frequently do have a materials manager to handle supply matters. However, managing logistics in service industries does represent a new direction for the future development of logistics practice.

Military

Before businesses showed much interest in coordinating supply chain processes, the military was well organized to carry out logistics activities. More than a decade before business logistics' developmental period, the military carried out what was called the most complex, best-planned logistics operation of that time—the invasion of Europe during World War II.

Although the problems of the military, with its extremely high customer service requirements, were not identical with those of business, the similarities were great enough to provide a valuable experience base during the developmental years of logistics. For example, the military alone maintained inventories valued at about one-third of those held by all U.S. manufacturers. In addition to the management experience that such large-scale operations provide, the military sponsored, and continues to sponsor, research in the logistics area through such organizations as the RAND Corporation and the Office of Naval Research. With this background, the field of business logistics began to grow. Even the term *logistics* seems to have had its origins in the military.

Earliest example of military logistics on a large scale can be traced to the times of Alexander the Great. It was the dawn of logistics strategy which clearly focused on where to battle and when, where, and how much to enter and exit. As a result, smaller armies could defeat a larger competitor. Partha Bose[32] gives a detailed account of such *teeth versus tail* logistics strategy which mainly focused on simple themes like keeping lean force with efficient supply through setting forward bases. This was achieved through better planning, information sharing, and flawless execution.

The most recent example of military logistics on a large scale was the conflict between the United States and Iraq over Iraq's invasion of the small country of Kuwait. This invasion has been described as the largest military logistics operation in history.[33] The logistics support in that war is yet another illustration of what

[31] Theodore Levitt, *The Marketing Imagination* (New York: The Free Press, 1983), pp. 108–110.
[32] Partha Bose, *Alexander the Great's Art of Strategy* (England: Penguin Books, 2003).
[33] *Business Week*, March 4, 1991, pp. 42–43.

world-class companies have always known: Good logistics can be a source of competitive advantage. Lieutenant General William Pagonis, who was in charge of logistics support for Desert Storm, observed:

> When the Middle East started heating up, it seemed like a good time to pull out some history books on desert warfare in this region. . . . But there was nothing on logistics. Logistics is not a best seller. In a couple of his diaries, Rommel talked about logistics. He thought the Germans lost the battle not because they didn't have great soldiers or equipment—in fact, the German tanks outfought ours almost throughout World War II—but because the British had better logistics.[34]

Good logistics performance was obvious. The first wave of 200,000 troops and their equipment was deployed in a month and a half, whereas troop deployment took nine months in the Vietnam conflict. In addition, the application of many good logistics concepts was evident. Take customer service, for example:

> We believed that if we took care of our troops, the objectives would be accomplished no matter whatever else happened. The soldiers are our customers. It is no different than a determined, single focus on customers that many successful businesses have. Now, you take care of your soldiers not only by providing them cold sodas, and burgers, and good food: you make sure they have the ammunition on the front line, so that when they go fight the war they know they have what they need.[35]

This meant that when 120 mm guns rather than 105 mm guns were desired on tanks, they were changed. When brown vehicles were preferred over the traditional camouflage green, they were repainted at the rate of 7,000 per month.

Environment

Population growth and resultant economic development have heightened our awareness of environmental issues. Whether it is recycling, packaging materials, transporting hazardous materials or refurbishing products for resale, logisticians are involved in a major way. After all, the United States alone produces more than 160 million tons of waste each year, enough for a convoy of 10-ton garbage trucks reaching halfway to the moon.[36] In many cases, planning for logistics in an environmental setting is no different from that in manufacturing or service sectors. However, in a few cases additional complications arise, such as governmental regulations that make the logistics for a product more costly by extending the distribution channel.

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[34]Graham Sharman, "Good Logistics Is Combat Power," *McKinsey Quarterly*, No. 3 (1991), pp. 3–21.
[35]Ibid.
[36]E. J. Muller, "The Greening of Logistics," *Distribution* (January 1991), p. 32.

Example

In Germany, the government requires retail grocers to collect cereal boxes at the point of sale. Typically, consumers pay for the product, then open the box and empty the contents into containers they brought from home, and put the empty boxes into collection bins. The seller has the responsibility either for recovery of the spent materials and their repackaging and reuse, or for their disposal.[37]

Business Logistics/SC in the Firm

It has been the tradition in many firms to organize around marketing and production functions. Typically, marketing means selling something and production means making something. Although few business people would agree that their organization is so simple, the fact remains that many businesses emphasize these functions while treating other activities, such as traffic, purchasing, accounting, and engineering, as support areas. Such an attitude is justified to a degree, because if a firm's products cannot be produced and sold, little else matters. However, such a pattern is dangerously simple for many firms to follow in that it fails to recognize the importance of the activities that must take place between points and times of production or purchase and the points and times of demand. These are the logistics activities, and they affect the efficiency and effectiveness of both marketing and production.

Example

General Motors (GM) hopes improving customer service will boost sales of Cadillacs, which have been squeezed as buyers shift to other U.S. cars as well as to imports. Cadillac loses substantial sales when customers are put off by lengthy delivery times. Research shows that 10 percent to 11 percent of sales are lost simply because the cars are not available in a timely manner.

A production and distribution program was tested in Florida, a major market for Cadillacs. Under the program, about 1,500 Cadillacs were sent to a regional distribution center in Orlando, Florida, where they would be delivered to dealers state-wide within 24 hours. In some areas of Florida, many buyers wait two days for popularly equipped cars. Additionally, GM's Cadillac factory in Detroit increased production of specially ordered Cadillacs as well as reducing shipping time. Custom Cadillacs arrived at dealerships in about three weeks, compared with the usual 8 to 12 weeks. Under this program, GM expected dealership inventories to decline by about 50 percent.[38]

[37]"European Logistics Changes Sharply," *American Shipper* (May 1993), p. 66.
[38]*Wall Street Journal*, August 16, 1994, A5

Scholars and practitioners of both marketing and production have not neglected the importance of logistics. In fact, each area considers logistics within its scope of action. For example, the following definition of marketing management includes physical distribution:

> Marketing (management) is the process of planning and executing the conception, pricing, promotion, and distribution of ideas, goods, and services to create exchanges with target groups that satisfy individual and organizational objectives.[39]

Marketing's concern is to place its products or services in convenient distribution channels to facilitate the exchange process. The concept of production/operations management often includes logistics activities. For example, "operations management has the responsibility for the production and delivery of physical goods and services."[40] Production/operations, on the other hand, is likely to be most interested in those activities that directly affect manufacturing and its primary objective of producing at the lowest unit cost. Now, viewing product flow activities as a process to be coordinated, product flow aspects within marketing, production, and logistics are collectively managed to achieve customer service objectives.

The difference in operating objectives (maximize revenue versus minimize cost) for marketing and production/operations may lead to a fragmentation of interest in, and responsibility for, logistics activities, as well as a lack of coordination among logistics activities as a whole. This, in turn, may lead to lower customer service levels or higher total logistics costs than are necessary. Business logistics represents a regrouping, either by formal organizational structure or conceptually in the minds of management, of the move-store activities that historically may have been partially under the control of marketing and production/operations.

If logistics activities are looked upon as a separate area of managerial action, the relationship of logistics activities to those of marketing and production/operations would be as shown in Figure 1-7. Marketing would be primarily responsible for market research, promotion, sales-force management, and the product mix, which create possession value in the product. Production/operations would be concerned with the creation of the product or service, which creates form value in the product. Key responsibilities would be quality control, production planning and scheduling, job design, capacity planning, maintenance, and work measurement and standards. Logistics would be concerned with those activities (previously defined) that give a product or service time and place value. This separation of the activities of the firm

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[39]Definition approved by the American Marketing Association as paraphrased in Philip Kotler, *Marketing Management: Planning, Analysis, Implementation, and Control*, 10th ed. (Upper Saddle River, NJ: Prentice-Hall, 2000), p. 13.

[40]John O. McClain and L. Joseph Thomas, *Operations Management: Production of Goods and Services*, 2nd ed. (Upper Saddle River, NJ: Prentice-Hall, 1985), p. 14.

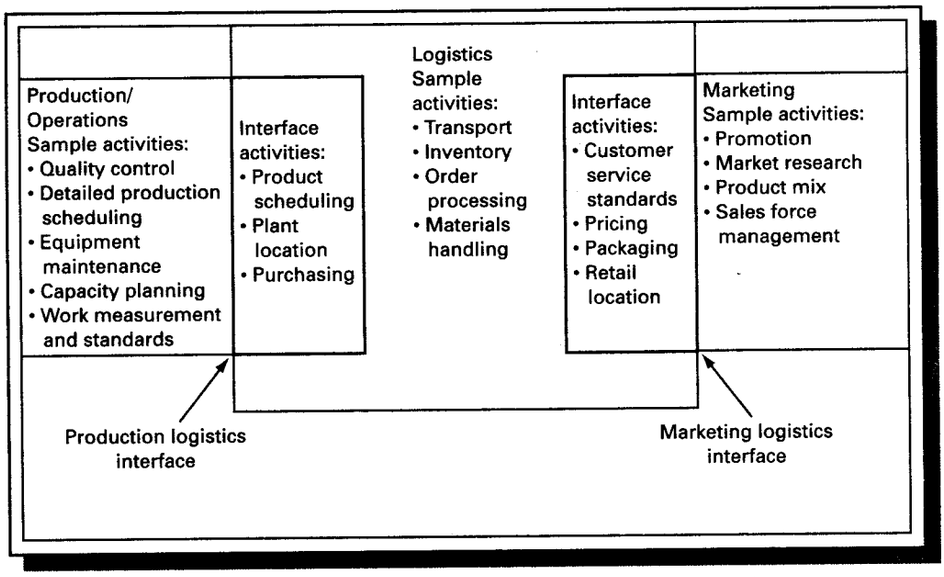
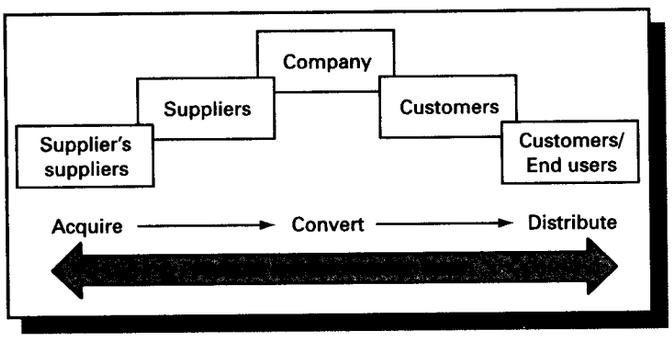


Figure 1-7 Logistics/SC Interfaces with Marketing and Production

into three groupings rather than two is not always necessary or advisable to achieve the coordination of logistics activities that is sought. Marketing and production/operations, when broadly conceived and coordinated, can do an effective job of managing logistics activities without creating an additional organizational entity. Even if a separate functional area is created for logistics within the firm so as to achieve effective control of the firm's immediate logistics activities, logisticians will need to view their responsibility as one of coordinating the entire supply chain process rather than being just a local logistics activity administrator. To do otherwise may miss substantial opportunities for cost reduction and logistics customer service improvement.

Figure 1-7 also shows activities that are at the interface of marketing and logistics and production/operations and logistics within the immediate firm. An interface activity is one that cannot be managed effectively within one functional area. The interface is created by the arbitrary separation of a firm's activities into a limited number of functional areas. Managing the interface activities by one function alone can lead to suboptimal performance for the firm by subordinating broader company goals to individual functional goals—a potential danger resulting from the departmental form of organizational structure so common in companies today. To achieve interfunctional coordination, some measurement system and incentives for cooperation among the functions involved need to be established. This is equally true of the interorganizational coordination required to manage product flows across company boundaries.

Figure 1-8
Scope of the Modern Supply Chain



It is important to note, however, that establishing a third functional group is not without its disadvantages. Two functional interfaces now exist where only one between marketing and production/operations previously existed. Some of the most difficult administrative problems arise from the interfunctional conflicts that occur when one is attempting to manage interface activities. Some of this potential conflict may be dissipated if a new organizational arrangement is created whereby production/operations and logistics are merged into one group called supply chain.

Just as managers are beginning to understand the benefits of interfunctional logistics management, interorganizational management is being encouraged. Supply chain management proponents who view the area more broadly than some logisticians have been strongly promoting the need for collaboration among supply channel members that are outside the immediate control of a company's logistician, that is members who are legally separate companies. Collaboration among the channel members that are linked through buyer-seller relationships is essential to achieving cost-service benefits unable to be realized by managers with strictly an internal view of their responsibilities. Supply chain managers consider themselves to have responsibility for the entire supply channel of the scope as illustrated in Figure 1-8. Managing in this broader environment is the new challenge for the contemporary logistician.

Objectives of Business Logistics/SC

Within the broader objectives of the firm, the business logistician seeks to achieve supply channel process goals that will move the firm toward its overall objectives. Specifically, the desire is to develop a logistics activity mix that will result in the highest possible return on investment over time. There are two dimensions to this goal: (1) the impact of the logistics system design on the revenue contribution, and (2) the operating cost and capital requirements of the design.

Ideally, the logistician should know how much additional revenue would be generated through incremental improvements in the quality of customer service provided. However, such revenue is not generally known with great accuracy. Often, the customer service level is set at a target value, usually one that is acceptable to customers, the sales function, or other concerned parties. At this point, the logistics objective may become one of minimizing costs subject to meeting the desired service level rather than profit maximization or return on investment.

Unlike revenue, logistics costs usually can be determined as accurately as accounting practice will allow and are generally of two types: operating costs and capital costs. Operating costs are those that recur periodically or those that vary directly with variation in activity levels. Wages, public warehousing expenses, and administrative and certain other overhead expenses are examples of operating costs. Capital costs are the one-time expenses that do not change with normal variations in activity levels. Examples here are the investment in a private trucking fleet, the construction cost of a company warehouse, and the purchase of materials-handling equipment.

If it is assumed that there is knowledge of the effect of logistics activity levels on revenues of the firm, a workable financial objective for logistics can be expressed in the ratio known as *ROLA* (*return on logistics assets*). ROLA is defined as

$$\text{ROLA} = \frac{\text{Contribution to revenue} - \text{logistics operating costs}}{\text{Logistics assets}}$$

The contribution to revenue refers to the sales resulting from the logistics system design. Logistics operating costs are the expenses incurred to provide the level of logistics customer service needed to generate sales. Logistics assets are the capital investments made in the logistics system. ROLA is to be maximized over time.

If the value of money is high, maximizing the present value of cash flows or maximizing the internal rate of return is a more appropriate statement of the objective. Maximizing the cumulative return on investment over time is the single most important objective to ensure the long-run survival of the firm.

Approach to the Study of Logistics/SC

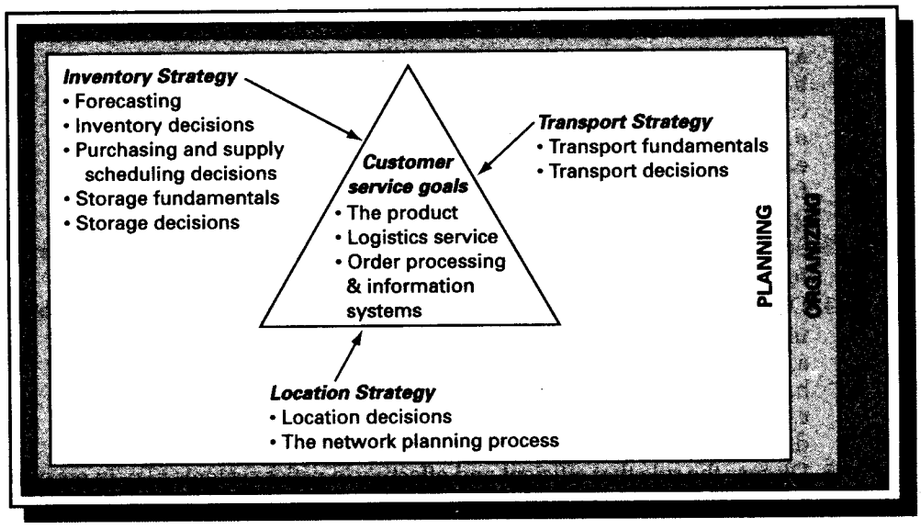
Now that a background of definition and significance has been provided, we can begin our study of the management of logistics in a systematic way. Two themes are used in this text; they follow what management does and the skills needed to perform in a technically complex world. First, the work of management can be looked upon as performing the tasks of planning, organizing, and controlling to achieve the objectives of the firm. *Planning* refers to deciding on the goals for the firm, *organizing* refers to collecting and positioning the resources of firm to accomplish the company goals, and *controlling* refers to measuring company performance and taking corrective action when performance is not in line with goals. Because these are central to

what management does, each will be discussed within the various chapters of this book.

Second, managers, whether at entry level or top level, spend a great deal of time in the planning activity. To do effective planning, it is useful to have a vision of the goals of the firm, to have concepts and principles for guidance on how to get there, and to have tools that help to sort among alternative courses of action. Specifically for logistics management, planning follows a primary decision triangle of location, inventory, and transportation, with customer service being the result of these decisions (see Figure 1-9). Although the logistics' planning triangle is the primary organizational theme for this book, additional topics that relate to it will also be discussed. We begin with, an overview of a strategy for logistics planning and the information systems and technology that support the strategy. A chapter follows on the customer, who drives all logistics decision making. Chapters covering transportation, location, and inventory, which form the cornerstones of the logistics' planning triangle, are all included. Finally, chapters on organization and control round out the planning, organizing, and control theme. Contemporary issues such as global logistics, service industry logistics, quality, collaborative logistics, and reverse logistics are important, but are recognized as extensions of the basic ideas presented in the text. Therefore, their discussion is integrated throughout the text. Numerous examples are given to illustrate how the concepts and tools for good logistics/supply chain management apply to the problems actually encountered in the real world.

From just about every standpoint—whether cost, value to customers, or strategic importance to a firm's mission—logistics/SC is vital. However, only in recent years have businesses on a broad scale begun to manage supply chain activities in an

Figure 1-9 The Planning Triangle in Relation to the Principal Activities of Logistics/Supply Chain Management



integrated way—that is, to think about products and services flowing seamlessly from the sources of raw materials to the final consumers. Moreover, in recent times that flow must include backward movement in the supply channel, or reverse logistics. The economic forces—mainly increased worldwide deregulation of business, proliferation of free trade agreements, increased foreign competition, increased globalization of industries, and increased requirements for faster and more certain logistics performance—have all been instrumental in elevating logistics to a high level of importance in many firms. New opportunities for logistics management, brought about by growth in the service sector, environmental issues, and information technology, will continue to support the vital nature of logistics for many years to come.

The primary emphasis of this text is directed toward dealing effectively with the managerial problems associated with moving and storing goods throughout the supply chain by business firms. These firms may be producing either goods or services and will have profit-making objectives.

This text is organized around the three primary tasks of management: planning, organizing, and controlling. Usually, the most difficult of these is planning, that is, the identification of, and selection among, alternative courses of action. Therefore, major emphasis will be given to this phase of management. It is the approach of this text to describe logistics problems as simply as possible and to apply definitive methodology in solving them that has proven to be of practical value in real applications. It is a decision-making approach.

Questions and Problems

1. What is supply chain management? Contrast it with business logistics management.
2. Describe business logistics, as you would expect it to be practiced in the following countries or regions:
   a. United States
   b. Japan
   c. European Union
   d. Australia
   e. South Africa
   f. China
   g. Brazil
3. Summarize the factors and forces that give logistics importance among other functional areas (marketing, finance, production) of a firm.
4. Discuss the similarities and differences between logistics management of a manufacturing firm and
   a. a service firm (bank, hospital, etc.)
   b. a nonprofit organization (symphony orchestra, art museum, etc.)
   c. the military
   d. a retailing firm (general merchandise, fast food, etc.)
5. Discuss the role that efficient and effective logistics systems play in encouraging a high level of foreign trade.

6. Why is it that both marketing and production may claim some or all of logistics activities as part of their area of responsibility?
7. What are the key activities of the business logistics function? Discuss their existence and importance to the management of
   a. a TV manufacturer (Sony)
   b. a touring musical group (Berlin Philharmonic)
   c. a hospital (Massachusetts General)
   d. a city government (New York City)
   e. a fast-food chain (McDonald's)
8. How do you think international logistics differs from logistics for a firm with global operations?
9. Suggest some products that benefit significantly from increased time and place value.
10. Establishing logistics as a separate area for management within a business firm creates an additional set of interface activities. What are interface activities? Why would the creation of an additional set of interface activities cause concern in most companies?
11. The political and economic barriers are continuing to come down among the several countries of the European Union. If you are a manager of physical distribution for a multinational company that sells finished consumer goods (e.g., Procter & Gamble of Italy) within your own country, what distribution decisions are facing you in the future?
12. Suppose that a manufacturer of men's shirts can produce a dress shirt in its Houston, Texas plant for $8 per shirt (including the cost of raw materials). Chicago is a major market for 100,000 shirts per year. The shirt is priced at $15 at the Houston plant. Transportation and storage charges from Houston to Chicago amount to $5 per hundredweight (cwt.). Each packaged shirt weighs 1 pound.

    As an alternative, the company can have the shirts produced in Taiwan for $4 per shirt (including the cost of raw materials). The raw materials, weighing about 1 pound per shirt, would be shipped from Houston to Taiwan at a cost of $2 per cwt. When the shirts are completed, they are to be shipped directly to Chicago at a transportation and storage cost of $6 per cwt. An import duty of $0.50 per shirt is assessed.
    a. From a logistics-production cost standpoint, should the shirts be produced in Taiwan?
    b. What additional considerations, other than economic ones, might be considered before making a final decision?
13. Use the following form as part of an in-class exercise. Be prepared to discuss your choices and to contrast them with others in the class. Identify the common elements making some companies successful logistically and the elements that are missing among others leading to logistics/SC failures.

CORPORATE STRATEGY

Corporate strategy creation begins with a clear expression of the firm's objectives. Whether the company is to seek profit, survival, social, return on investment, market share, or growth goals should be well understood. Next, a process of *visioning* is likely to take place where unconventional, unheard of, and even counterintuitive strategies are considered. This requires addressing the four components of good strategy: *customers, suppliers, competitors,* and the *company* itself. Assessing the needs, strengths, weaknesses, orientations, and perspectives of each of these components is a beginning.[3] Then, brainstorming about what may be possible as a niche strategy is the output of this visioning process. The following are examples of such visions:

- General Electric's vision is to be number one or two in each market that it serves; it will get out of any market in which it cannot maintain that standard.
- Hewlett-Packard envisions serving the scientific community.
- IBM constantly reshapes itself to remain an effective competitor.[4]
- Hero Group (the largest motorcycle maker in the world) continuously strives for synergy between technology, systems and human resources to provide products and services that meet the quality, performance, and price aspirations of the customers.[5]
- Infosys' vision is to be a globally respected corporation that provides best-of-breed business solutions, leveraging technology, delivered by best-in-class people.[6]
- Maruti Udyog Limited (MUL) has a vision of creating customer delight and shareholder wealth.[7] For this, it continuously focuses on its core values.

Next, the broad, general visioning strategies need to be converted into plans that are more definitive. With a clear understanding of the firm's costs, financial strengths and weaknesses, market share position, asset base and deployment, external environment, competitive forces, and employee skills, a selection is made from alternative strategies that evolve from the threats and opportunities facing the firm. These strategies now become specific directions for how the vision will be made reality.

Examples

- Xerox's copier patents were running out, meaning the company would no longer have a differentiated product in the marketplace. Therefore, it adopted the strategy to be number one in field service.
- StarKist Foods adopted a supply-side strategy of buying and packing all the tuna that its own fleet and its contracted fleets could catch. This would help it to be the dominant packer in the tuna business.

[3]Roger Kallock, "Develop a Strategic Outlook," *Transportation and Distribution* (January 1989), pp. 16–18.
[4]Kenneth R. Ernst, "Visioning: Key to Effective Strategic Planning," *Annual Conference Proceedings,* volume 1 (Boston: Council of Logistics Management, 1988), pp. 153–165.
[5]Available at http://www.herogroup.com/vision.htm.
[6]Available at http://www.infosys.com/about/vision_and_mission.asp.
[7]Available at http://www.marutiudyog.com.

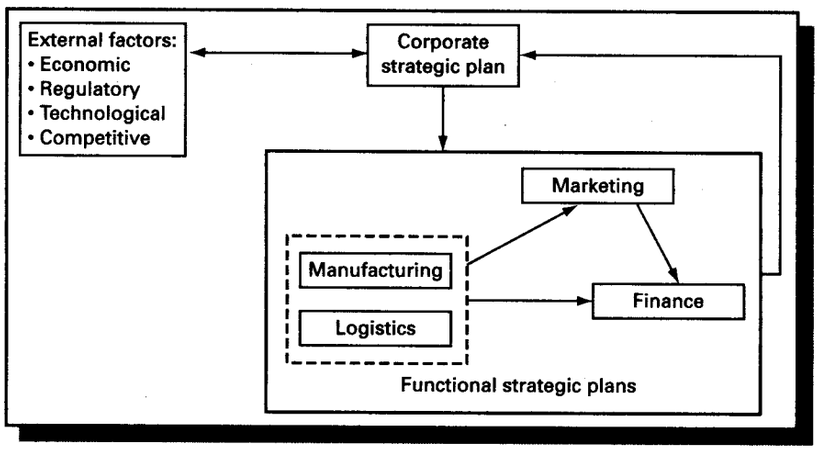


Figure 2-1 Overview of Corporate Strategic Planning to Functional Strategic Planning

Source: William Copacino and Donald B. Rosenfield, "Analytic Tools for Strategic Planning," *International Journal of Physical Distribution and Materials Management*, Vol. 15, No. 3 (1985), p. 48.

The corporate strategy drives the functional strategies because they are contained within the former, as shown in Figure 2-1. The corporate strategy is realized as manufacturing, marketing, finance, and logistics shape their plans to meet it. When StarKist Foods decided on a supply-side strategy, marketing and logistics responded with their plan to control the potential excess inventories that would result. This plan was to place tuna on sale to reduce inventories when necessary. The plan works because tuna is in such demand that consumers often stock up when it is on sale. Let's now turn to the specific way logistics strategies are developed.

LOGISTICS/SC STRATEGY

Selecting a good logistics/SC strategy requires much of the same creative processes as developing a good corporate strategy. Innovative approaches to logistics/SC strategy can give a competitive advantage.

Examples

- An office machine company took a bold step to save on valuable machine repair time. Traditionally, repair technicians were sent by a central service center to the customer repair site. These highly trained and highly paid personnel spent a fair amount of their time traveling to and from these sites. The company redesigned its logistics system so that inventories of on-loan and replacement machines were placed at service centers around the country. When a machine broke down, a replacement machine would be sent to the customer, and the

broken machine sent to the service center for repair. The new system not only saved on repair costs, but improved customer service as well.

- American Hospital Supply developed an efficient purchasing system for its customers by putting terminals in each of its customers' offices. The system simplified and facilitated the ordering process for its customers, and guaranteed a higher proportion of orders for American Hospital Supply.[8]

It has been suggested that a logistics strategy has three objectives: cost reduction, capital reduction, and service improvement.

Cost reduction is strategy directed toward minimizing the variable costs associated with movement and storage. The best strategy is usually formulated by evaluating alternative courses of action, such as choosing among different warehouse locations or selecting among alternative transport modes. Service levels are typically held constant while the minimum cost alternatives are being found. Profit maximization is the prime goal.

Capital reduction is strategy directed toward minimizing the level of investment in the logistics system. Maximizing the return on logistics assets is the motivation for this strategy. Shipping direct to customers to avoid warehousing, choosing public warehouses over privately owned warehouses, selecting a just-in-time supply approach rather than stocking to inventory, or using third-party providers of logistics services are examples. These strategies may result in higher variable costs than strategies requiring a higher level of investment; however, the return on investment may be increased.

Service improvement strategies usually recognize that revenues depend on the level of logistics service provided. Although costs increase rapidly with increased levels of logistics customer service, the increased revenues may offset the higher costs. To be effective, the service strategy is developed in contrast with that provided by the competition.

Example

Parker Hannifin, a maker of seals and O-rings, won sales with superior logistics customer service. A customer's purchasing agent showed the Parker Hannifin salesperson two invoices for the same product, one from a competitor and one from Parker Hannifin. The competitor's price was 8 percent lower. However, if Parker Hannifin would maintain a service center (an inventory stocking point with additional value-added services) for the customer, then Parker Hannifin stood to gain over a million dollars of business at the higher price. Parker Hannifin complied and established the center, getting the contract. The customer was satisfied and Parker Hannifin made a profit, since operating the service center cost 3.5 percent of the sale!

[8]William Copacino and Donald B. Rosenfield, "Analytic Tools for Strategic Planning," *International Journal of Physical Distribution and Materials Management*, Vol. 15, No. 3 (1985), pp. 47–61.

Maruti Udyog Limited has a very extensive service network. It has two kinds of service stations—Dealer workshops and Maruti Authorised Service Stations (MASS). These are spread throughout the nooks and corners of India and helps the company in ensuring high level of customer service. The J.D. Power Asia Pacific 2006 India Sales Satisfaction Index Study ranks the company highest in overall sales satisfaction for a third consecutive year.[9]

A proactive logistics strategy often begins with the business goals and customer service requirements. These have been referred to as "attack" strategies to meet competition. The remainder of the logistics system design can then be derived from these attack strategies.

Examples

- Nabisco comfortably reigned as king of steak sauces with its A-1 brand. Then Kraft came out with a spicier version called Bulls Eye. This competitive move by Kraft threatened Nabisco's franchise. Nabisco responded with A-1 Bold, throwing its supply chain into overdrive and putting Bold on the store shelves in a matter of months. Nabisco succeeded in knocking Bulls Eye off the market. Without Nabisco's fast-response supply chain, Bulls Eye, which was a very good product, would have had time to take market share.[10]
- Domino Pizza is just one of many in the pizza market, serviced by competitors such as Pizza Hut as well as an army of independent retail operations. It has now become America's second-largest pizza chain by promising customers a $3 discount on any pie not delivered within 30 minutes from the time it's ordered.[11]
- Frito-Lay developed a strategic advantage with its direct-to-store delivery system, and Atlas Door recognized that no company in the industrial door business could get a door to a customer in less than three months. Atlas stepped in and developed a strategy based on delivering a door in much less time, and it now enjoys a major share of the market.[12]

Tata Motors is now set at manufacturing Rs. 1-lakh small car (approximately $2,200), which will make it the cheapest four-seater car in the world. The company is expected to produce 2 lakh units of such cars[13] and is now testing the prototypes. The 1,000-acre first plant coming up at Singur in West Bengal will involve an estimated investment of Rs. 1,000 crore and create direct jobs for around 2,000 persons. The plant is scheduled to be commissioned by 2008.[14] To achieve the economies of scale, it will have a vendor base of 300–400 suppliers (including about 100 tier-1 suppliers).

[9]Ibid.
[10]J. Robert Hall, "Supply Chain Management from a CEO's Perspective," *Proceedings of the Council of Logistics Management* (San Diego, CA: October 8–11, 1995), p. 164.
[11]"How Managers Can Succeed Through SPEED," *Fortune* (February 13, 1989), pp. 54–59.
[12]Ernst, "Visioning," pp. 153–165.
[13]*Business Line* (July 8, 2006), p. 2.
[14]*Auto Monitor* (July 15, 2006), p. 8.

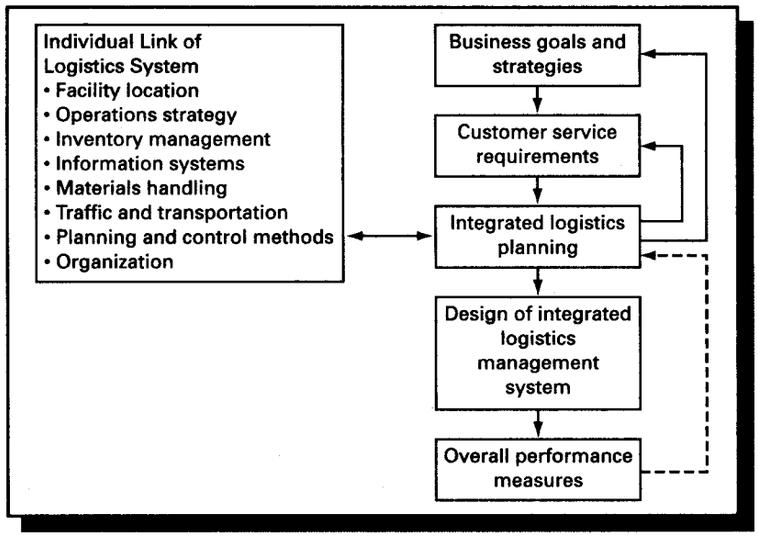


Figure 2-2 Flow of Logistics Planning

Source: William Copacino and Donald B. Rosenfield, "Analytic Tools for Strategic Planning," *International Journal of Physical Distribution and Materials Management*, Vol. 15, No. 3 (1985), p. 49.

This includes a 300-acre vendor park to accommodate some of the key suppliers. The company expects the vendors to put up design and development facilities too.[15]

Each link in the logistics system is planned and balanced with each other in an integrated logistics planning process (see Figure 2-2). Design of the management and control systems completes the planning cycle.

Designing effective logistics customer service strategies requires no particular program or technique. It is simply the product of a sharp mind. Once the logistics service strategy is formulated, the task is then to meet it. This involves selecting among alternative courses of action. Such selection is amenable to various concepts and techniques for analysis. The next section sets the stage for such evaluation. A recurrent theme throughout this book is understanding the logistical alternatives open to the supply chain manager and how they can be evaluated.

LOGISTICS/SC PLANNING

Levels of Planning

Logistics planning attempts to answer the questions of what, when, and how, and it takes place at three levels: strategic, tactical, and operational. The major difference between them is the time horizon for the planning. *Strategic planning* is considered

[15]*The Telegraph* (August 23, 2006), p. 15.

Decision Area	Level of Decision		
	Strategic	Tactical	Operational
Facility location	Number, size, and location of warehouses, plants, and terminals		
Inventories	Stocking locations and control policies	Safety stock levels	Replenishment quantities and timing
Transportation	Mode selection	Seasonal equipment leasing	Routing, dispatching
Order processing	Order entry, transmittal, and processing system design		Processing orders, filling back orders
Customer service	Setting standards	Priority rules for customer orders	Expediting deliveries
Warehousing	Handling equipment selection, layout design	Seasonal space choices and private space utilization	Order picking and restocking
Purchasing	Development of supplier-buyer relationships	Contracting, vendor selection, forward buying	Order releasing and expediting supplies

Table 2-1 Examples of Strategic, Tactical, and Operational Decision Making

long-range, where the time horizon is longer than one year. *Tactical planning* involves an intermediate time horizon, usually less than a year. *Operational planning* is short-range decision making, with decisions frequently made on an hourly or daily basis. The concern is how to move the product effectively and efficiently through the strategically planned logistics channel. Selected examples of typical problems with these various planning time horizons are shown in Table 2-1.

Each planning level requires a different perspective. Because of its long time horizon, strategic planning works with data that are often incomplete and imprecise. Data may be averaged, and plans are usually considered good enough if they are reasonably close to optimum. At the other end of the spectrum, operational planning works with very accurate data, and the methods for planning should be able to handle a great deal of these data and still find reasonable plans. For example, we may strategically plan *all* company inventories not to exceed a certain dollar limit or to achieve a certain inventory turnover ratio.[16] On the other hand, an operational plan for inventories requires that each item be managed individually.

Much of our attention will be directed toward strategic logistics planning, since it can be discussed using a general approach. Operational and tactical planning often requires an intimate knowledge of the particular problem, and specific approaches must be customized. Because of this, we begin with what is the major logistics planning problem, which is designing the overall logistics system.

[16]Inventory turnover ratio is defined as the ratio of annual sales to the average inventory level for the same annual period, usually in dollar units.

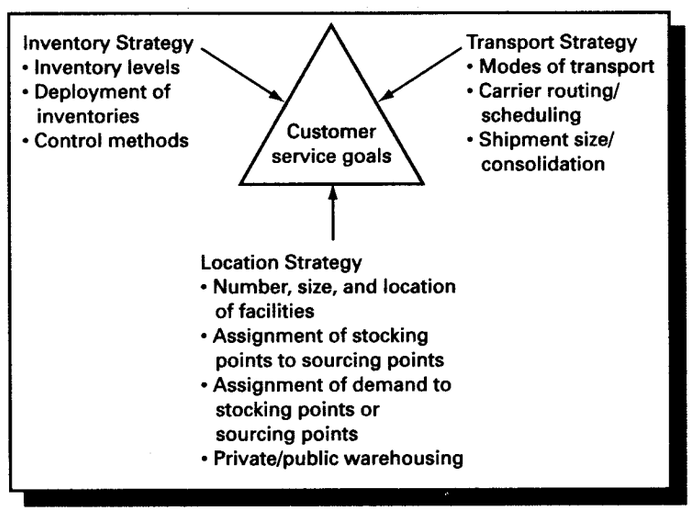


Figure 2-3
The Triangle of Logistics Decision Making

Major Planning Areas

Logistics planning tackles four major problem areas: customer service levels, facility location, inventory decisions, and transportation decisions, as shown in Figure 2-3. Except for setting a desired customer service level (customer service is a resultant of the strategies formulated in the other three areas), logistics planning may be referred to as a triangle of logistics decision making. These problem areas are interrelated and should be planned as a unit, although it is common to plan them separately. Each has an important impact on system design.

Customer Service Goals

More than any other factor, the level of logistics customer service provided dramatically affects system design. Low levels of service allow centralized inventories at few locations and the use of less expensive forms of transportation. High service levels generally require just the opposite. However, when service levels are pressed to their upper limits, logistics costs will rise at a rate disproportionate to the service level. Therefore, the first concern in logistics strategic planning must be the proper setting of customer service levels.

Facility Location Strategy

The geographic placement of the stocking points and their sourcing points creates an outline for the logistics plan. Fixing the number, location, and size of the facilities and assigning market demand to them determines the paths through which products are directed to the marketplace. 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 locations through the intermediate stocking points, and on to 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

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 represent two strategies. Selective location of various items in the product line in plant, regional, or field warehouses or managing inventory levels by various methods of perpetual inventory control are others. The particular policy used by the firm affects the facility location decision and, therefore, the policy should be considered in the logistics strategy.

Transport Strategy

Transport decisions can involve mode selection, shipment size, and routing and 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 firm's profitability, cash flow, and return on investment. Each decision area is interrelated and transport strategy should be planned with at least some consideration of the trade-off effect.

Conceptualizing the Logistics/SC Planning Problem

Another way to look at the logistics planning problem is to view it in the abstract as a network of *links* and *nodes*, as shown in Figure 2-4. 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 alternate forms of transportation service, different routes, and different products. Nodes represent points where the flow of inventory is temporarily stopped—for example, at a warehouse—before moving on to a retail store and on to the final consumer.

These move-store activities for inventory flows are only one part of the total logistics system. In addition, there is a network 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 consist of the mail or electronic methods for transmitting information from one geographic point to another. Nodes are the various data collection and processing points, such as a clerk who handles order processing and prepares bills of lading[17] or a computer that updates inventory records.

In concept, the information network is much like the product flow network in that both can be viewed as a collection of links and nodes. However, a major difference in the networks is that product mainly flows "down" the distribution channel (toward

[17]A bill of lading is a contractual agreement between the shipper and carrier setting forth the conditions under which the freight will be moved.

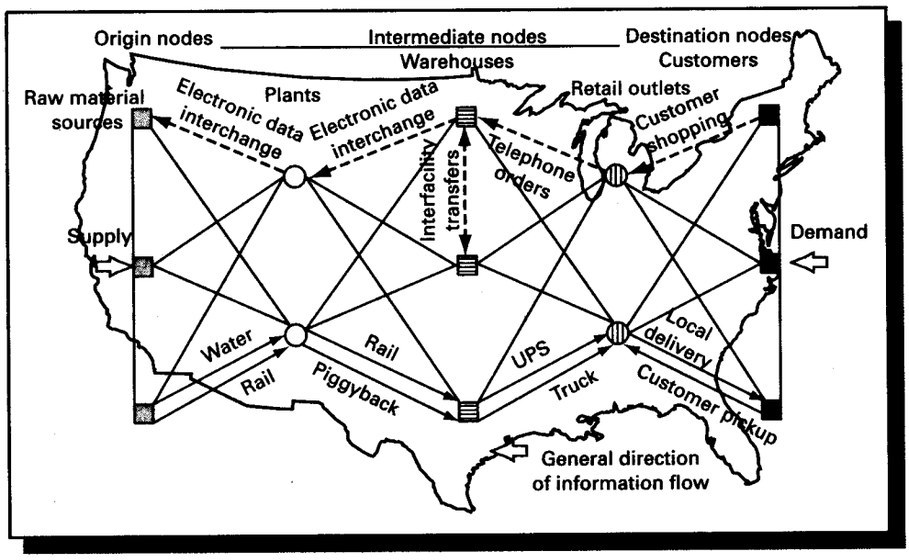


Figure 2-4 An Abbreviated Network Diagram for a Logistics System

the final consumer), whereas information mainly, but not entirely, flows "up" the channel (toward raw material sources).

The product flow network and the information network combine to form a logistics system. The networks are combined, since designing each separately can lead to a suboptimal design for the entire system. Thus, the networks are dependent. For example, the design of the information network influences the order-cycle times for the system. Order-cycle times, in turn, affect the inventory levels that must be maintained at the nodes in the product network. The availability of inventory affects customer service levels, and customer service levels, in turn, affect order-cycle times and the information network design. In addition, still other interdependencies require viewing the logistics system as a whole rather than by its parts.

Logistics planning is a design problem. The network is to be constructed as a configuration of warehouses, retail outlets, factories, deployed inventories, transportation services, and information processing systems that will achieve an optimum balance between the revenues resulting from the level of customer service established by the network design and the costs associated with the creation and operation of the network.

When to Plan[18]

In the planning process, when the network should be planned or planned again is the first consideration. If no logistics system currently exists, as in the case of a new firm or of new items within an existing product line, the need for planning a logistics network

[18]Adapted from Ronald H. Ballou, "How to Tell When Distribution Strategy Needs Revision," *Marketing News*, May 1, 1982, Sec. 2, p. 12.

is obvious. However, in most cases in which a logistics network is already in place, a decision must be made either to modify the existing network or to allow it to continue to operate, even though it may not be an optimal design. A definitive answer to this question cannot be given without doing the actual planning. However, general guidelines for network appraisal and audit can be offered in the five key areas of demand, customer service, product characteristics, logistics costs, and pricing policy.

Demand

Both the level of demand and its geographic dispersion greatly influence the configuration of logistics networks. Firms often experience disproportionate growth or decline in one region of the country compared with others. Although only expansion or reduction at current facilities may be required, substantial shifting of demand patterns may require that new warehouses or plants be located in rapidly growing areas while facilities in slow growth or declining markets need to be closed. Such disproportionate growth of only a few percentage points a year often is sufficient to justify network replanning.

Customer Service

Customer service broadly includes inventory availability, speed of delivery, and order filling speed and accuracy. The costs associated with these factors increase at a higher rate as the customer service level is raised. Therefore, distribution costs will be quite sensitive to the level of customer service provided, especially if it is already high.

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 originally was based. However, minor changes in service levels, when they already are low, are not likely to trigger the need for replanning.

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 rates. Because altering a product's characteristics can substantially change one cost element in the logistics mix with little change to the others, this creates a new cost balance point for the logistics system. Thus, when substantial changes are made in the product characteristics, replanning the logistics system could be beneficial.

Logistics Costs

The costs that a firm incurs for physical supply and physical distribution often determine how frequently its logistics system should be replanned. All other factors being equal, a firm producing high-valued goods (such as machine tools or computers); with logistics costs being a small portion 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. With high logistics costs, even the small improvements brought about by frequent replanning can result in substantial cost reductions.

Pricing Policy

Changes in the pricing policy under which goods are purchased or sold will affect logistics strategy, mainly because it defines responsibility for certain logistics activities. A supplier that switches from an f.o.b. factory price (transportation costs not included) to a delivered price (transportation costs included) will usually relieve the buying firm of the responsibility for providing or arranging for the inbound transportation. Similarly, price policy affects the transfer of title to goods and the responsibility for transportation in the distribution channel as well.

Although costs are transferable through the logistics channel regardless of how they are assigned by the pricing mechanism, some firms plan their logistics system based on the costs for which they are directly responsible. If a firm has a price policy where the customer pays for the delivery of goods, the resulting strategy is likely to be one where there are few stocking points, unless customer service restrictions force these to be increased. Due to the importance of transportation costs in total logistics costs, shifts in price policy will usually trigger strategy reformulation.

When changes have occurred in one or several of these areas, replanning the logistics strategy should be considered. Next, let us consider some of the logistics principles and concepts that are useful for strategy formulation.

Guidelines for Strategy Formulation

Many of the principles and concepts that guide logistics planning are derived from the unique nature of logistics activities, especially transportation. Others are a result of general economic and market phenomena. All give insight as to what the logistics strategy might be and set the stage for more detailed analysis. Several of these will now be outlined and illustrated.

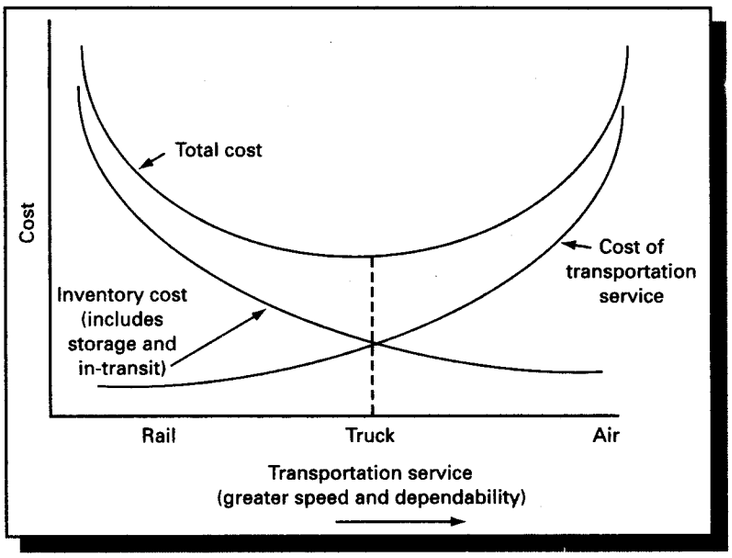
Total Cost Concept

Central to the scope and design of the logistics system is trade-off analysis, which, in turn, leads to the total cost concept. The cost trade-off is the recognition that cost patterns of various activities of the firm frequently display characteristics that put them in conflict with one another. This conflict is managed by balancing the activities so that they are collectively optimized. For example, Figure 2-5 shows that when a transportation service is being selected, the direct cost of the transport service and the indirect cost effect on inventory levels in the logistics channel due to different delivery performance of carriers are said to be in cost conflict with each other. The best economic choice occurs at the point where the sum of both costs is lowest, as indicated by the dashed line in Figure 2-5.

Choosing a transportation service based on lowest rates or fastest service may not be the best method. Therefore, the basic problem in logistics is one of cost conflict management. Wherever there are substantial cost conflicts among activities, they should be managed in a coordinated manner. The network, as previously described, incorporates most of the potential cost conflicts relevant to logistics.

The total cost concept applies to more than the problem of selecting transportation service. Additional examples of logistics problems, where a trade-off of costs is

Figure 2-5
Generalized Cost Conflict Between Transportation and Inventory Costs As a Function of Transportation Service Characteristics



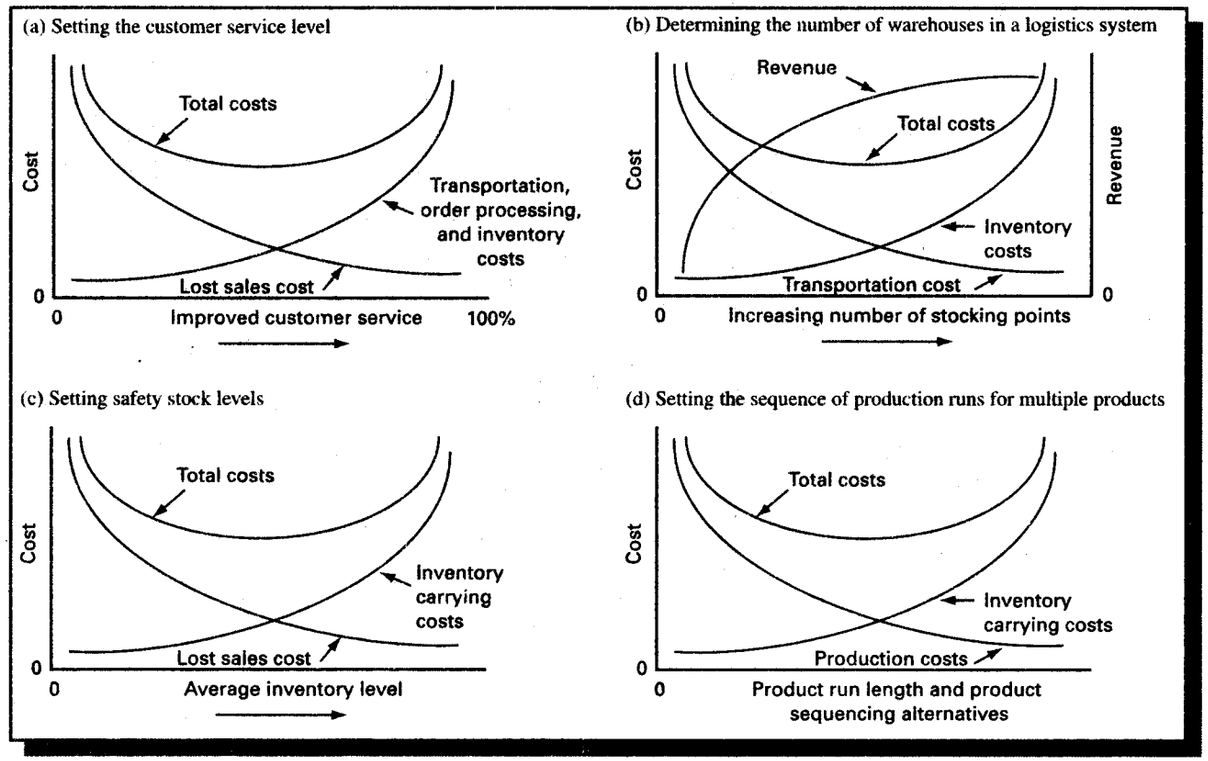
indicated, are shown in Figure 2-6. Figure 2-6(a) illustrates the problem of setting the customer service level. As customers receive a higher level of service, fewer of them are lost because of out-of-stock situations, slow and unreliable deliveries, and inaccurate order filling. The cost of lost sales decreases with improved service. Counterbalancing the lost sales cost is the cost of maintaining the level of service. Improved service usually means that more must be paid for transportation, order processing, and inventories. The best trade-off occurs at a point below 100 percent (perfect) customer service.

Figure 2-6(b) shows the basic economic considerations in determining the number of stocking points in a logistics network. When customers purchase in small quantities and stocking points are replenished in large quantities, the cost of transportation from the stocking points exceeds the inbound costs so that transportation costs decline when the number of stocking points is increased. However, as the number of stocking points increases, the inventory level for the entire network increases and inventory costs rise. In addition, the customer service level is affected by this decision. The problem is one of balancing the combined inventory-transportation costs against the contribution to revenues from the customer service level provided.

Figure 2-6(c) illustrates the problem of setting the safety stock level for inventories. Because safety stock increases the average level of inventories and affects the customer service level through the availability of stock when an order is placed, the cost of lost sales declines. Increasing the average level of inventories will increase the inventory carrying cost. Transportation costs remain relatively unaffected. Again, a balance is sought between these opposing costs.

Finally, Figure 2-6(d) shows the basic features of a multiproduct scheduling problem. Production costs are affected by the sequence in which the products are produced and the length of production runs. As the production sequence is changed,

Figure 2-6 Additional Generalized Logistics System Trade-Offs



inventory costs will increase, because orders will not necessarily be received at the optimum time to replenish depleted stocks. The effect is to raise the average inventory level. The best production sequence and run length to produce the products are found where the combined production and inventory costs are minimized.

These examples illustrate the total cost concept as applied to the internal problems of the firm and specifically to logistics problems. However, at times, decisions made by a firm in a channel of distribution affect the logistics costs of another firm. For example, the inventory policies of a buyer affect both the inventory costs of the shipper and the operating costs of the carrier. In this case, it is necessary to extend the boundaries of the system beyond either the logistics function or the firm, possibly to include several firms. Thus, the total cost equation would be expanded, and the scope of managerial decision making would extend beyond the legal limits of the firm.

The point is that the total cost, or alternately the total system, concept is a concept without clear boundaries. Although one might argue that in some way all activities of the entire economy are economically related to the logistics problem of the firm, to attempt to assess all the various cost trade-offs that might relate to any decision problem is folly. It is left to managerial judgment to decide the factors considered relevant and to include them in the analysis. This defines whether the total cost analysis will include only factors within the logistics function as we have defined it, or whether the analysis should be extended to include other factors under the control of the firm and even some beyond the immediate control of the firm, as in the entire supply chain. *The total cost concept is the trade-off of all costs that are in cost conflict with each other and that can affect the outcome of a particular logistics decision.*

Application

A large manufacturer of marine products was constructing a warehouse in St. Louis. The choice of location was based on minimizing transportation costs. A follow-up study that included the effect of inventory consolidation on transportation costs showed that the warehouse was best located in Chicago. The more comprehensive analysis resulted in cost differences that were so dramatic that the company sold the partially constructed warehouse and moved the inventory to Chicago.

The earlier structure of state taxes and laws in India led fast-moving consumer-goods (FMCG) companies into setting up multiple warehouses (around15–25), as it was the most cost-effective solution. However, after implementation of uniform VAT (a multi-stage tax, levied on value added at different stages of production and distribution of a commodity or the supply of a service), there could be just few warehouses serving a host of smaller, transit warehouses in over 4–5 surrounding states, boosting the creation of hubs and spokes model of logistics. This will require not only strategic redesign but also involve other considerations related to closure of some existing facilities and reallocation of capacities.[19]

[19]Samir K. Srivastava, "Logistics and Supply Chain Practices in India," *Vision: The Journal of Business Perspective*, Vol. 10, No. 3 (2006), pp. 69–79.

Differentiated Distribution

Not all products should be provided the same level of customer service. This is a fundamental principle for logistics planning. Different customer service requirements, different product characteristics, and different sales levels among the multiple items that the typical firm distributes suggest that multiple distribution strategies should be provided within the product line. Managers have made use of this principle when they broadly classify their products into a limited number of groups, such as high, medium, and low sales volume, and then apply a different stocking level to each. To a lesser extent, the principle is also applied to inventory location. When a firm stocks all products at all warehouse locations, it may do so to simplify administration, but this strategy denies the inherent differences between products and their costs, and it leads to higher than necessary distribution costs.

An improved strategy might be first to differentiate those products that should move through the warehouse from products that should be shipped directly to customers from plant, vendors, or other source points. Because the transportation rate structure encourages shipments in vehicle-load volumes, the products might first be divided according to shipment size. Those customers ordering in high-volume quantities would be served direct, while all others would be served from warehouses.

Of the sales volume remaining, the products should be differentiated by location. That is, the fast-moving items should be placed in the field warehouses with the most forward locations in the distribution channel. Medium-volume items should be placed in fewer regional locations. The slow-moving items should be located only at centralized stocking points such as plants. As a result, each stocking point may contain a different product mix.

Application

A small specialty chemical company manufactured a variety of products for coating metals for corrosion prevention. All products were produced at a single location. A study of the distribution network recommended distribution patterns somewhat different from those historically used by the company. That is, all shipments that could be made in full truckload quantities were to be shipped direct from plant to customers. All large customer orders, the top ten percent of the company's volume, were also to be shipped direct to customers from the plant. The remainder of the product line, with its small shipment sizes, was to be shipped out of two strategically located warehouses as well as from the plant. This differentiated distribution strategy saved the company 20 percent of its distribution costs while preserving the existing level of logistics customer service.

Differentiated distribution may be applied to factors other than volume. That is, separate distribution channels may be established for regular customer orders and back orders. The regular distribution channel might be to fill orders from warehouses. When an out-of-stock situation occurs, a backup distribution system may

come into play that fills the order from secondary stocking points and uses premium transportation to overcome the disadvantage of increased delivery distances. Similarly, many other examples can be offered where multiple distribution channels give lower overall distribution costs than a single channel design.

Mixed Strategy

The concept of a mixed strategy is similar to that of differentiated distribution. The concept is: *A mixed distribution strategy will have lower costs than a pure, or single strategy.* Although single strategies may benefit from economies of scale and administrative simplicity, they are at an economic disadvantage when the product line varies substantially in terms of cube, weight, order size, sales volume, and customer service requirements. A mixed strategy allows an optimal strategy to be established for separate product groups. This often has lower costs than a single, global strategy that must be averaged across all product groups.

Application

One retailer of prescription drugs and sundry products was faced with expanding its distribution system to meet rapidly increasing sales brought about by a program of retail store acquisitions. A configuration of six warehouses was used to service about one thousand stores throughout the United States. The company's strategy was to use only privately owned warehouses and trucks to provide high levels of service to the stores. Expansion plans called for the construction of a new $7 million facility. The warehouse was to supplement an overloaded facility that served a primary market area around Pittsburgh and to lower costs by using up-to-date handling and storage equipment and procedures. Management was committed to this strategy and had begun searching for a site for the new building.

At this time, a network planning study was conducted. The results showed that while the Pittsburgh facility was expensive to operate, the savings generated by the new warehouse could not justify the $7 million investment. Although this was informative, it did not solve the company's need for additional space.

A mixed strategy was suggested to the vice president of distribution (see Figure 2-7). The use of some public (for rent) warehouse space along with the company-owned space could offer lower total costs than the all-private strategy. The company was able to move the high-cube products into a nearby public warehouse, install new equipment, and recover enough space to meet foreseeable needs. The costs were about $200,000 for the new equipment and about $100,000 for additional annual transport expense for serving the stores from both facilities. Thus, the company was successfully able to avoid the $7 million that it had already agreed to spend if a single, or pure, distribution strategy were pursued.

Postponement

The principle of postponement can be stated as follows: *The time of shipment and the location of final product processing in the distribution of a product should be delayed until a*

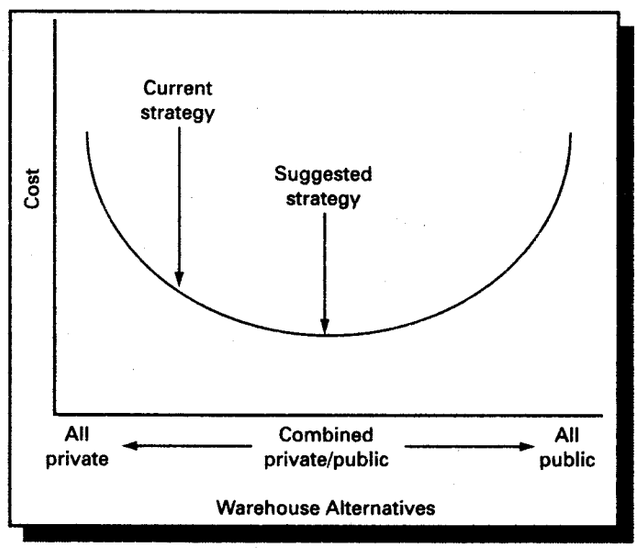


Figure 2-7
A Total Cost Curve for Single and Mixed Warehousing Strategies

customer order is received.[20] The idea is to avoid shipping goods in anticipation of when demand will occur (time postponement) and to avoid creating the form of the final product in anticipation of that form (form postponement).

Examples

- JCPenney regularly practices time postponement in its retail catalog operations by filling orders on demand from relatively few warehouse locations.
- Dell Computer, a manufacturer of mail-order personal computers, practices form postponement by configuring microcomputer systems to customer order from available options.
- Sherwin-Williams retail paint stores create an endless variety of colors for customers by mixing pigments in relatively few base colors, rather than stocking all colors ready mixed (form postponement). Asian Paints does the same in India.
- Steel service centers cut standard shapes and sizes of steel products into custom products for customers (form postponement). Tata Iron and Steel Company (TISCO) does the same in India.
- Postponement was used by Hewlett-Packard as a critical element in DeskJet Plus product design—the relationship between design and the eventual customization, distribution, and delivery of the product to multiple market segments.[21]

[20]Walter Zinn and Donald J. Bowersox, "Planning Physical Distribution with the Principle of Postponement," *Journal of Business Logistics*, Vol. 9, No. 2 (1988), pp. 117–136.
[21]Hau Lee, Corey Billington, and Brent Carter, "Hewlett-Packard Gains Control of Inventory and Service Through Design for Localization," *Interfaces*, Vol. 23, No. 4 (July/August 1993), pp. 1–11.

- SW, a manufacturer of graphical software, developed its products at its U.S. headquarters. To save on transportation and inventory costs, it shipped master copies of the software to Europe for duplication and final customization for that market.[22]

Specifically, consider how StarKist Foods reworked its distribution strategy using the principle of postponement.

Application

StarKist Foods, a canner of tuna products, changed its distribution strategy to take advantage of the postponement principle and lower inventory levels. Historically, the company packed fish in its California cannery for both company-label and private-label markets. The end products were shipped to field warehouses for storage. A decision had to be made at the time of canning as to what proportion of the catch would be committed to the two end products, since there was too little capacity to store fish as a raw material. There was no difference in the quality of the final product under the two labels.

The company established a forward labeling operation on the East Coast to serve the eastern markets. The fish was packed in unlabeled cans called "brights" and shipped to the East Coast warehouse. As the market developed for the end products, the "brights" were labeled and shipped to customers. Inventories were lowered through avoiding the costs associated with having too little or too much of the product with a particular label.

Zinn and Bowersox classify five types of postponement and give suggestions as to the firms that might be interested in applying the principle. Form postponement can take four forms: labeling, packaging, assembly, and manufacturing; the fifth type is time postponement. Their suggestions are summarized in Table 2-2. Postponement is favored when the following characteristics appear to be present.

Technology and Process Characteristics

- Feasible to decouple primary and postponed operations
- Limited complexity of customizing
- Modular product design
- Sourcing from multiple locations

Product Characteristics

- High commonality of modules
- Specific formulation of products
- Specific peripherals

[22]Remko I. van Hoek, Harry R. Commandeur, and Bart Vos, "Reconfiguring Logistics Systems Through Postponement Strategies," *Planning for Virtual Response, Proceedings of the Twenty-Fifth Annual Transportation and Logistics Educators Conference* (Orlando, FL: The Transportation and Logistics Research Fund, 1996), pp. 53–81.

Postponement Type	Potentially Interested Firms
Labeling[a]	Firms selling a product under several brand names Firms with high unit value products Firms with high product value fluctuations
Packaging[a]	Firms selling a product under several package sizes Firms with high unit value products Firms with high product sales fluctuations
Assembly[a]	Firms selling products with several versions Firms selling a product whose cube is greatly reduced if shipped unassembled Firms with high unit value products Firms with high product sales fluctuations
Manufacturing[a]	Firms selling products with a high proportion of ubiquitous materials Firms with high unit value products Firms with high product sales fluctuations
Time[b]	Firms with high unit value products Firms with a large number of distribution warehouses Firms with high product sales fluctuations

[a]A type of form postponement
[b]Time postponement
Source: Adapted from Walter Zinn and Donald J. Bowersox, "Planning Physical Distribution with the Principle of Postponement," *Journal of Business Logistics*, Vol. 9, No. 2 (1988), p. 133.

Table 2-2 Types of Firms Potentially Interested in Using the Postponement Principle

- High value density of products
- Product cube and/or weight increases through customization

Market Characteristics

- Short product life cycles
- High sales fluctuations
- Short and reliable lead times
- Price competition
- Varied markets and customers[23]

Consolidation

Creating large shipments from small ones (consolidation) is a powerful economic force in strategic planning. It results from the substantial economies of scale that are present in the transport cost-rate structure. Managers can use this concept to improve strategy. For example, customer orders arriving at a warehouse might be combined with orders received later. This would increase the size of the average shipment, which in turn would lower average per-unit shipping costs. Potentially reduced customer service resulting from increased delivery time must be balanced with the cost benefits of order consolidation.

[23]Ibid.

Application

A firm had a master warehouse in the Rochester, New York, area to serve a number of general merchandise stores in the eastern United States. The merchandise consisted of many items purchased in small quantities from thousands of vendors. To reduce inbound transportation costs, the company established consolidation terminals in major vendor regions. Vendors were instructed to ship the purchased quantities into the consolidation terminal. When full truckload quantities were accumulated, the company's own trucks moved the merchandise from the consolidation terminal to its master warehouse. This avoided shipping small quantities over long distances to the master warehouse, at very high per-unit transport rates.

In general, the concept of consolidation will be most useful in strategy formulation when quantities shipped are small. That is, *the smaller the shipment size, the disproportionately greater the benefits of consolidation.*

Standardization

Variety exacts its price in the logistics channel. Proliferation of product variety can increase inventories and decrease shipment sizes. Just adding a new item to the product line that is similar to an existing one can increase the combined inventory levels of both items by 40 percent or more, even though total demand does not increase. The key question in strategy formulation is how to provide the variety in the marketplace that customers desire without dramatically increasing logistics costs. The use of the concepts of standardization and postponement in combination is often effective for this problem.

Standardization in production is created through interchangeable parts, modularizing products, and labeling the same products under different brand names. This effectively controls the variety of parts, supplies, and materials that must be handled in the supply channel. The disadvantages of product variety are controlled in the distribution channel through postponement. For example, automakers create endless product variety without increasing inventories by adding or substituting options at the point of sale and creating multiple brands from the same basic components. Clothing manufacturers do not attempt to stock exact sizes that many customers require, but alter standard sizes to fit.

Selecting the Proper Channel Strategy[24]

Selecting the proper channel design greatly affects the efficiency and effectiveness of the supply chain. Fundamentally, two strategies are significant—*supply-to-stock* and *supply-to-order*. These are the end points in a mixture of alternative strategies blended to meet a variety of product and demand characteristics.

[24]Based on Marshall L. Fisher, "What Is the Right Supply Chain for Your Product?" *Harvard Business Review*, Vol. 75, No. 2 (March/April 1997), pp. 105–116.

Figure 2-8
Characteristics of Supply-to-Stock and Supply-to-Order Supply Chains

Supply Chain Type	*Channel Design Characteristics*
Efficient supply chain ***Supply-to-Stock***	• Economical production runs • Finished goods inventories • Economical buy quantities • Large shipment sizes • Batch order processing
Responsive supply chain ***Supply-to-Order***	• Excess capacity • Quick changeovers • Short lead times • Flexible processing • Premium transportation • Single order processing

A supply-to-stock strategy is one where the supply channel is set up for maximum *efficiency*. That is, inventories are used to achieve good economies by allowing economical production runs, purchasing in quantity, batch order processing, and transporting in large shipment sizes. Safety stocks are maintained to realize high levels of product availability. Demand is usually met from inventories, but careful control holds inventory levels to a minimum. In contrast, a supply-to-order strategy is one where the supply channel is set up for maximum *responsiveness*. The channel characteristics are excess capacity, quick changeovers, short lead times, flexible processing, premium transportation, and single order processing. Postponement strategies are used to delay the creation of product variety as long and as far down the supply channel as possible. The costs associated with responsiveness are offset by the minimization of finished goods inventories. A summary of the differences between the two approaches is given in Figure 2-8.

The predictability of demand and the profit margin of products are the primary determinants of supply channel choice. When products have a stable demand pattern and are therefore reasonably predictable, planning their supply is reasonably easy. Many products that have a stable demand pattern also have a mature characteristic where competition is keen and profit margins are low. These characteristics lead the logistician to design a supply channel to be as low cost as possible consistent with meeting customer service goals. Typical products that might be in the predictable category are shown in Table 2-3.

On the other hand, products that are highly unpredictable frequently carry a higher profit margin than unpredictable ones. See examples in Table 2-3. They are often innovative, are new product developments, and incorporate new technology; therefore, they command a higher return. There is less of an historical basis for estimating their sales level. Even some products that have been in product lines for many years display demand that is highly variable, or lumpy. Low volume items are typical of these. Unless the products are low valued, there is an economic disincentive to

Table 2-3
Classification of Products

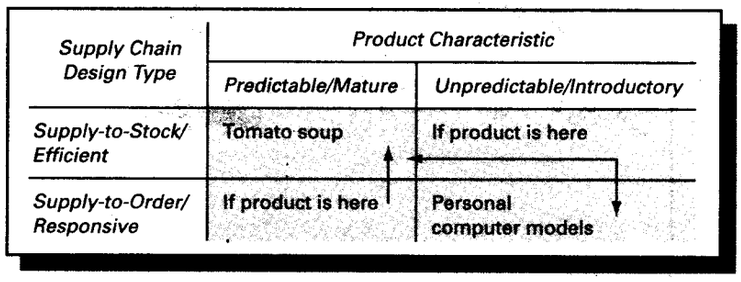
Predictable/Mature Products	Unpredictable/Introductory Products
• Gelatin desserts	• New CDs
• Corn flakes	• New computer games
• Lawn fertilizer	• High-fashion clothes
• Ballpoint pens	• Artwork
• Lightbulbs	• Movies
• Auto replacement tires	• Consulting services
• Some industrial chemicals	• New product offerings of existing product lines
• Tomato soup	

maintain inventories of these products to meet the uncertain demand. The better strategy is to respond quickly to demand at the time that it occurs, not from inventories but from production processes or from vendors. Applying the supply-to-stock design to the unpredictable product class results in excessive finished goods inventories needed to maintain adequate product availability levels, increased product cycle times resulting from batch production or quantity purchasing, and slow deliveries resulting from shipment consolidation. A responsive design avoids the long delivery times and/or excessive inventories by meeting demand as it occurs.

In fashioning the right strategy, it is necessary to categorize correctly existing items in a product line. Once this has been done, they should be matched to their supply chain design as shown in Figure 2-9. When there is a mismatch, two options are available. First, an attempt can be made to change the product characteristics. For an unpredictable product, an improved forecast method may be sought so that a supply-to-stock design is appropriate. Second, the type of supply chain design may be changed. A supply-to-stock design used for an unpredictable product may be changed to a supply-to-order, or responsive, design. On the other hand, a product categorized as predictable but being supplied under a responsive design can be changed to the efficient design. It is doubtful that a predictable product would be moved to the unpredictable category.

General guidelines have been provided to select the proper supply chain design; however, some mismatching of product characteristics to design type may be tolerated. Some products may have highly unpredictable demand, but their low value and low margin suggests that holding extra inventory resulting from poor forecasting, or

Figure 2-9
Actions for Misclassified Products



highly variable replenishment lead times, is justified. Responsive design requiring careful management is not warranted. Similarly, products with predictable demand do not need to be moved from a responsive to an efficient design if there is no benefit from lower channel costs or higher customer service.

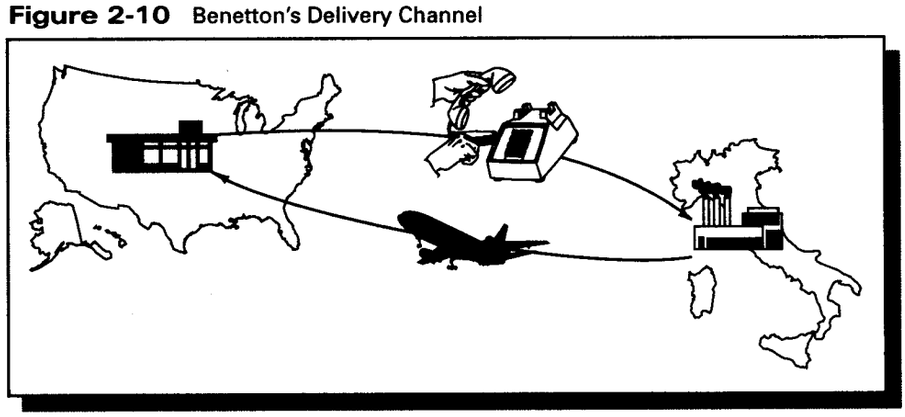
Consider how Benetton, an Italian clothing manufacturer and retailer best known for its colorful sweaters, introduced a supply-to-order strategy at its stores in a traditional supply-to-stock retail environment to reduce inventory obsolescence and increase sales. Sweater sales have been unpredictable, but because of long lead times from manufacturers, retailers took their best guess at sales and stocked accordingly. The principle of postponement plays an important role in the supply-to-order strategy whereby yarns and often sweaters are made up in a "gray" state ready for final knitting and dying to the finished color.

Example

Benetton, the Italian sportswear company, has knitting as its core. Located in Ponzano, Italy, Benetton makes and distributes 50 million pieces of clothing worldwide each year. They produce mostly sweaters, slacks, and dresses.

Benetton, found that the fastest way to run a distribution system is to create an electronic loop linking sales agent, factory, and warehouse, as illustrated in Figure 2-10. If, say, a salesperson in one of Benetton's Los Angeles shops finds that she is starting to run out of a best-selling red sweater in early October, she calls one of Benetton's 80 sales agents, who enters the order in his personal computer, which sends it to a mainframe in Italy. Because the red sweater was originally created on a computer-aided design system, the mainframe has all its measurements on hand in digital code, which can be transmitted to a knitting machine. The machine makes the sweaters, which factory workers put in a box with a bar code label containing the address of the Los Angeles store, and the box goes into the warehouse. That's right—one warehouse serves Benetton's 5,000 stores in 60 countries around the world. It cost $30 million, but this distribution center, run by only eight people, moves 230,000 pieces of clothing a day.

Figure 2-10 Benetton's Delivery Channel



Once the red sweaters are sitting snugly in one of 300,000 slots in the warehouse, a computer sends a robot flying. By reading the bar codes, the robot finds the right box and any other boxes being shipped to the Los Angeles store, picks them up, and loads them onto a truck. Including manufacturing time, Benetton can get the order to Los Angeles in four weeks. If the warehouse already has red sweaters in stock, it takes one week. That's quite a performance in the notoriously slow garment industry, where hardly anyone else will even bother with reorders. And if Benetton suddenly realizes that it didn't make any, say, black cardigans and purple blouses this year and they're hot, it can manufacture and ship a "flash collection" of black cardigans and purple blouses in huge quantities in a few weeks.[25]

Measuring Strategy Performance

Once supply chain strategies are planned and implemented, managers want to know if they are working. Three measures are useful to monitor this: cash flow, savings, and return on investment. If all are positive and substantial, the strategies are probably working well. These financial measures are of particular interest to top management.

Cash Flow

Cash flow is the money that a strategy generates. For example, if the strategy is to decrease the amount of inventory in a supply channel, then the money released from the inventory carried as an asset is turned into cash. This cash can then be used to pay salaries or dividends, or can be invested in other areas of the business.

Savings

Savings refer to the change in all relevant costs associated with a strategy. These savings contribute to period profits of the business. A strategy that changes the number and location of the warehouses in a logistics network will affect transportation, inventory carrying, warehousing, and production/purchase costs. A good network design strategy will produce a significant annual costs savings (or, alternately, a customer improvement that contributes to revenue growth). These savings appear as a profit improvement on a business's profit and loss statement.

Return on Investment

Return on investment is the ratio of the annual savings from the strategy to the investment required by the strategy. It indicates the efficiency with which capital is being used. Good strategies should show a return greater than or equal to the expected return on a company's projects.

[25]"How Managers Can Succeed Through SPEED," *Fortune*, February 13, 1989, pp. 54–59. © 1989 The Time Inc. Magazine Company. All rights reserved.

Application

A company was looking to consolidate its warehouses from 19 to four locations. The current system of warehouses had grown due to the company's aggressive merger program, resulting in warehouses not suited to the revised geographic demand profile. In addition, improvements in transportation allowed carriers to deliver products at farther distances in shorter time. As a result, fewer warehouses might save costs while preserving customer service.

Analysis of the four-warehouse strategy revealed substantial improvement in the three performance measures. It was reported to top management that cash flow would increase by $59 million, mainly due to inventory reduction. Profits would improve since a reduction in distribution costs would annually save $20 million dollars. Finally, because only one new warehouse was required and little moving expense was anticipated, the projected return on investment was 374 percent. Top management was pleased and the strategy was implemented.

Concluding Comments

This chapter has attempted to lay down a framework for planning the logistics network. The plan begins with a vision of where the company as a whole wishes to go and an outline of its competitive strategy. This vision is converted into specific plans for the functional areas of the firm, of which logistics is one.

Logistics strategy is typically formed around three goals: cost reduction, capital reduction, and service improvement. Depending on problem type, strategies may range from long to short time periods. Planning usually takes place around four key areas: customer service, location, inventories, and transportation. The network of links and nodes serves as an abstract representation of the planning problem.

Suggestions were given as to when the planning should be undertaken. Several principles and concepts were laid down that can prove useful to formulating effective logistics strategies. Finally, guidelines for selecting the right supply chain design were discussed.

Questions

1. You plan to start a company that will produce household furniture (sofas, chairs, tables, and the like). Outline a corporate strategy for competing in the marketplace. What logistics strategy might you derive from your corporate one?
2. Suppose in your company that you are responsible for distributing Taiwanese beer throughout the European Union. Suggest a distribution network that meets the three individual goals of cost reduction, capital reduction, and service improvement. Contrast each of these designs and suggest what you think would be a good balanced design.

3. Sketch a network diagram of the logistics systems you think would be appropriate for the following companies:
   a. A steel company supplying sheet steel to auto manufacturers.
   b. An oil company supplying heating fuel to the northeastern United States.
   c. A food company distributing canned goods to a domestic market.
   d. A Japanese electronics firm distributing television sets in Europe.
4. Consider the problem of locating a company-owned warehouse that will serve as a regional distribution point for its line of housewares.
   a. Describe the planning process that the logistician might follow to decide where to locate the warehouse.
   b. Which environmental factors are most important in this decision?
   c. What should the goals be for this problem—cost minimization, capital minimization, or service maximization?
   d. How should the logistician proceed with implementing the chosen plan, and how should the performance of the plan be controlled once it has been implemented?
5. Explain the meaning of strategic planning for a logistics system. Selecting several companies of your choice, discuss which activities should be included and why. How would you distinguish tactical and operational planning from strategic planning?
6. Describe as many cost trade-offs as you can that a logistics manager might encounter in strategic planning.
7. Describe the principle of differentiated distribution. Explain how it is illustrated in the following situations:
   a. Total distribution costs are minimized if back orders on field warehouse inventories are filled from plant inventories. Premium transportation is used to ship back orders directly from plant to customers.
   b. The product items stocked in a warehouse are grouped so that different stock availability levels are set for each of the groups.
   c. All products are grouped according to an *ABC* classification scheme, where *A* items have high sales volume, *B* items have moderate sales volume, and *C* items have low sales volume. *A* items are stocked in field warehouses, *B* items are stocked in regional warehouses, and *C* items are stocked only at plant locations.
8. The Savemore Grocery Company is a chain of 150 supermarkets. The stores in the chain are supplied from a central distribution center. The company uses only privately owned trucks to make these deliveries. How is this possibly a violation of the principle of mixed strategy?
9. Explain how the following situations illustrate the principle of postponement.
   a. Toothpaste is shipped in bulk quantities to warehouses close to markets where sales in the area determine the package size of the final product.
   b. A paint manufacturer ships "brights," or unlabeled product, into its warehouses. Labeling equipment in the warehouse commits the product to the final brand.
10. Describe how automakers routinely practice standardization in their distribution channels.

11. What economic facts form the basis for the principle of consolidation? As shipment sizes become smaller, why is this principle more effectively applied? Describe a situation where consolidation has substantial economic benefits.
12. A battery manufacturer ships unmarked product from its factory to a warehouse along with labels and cartons. As customer orders are received for private-label or company-label batteries, the warehouse places the appropriate labels on the products and ships them in the proper cartons. What concept is the battery manufacturer applying, and what advantages is he likely to realize?
13. The traffic manager of the Monarch Electric Company has just received a rate-reduction offer from a trucking company for the shipment of fractional horsepower motors to the company's field warehouse. The proposal is a rate of $3 per hundredweight (cwt.) if a minimum of 40,000 pounds is moved in each shipment. Currently, shipments of 20,000 pounds or more are moved at a rate of $5 per cwt. If the shipment size falls below 20,000 pounds, a rate of $9 per cwt. applies.

    To help the traffic manager make a decision, the following additional information has been gathered:

Annual demand on warehouse	5,000 motors per year
Warehouse replenishment orders	43 orders per year
Weight of each motor, crated	175 lb per motor
Standard cost of motor in warehouse	$200 per motor
Stock replenishment order handling costs	$15 per order
Inventory carrying costs as a percentage of average value of inventory on hand for a year	25 percent per year
Handling cost at warehouse	$0.30 per cwt.
Warehouse space	unlimited

    Should the company implement the new rate?
14. What are the differences between a supply-to-stock and a supply-to-order supply channel design? When is the use of each appropriate?
15. Describe why you think the sales of the following products are predictable or unpredictable.
    a. Coca-Cola
    b. A music compact disc release of a new artist
    c. Lightbulbs
    d. Custom-fitted bicycles

    Discuss what the supply channel characteristics should be for each product in terms of production processes, transportation services, inventory levels, order processing, and vendor responsiveness.
16. What differences are there, if any, between logistics management and supply chain management?
17. You are planning to start a mail-order business that will sell moderately priced clothing for short men and petite women. Local clothing stores, your major competition, carry a limited selection of sizes for this market, and have little opportunity to obtain items not in their immediate stock. Some customers appreciate the chance to try on clothes and listen to the advice of the salespeople, but are often frustrated by the limited selection. You feel that you have a price advantage

because of low overhead (only order takers and order fillers make up the staff, and the warehouse is in a low rent district).

What strategy can you formulate that will allow you to compete effectively with local retailers?

18. Storck is a German producer of candies, of which the best-known brand names are Werther's, Riesen, and Golden Best. All production takes place in Europe; in fact, Storck is the largest consumer of sugar in Europe. Storck USA imports its candy products to the United States through an East Coast port and distributes them to retail and distribution outlets such as Wal-Mart, CVS Pharmacy, McLane, Target, Tri-Cor Distributors, and Winn-Dixie. Sales in the United States are about $100 million. Distribution currently takes place through a few public warehouses and some pool points. Consolidation among the retailers and a repositioning of their warehouses, shifts in demand levels, and the need to correct some customer degradation in order to protect market share have led to reevaluating the U.S. distribution system.

    Considering common logistics strategies that might maximize return on logistics assets (ROLA), what distribution system design can you propose that will generally meet each of this goal?

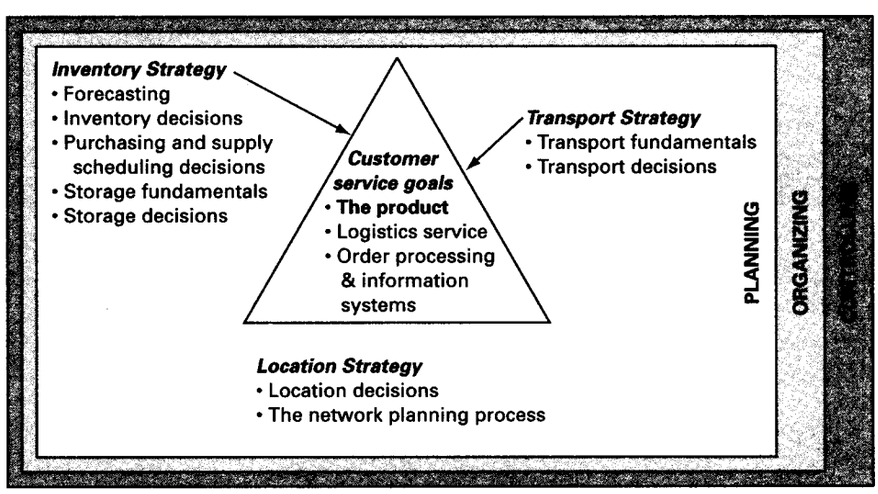
Chapter 3

The Logistics/Supply Chain Product

[redacted]

—Lieutenant General William Pagonis

The logistics/SC product is a collection of characteristics that can be manipulated by the logistician. To the extent that product characteristics can be shaped and reshaped to better position them for the marketplace, a competitive advantage can be created. Customers respond with their patronage.



The product is the center of focus in logistics system design because it is the object of flow in the supply chain, and, in its economic form, it generates the firm's revenues. A clear understanding of this basic element is essential to formulating good logistics system designs. It is the reason for exploring the product's basic dimensions, as represented by its characteristics, package, and price, as an element of customer service in the design of logistics systems.

Nature of the Logistics/SC Product

According to Juran, a product is the outcome, or result, of any activity or process.[1] The product is composed of a physical part and an intangible part which together make up what is called a company's total product offering. The physical portion of the product offering is composed of characteristics such as weight, volume, and shape as well as features, performance, and durability. The intangible part of the product offering may be after-sales support, company reputation, communication to provide correct and timely information (e.g., shipment tracking), flexibility to meet an individual customers needs, and recovery to rectify mistakes.[2] Any company's total product offering will be a mixture of both physical and service characteristics.

Classifying Products

Depending on who will use the product, the logistics system design should reflect the different use patterns. Broad product classifications are valuable for suggesting logistics strategy and, in many cases, for understanding why products are supplied and distributed in the manner that they are. One traditional classification is to divide goods and services into consumer products and industrial products.

Consumer Products

Consumer products are those that are directed to ultimate consumers. Marketing people have long recognized the basic differences in the way consumers go about selecting goods and services, and where they buy them. A threefold consumer products classification has been suggested: convenience products, shopping products, and specialty products.

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

[1]Joseph M. Juran, *Juran on Leadership for Quality* (New York: The Free Press, 1989).
[2]Tommy Carlsson and Anders Ljundberg, "Measuring Service and Quality in the Order Process," *Proceedings of the Council of Logistics Management* (San Diego; Council of Logistics Management, 1995), pp. 315–331.

require wide distribution through many outlets. Distribution costs are typically high but are more than justified by the increased sales potential that is brought about by this wide and extensive distribution. Customer service levels, as expressed in terms of product availability and accessibility, must be high to encourage any reasonable degree of customer patronage for the products.

Example

PepsiCo and Coca-Cola recognize that their soft drink products are convenience goods. Therefore, one channel of distribution is through vending machines located just about anywhere people may congregate.

As a result, public telephones are located widely and conveniently throughout the land as are cellular telephone towers, which are now replacing many of the public telephone sites.

Initially, the cellular phone companies in India provided only one mode to recharge their prepaid connections. This was through dialing the interactive voice response (IVR), followed by the 16-digit recharge code on the scratchable silver panel of the recharge cards, which came for fixed denominations with an expiry date. All this required complex supply chain operations. Now, most of the firms offer a cafeteria of options some of which allow recharging for any amount and suiting individual customer preferences. For example, Hutchison Essar users in Mumbai can recharge their cards in a number of ways.[3] They may just walk to the dealer and tell him the amount they wish to recharge their Hutch prepaid card with. Their card will be recharged instantly. They do not even need to dial the IVR. Similarly, they may use SMS for recharging. If they are a customer of a large list of Indian banks, they can now recharge their prepaid card anytime, anywhere, and for any amount via ATM or SMS. Of course, the earliest system of dialing through IVR also continues but its use is on decline. Hutchison Essar Limited, with about 18.4 million[4] subscribers, is one of the most reputed telecom companies in India.

Shopping products are those for which consumers are willing to seek and compare: shopping many locations; comparing price, quality, and performance; and making a purchase only after careful deliberation. Typical products in this category are high-fashion clothes, automobiles, home furnishings, and medical care. Because of the customer's willingness to shop around, the number of stocking points is substantially reduced as compared with convenience goods and services. An individual supplier may stock goods or offer services in only a few outlets in a given market area. Distribution costs for such suppliers are somewhat lower than for convenience products, and product distribution need not be as widespread.

[3]Available at http://www.hutch.in/prepaid/how_to_refill_mum.asp.
[4]Figures from Cellular Operators Association of India (August 31, 2006).

Example

High-level, specialized medical care is concentrated in relatively few university hospitals, clinics, and privately owned hospitals, due to the high costs of facilities, equipment, and highly trained personnel. Because patients often want the very best care possible, they are willing to seek out and travel to such places, often bypassing intervening health care providers that may be located closer to them.

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 acquire them; examples range from fine foods to custom-made automobiles, or services such as management consulting advice. Because buyers insist on particular brands, distribution is centralized and customer service levels are not as high as those 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 brand preference for their product line.

Example

Many professional musicians will go to almost any length to find the right equipment to perform their very best. For example, a clarinetist requires a reed, which is a small piece of cane that is the tone generator for the clarinet. This capricious piece of dried grass can make or break a professional musician, or so he or she thinks. One brand of reed is particularly sought. It is grown in the south of France and distributed through only one retail outlet in the United States. According to the store owner, one professional clarinetist regularly drives over 600 miles to his store to acquire a supply of this specialty good.

Industrial Products

Industrial goods and services 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. Because vendors typically seek the buyers, a classification based on shopping patterns would not be relevant.

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 that it is useful in planning a physical distribution strategy. Industrial buyers do not seem to show preferences

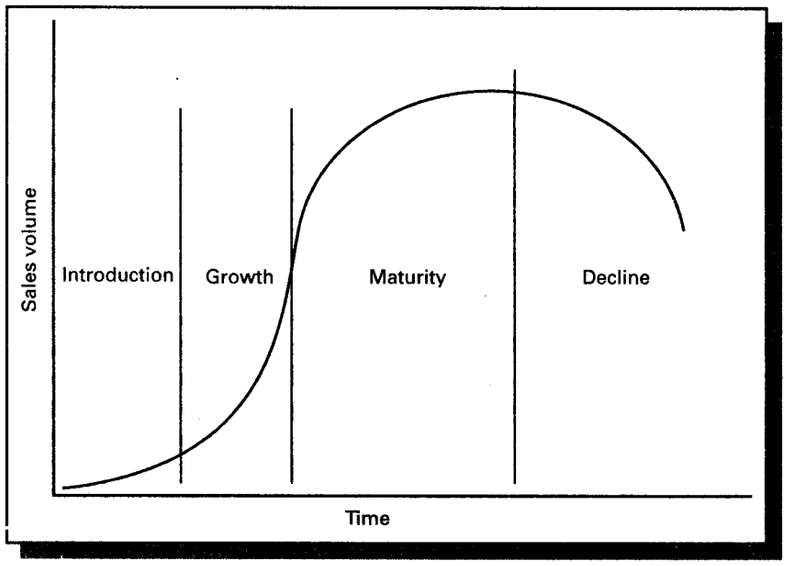


Figure 3-1 A Generalized Curve for Product Life Cycle

for different service levels for different product classes. This simply means that traditional product classifications for industrial products may not be as useful for identifying typical logistics channels as is the classification of consumer products.

The Product Life Cycle

Another traditional concept familiar to marketers is that of 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. Characteristically, products follow a sales volume pattern over time, going through four stages: introduction, growth, maturity, and decline (see Figure 3-1). The physical distribution strategy differs for each stage.

The introductory stage occurs just after a new product is introduced into the marketplace. Sales are not at a high level because there is not yet wide acceptance of the product. The typical physical distribution strategy is a cautious one, with stocking restricted to relatively few locations. Product availability is limited.

Example

When a young college graduate developed the popular board game Pictionary, a version of charades, no established manufacturing or distribution system existed. He borrowed $35,000 (from his parents) and had a limited supply of the game produced. To distribute Pictionary in this start-up phase, he hired teenagers to play the game in shopping malls and then sold them right there, to the interested passersby.

If the product receives market acceptance, sales are likely to increase rapidly. Physical distribution planning is particularly difficult in this stage. Often there is not much of a sales history to guide inventory levels at stocking points or even the number of stocking points to use. Distribution is frequently under managerial judgment and control during this expansion stage. However, product availability is also increasing rapidly over a wide geographic area in support of the growing customer interest in the product.

Example

An executive at the company distributing the Trivial Pursuit game purchased a copy of Pictionary and had his daughter and her friends play the game. Fascinated with their acceptance of the game, he arranged for the rights to its manufacture and sale. This was a wise move, as Trivial Pursuit was in the declining stage of its life cycle. Pictionary was distributed through the channels already established for Trivial Pursuit. Pictionary, in its growth stage, increased sales rapidly, becoming the best-selling board game of its time.

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 patterns 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 marketplace.

Example

The original Coca-Cola beverage, formulated by a pharmacist before the turn of the twentieth century, has been in the mature phase of its life cycle longer than about any other product. Distribution is worldwide, extending even to countries not usually considered to be open to free trade.

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 may have to be adjusted. The number of stocking points is likely to be decreased and the product stocking reduced to fewer, more centralized locations.

Examples

The Barnum and Bailey Circus once played in many cities across the nation. With changing interest patterns and competing entertainment options, demand for the circus has fallen from its previous levels. In the declining stage of its life cycle, the circus

is now booked into only a few major population centers each year so that large enough crowds can be drawn to cover costs.

The turntable, once a major piece of hardware in audio systems to play recorded music, is now taking a backseat to the compact disk player. The market has declined to sales limited to collectors and audiophiles.

The product life cycle phenomenon has an influence on distribution strategy. The logistician needs to be continually aware of a product's life cycle stage so that distribution patterns may be adjusted for maximum efficiency in that stage. The life cycle phenomenon in products allows the logistician to anticipate distribution needs and plan for them well in advance. Because a firm's different products are typically in different stages of their life cycles, the product life cycle serves as a basis for the 80-20 curve.

The 80-20 Curve

The logistics problem of any firm is the total of the individual product problems. The product line of the 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, a particularly valuable concept for logistics planning.

The 80-20 concept is derived after observation of product patterns in many firms, from the fact that the bulk of the sales is generated from relatively few products in the product line and from the principle known as Pareto's law.[5] That is, 80 percent of a firm's sales are generated by 20 percent of the product line items. An exact 80-20 ratio is rarely observed, but the disproportionality between sales and the number of items is generally true.

To illustrate, consider 14 products of a small chemical company. These products are ranked according to their sales volume, as shown in Table 3-1. A cumulative percentage of total dollar sales and of total number of items is computed. These percentages are then plotted, as in Figure 3-2, which exhibits the characteristic 80-20 curve. However, in this particular case, about 35 percent of the items account for 80 percent of the sales.

The 80-20 concept is particularly useful in distribution planning when the products are grouped or classified by their sales activity. The top 20 percent might be called *A* items, the next 30 percent *B* items, and the remainder *C* items. Each category of items could be distributed differently. For example, *A* items might receive wide geographic distribution through many warehouses with high levels of stock availability, whereas *C* items might be distributed from a single, central stocking point

[5]The 80-20 curve was first observed by Vilfredo Pareto in 1897 during a study of the distribution of income and wealth in Italy. He concluded that a large percentage of the total income was concentrated in the hands of a small percentage of the population in a proportion of roughly 80 percent to 20 percent, respectively. The general idea has found wide application in business.

Product Number	Product Rank by Sales[a]	Monthly Sales (000s)	Cumulative Percent of Total Sales[b]	Cumulative Percent of Total Items[c]	An ABC Classification
D-204	1	$ 5,056	36.2%	7.1%	
D-212	2	3,424	60.7	14.3	*A*
D-185-0	3	1,052	68.3	21.4	
D-191	4	893	74.6	28.6	
D-192	5	843	80.7	35.7	*B*
D-193	6	727	85.7	42.9	
D-179-0	7	451	89.1	50.0	
D-195	8	412	91.9	57.1	
D-196	9	214	93.6	64.3	
D-186-0	10	205	95.1	71.4	
D-198-0	11	188	96.4	78.6	*C*
D-199	12	172	97.6	85.7	
D-200	13	170	98.7	92.9	
D-205	14	159	100.0	100.0	
		$13,966			

[a] Ranked according to sales volume
[b] Sum of item sales ÷ total sales, e.g., (5,056 + 3,424) ÷ 13,966 = 0.607
[c] Item rank ÷ total number of items, e.g., 6 ÷ 14 = 0.429

Table 3-1 ABC Classification of 14 Products of a Chemical Company

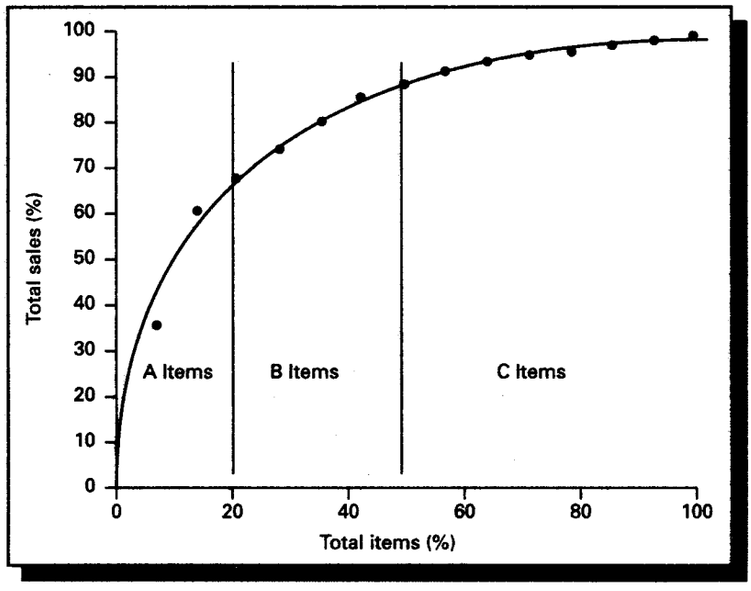


Figure 3-2 The 80-20 Curve with an Arbitrary *ABC* Product Classification

Source: Chemical company data from Table 3-1.

(e.g., a plant) with lower total stocking levels than for the *A* items. *B* items would have an intermediate distribution strategy where few regional warehouses are used.

Another frequent use of the 80-20 concept and an *ABC* classification is to group the products in a warehouse, or other stocking point, in a limited number of categories where they are then managed with different levels of stock availability. The product classifications are arbitrary. The point is that not all product items should receive equal logistics treatment. The 80-20 concept with a resulting product classification provides a scheme, based on sales activity, to determine the products that will receive various levels of logistics treatment.

For analytical purposes, it is useful to describe the 80-20 curve mathematically. Although a number of mathematical equations might be used, the following relationship has been suggested.[6]

$$Y = \frac{(1 + A)X}{A + X} \tag{3-1}$$

where

Y = cumulative fraction of sales
X = cumulative fraction of items
A = a constant to be determined

The constant A may be found by manipulating Equation (3-1) to give

$$A = \frac{X(1 - Y)}{Y - X} \tag{3-2}$$

where the relationship between Y and X is known. For example, if 25 percent of the items represent 70 percent of the sales, then, from Equation (3-2)

$$A = \frac{0.25(1 - 0.70)}{0.70 - 0.25}$$
$$= 0.1667$$

Equation (3-1) can be used to determine the relationship between various percentages of items and sales.

[6]Paul S. Bender, "Mathematical Modeling of the 20/80 Rule: Theory and Practice," *Journal of Business Logistics*, Vol. 2, No. 2 (1981), pp. 139–157.

If the relationship is to be established on actual sales item data, the constant A can be found by using the least squares curve fitting procedure. This means solving the following expression:

$$\sum_{i}^{N} \frac{Y_i X_i - Y_i X_i^2}{(A + X_i)^2} - \sum_{i}^{N} \frac{(1 + A)(X_i^2 - X_i^3)}{(A + X_i)^3} = 0$$

where Y_i and X_i are individual data pairs in a total sample size of N. The value for A is then determined through successive approximations. Constructing a small computer program to do these computations works nicely. When this technique was applied to the data in Table 3-1, an A value was found to be 0.143.

Example

Consider how the 80-20 rule is useful in estimating inventory levels. Suppose that a certain warehouse is to store 11 of the 14 items shown in Table 3-1. The same general relationship is expected to hold, that is, $X = 0.21$ and $Y = 0.68$, or 21 percent of the items result in 68 percent of the sales. Solving Equation (3-2) yields $A = 0.143$. A different inventory policy is maintained for different product groups. The turnover ratio (that is, annual sales/average inventory) for *A* items is 7 to 1, for *B* items 5 to 1, and for *C* items 3 to 1. If the annual sales through the warehouse are forecast to be $25,000, how much inventory investment in the warehouse can be expected?

The items stocked at the warehouse are shown in Table 3-2. They are the same as those in Table 3-1 except for items 5, 8, and 9, which were selected to not be included. The remaining items are ranked according to their relative sales level, highest to lowest. The cumulative item proportion is determined from $1/N$ for the first item, $2(1/N)$ for the second, $3(1/N)$ for the third, and so on. The constant (A) is found from Equation

Table 3-2 Warehouse Inventory Investment Estimation Using the 80-20 Curve

Product		Item No.	Cumulative Item Proportion (X)	Cumulative Sales (Y)	Projected Item Sales	Turnover Ratio	Average Inventory
D-204	*A*	1	0.0909[a]	$11,105	$11,105	7	
D-212		2	0.1818	15,994	4,889	7	
					$15,994		$2,285[c]
D-185-0	*B*	3	0.2727	18,745	2,751[b]	5	
D-192		4	0.3636	20,509[d]	1,764	5	
D-193		5	0.4545	21,736	1,227	5	
D-179-0		6	0.5454	22,639	903	5	
					$ 6,645		$1,329
D-195	*C*	7	0.6363	23,332	693	3	
D-198-0		8	0.7272	23,879	547	3	
D-199		9	0.8181	24,323	444	3	
D-200		10	0.9090	24,691	368	3	
D-205		11	1.0000	25,000	309	3	
					$ 2,361		$ 787
					$25,000		$4,401

[a] $1/N = 1/11 = 0.0909$
[b] $18,745 - 15,994 = 2,751$
[c] $\$15,994/7 = \$2,285$
[d] $[(1 + 0.143)(0.3636)/(0.143 + 0.3636)] \times [25,000] = \$20,509$

(3-2), or $A = [0.21(1 - 0.68)]\,[0.68 - 0.21] = 0.143$. The cumulative sales proportion is found by applying Equation (3-1), using $A = 0.143$. The sales for the first item would be

$$Y = \frac{(1 + 0.143)(0.0909)}{(0.143 + 0.0909)} = 0.4442,$$

which is the fraction of total warehouse sales represented by the first item, that is, $(0.4442 \times \$25{,}000) = \$11{,}105$. The procedure is repeated for each item in the list. The projected item sales is the difference between cumulative sales for successive items.

Average inventory value is then found by dividing the projected item sales by the turnover ratio for the item. The sum of the item inventory values is $4,401, which is the investment expected in the warehouse inventory.

PRODUCT CHARACTERISTICS

The most important characteristics of the product that influence logistics strategy are the attributes of the product itself—weight, volume, value, perishability, flammability, and substitutability. When observed in various combinations, these characteristics are an indication of the need for warehousing, inventories, transportation, materials handling, and order processing. These attributes can best be discussed in four categories: weight-bulk ratio, value-weight ratio, substitutability, and risk characteristics.

Weight-Bulk Ratio

The ratio of product weight to bulk (volume) is a particularly meaningful measure, as transportation and storage costs are directly related to them. Products that are dense, that is, have a high weight-bulk ratio (e.g., 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 (e.g., inflated beach balls, boats, potato chips, and lamp shades), the bulk capacity of transportation equipment is fully utilized 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.

The effect of varying weight-bulk ratios on logistics costs is shown in Figure 3-3. As the product density increases, both storage and transportation costs decline as a percentage of the sales price. Although price may also be reduced by lower storage and transportation costs, they are just two cost factors among many that make up price. Therefore, total logistics costs can decline faster than price.

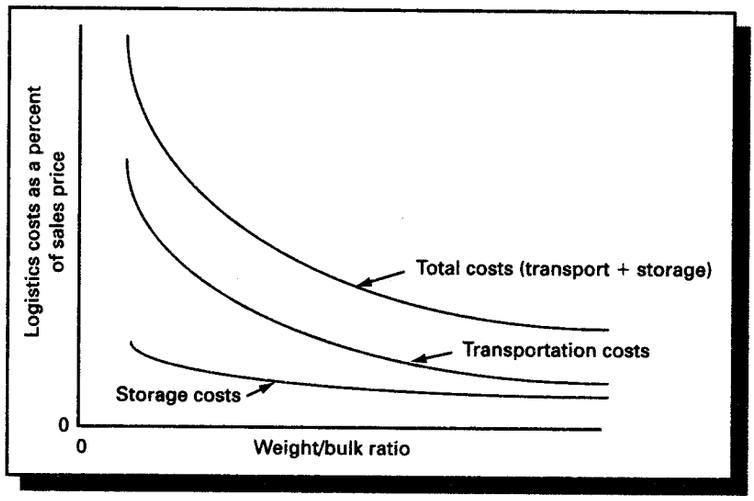


Figure 3-3 Generalized Effect of Product Density on Logistics Costs

Examples

J. C. Penney ships catalog furniture items in a knocked-down condition to reduce the packaged product bulk and lower transportation costs, but this practice forces assembly on the customer.

A steel storage rack manufacturer ships knocked-down racks to a forward assembly point in the distribution channel, where cross members are welded onto the frame and the product bulk is increased as close to the marketplace as possible. Again, transportation costs are reduced through controlling the weight-bulk ratio in this manner.

Shirdi Industries of Mumbai is a professionally managed, dynamic, interior solutions company. It is engaged in the manufacture and import of furniture inputs and accessories. It achieved a net profit of Rs. 4.5 crore on a turnover of Rs. 52.7 crore in 2005–2006. Manufacturing, presently, accounts for less than 23 percent of the company's total revenues. The company is setting up a manufacturing facility for decorative laminates, multiple-density fiber, and particleboards. It is planning to introduce furniture in completely knocked-down kits for the housing market.[7]

XL Telecom, Secunderabad, in association with Axesstel Inc., of California has secured a Rs. 98-crore tender from Bharat Sanchar Nigam Limited (BSNL) for supply of 3.65 lakh Axesstel L800 fixed wireless desktop phones. Axesstel will supply the phones in semi- knocked down form while XL Telecom will assemble the kits, load the required software into the phones, test the products, and distribute to various BSNL depots.[8]

[7]Available at http://www.asisindia.com.
[8]*Business Standard* (April 6, 2006).

Further, most Indian auto manufacturers either import or export knocked-down components and sub-assemblies, which are then assembled locally in close proximity of final assembly. For example, Hindustan Motors Limited intends to launch the Mitsubishi car in India by the end of 2007. It is likely to import the car in semi-knocked condition and assemble it at the plant in Tamil Nadu.[9] Bajaj Auto Limited has received clearance from the Government of Indonesia for setting up its manufacturing facility in that nation. The company has formed a joint venture with a local Indonesian who would be picking up a five-percent stake in the venture while Bajaj Auto will hold 95 percent. The joint venture will initially import completely knocked-down kits from India and assemble them in Indonesia.[10] On similar lines, Mahindra & Mahindra (M&M) plans to secure 10 percent of the Australian tractor market by 2009. The company has set up a unit in Australia to assemble completely knocked-down kits.[11]

Value-Weight Ratio

The dollar value of the product being moved and stored is important to storage costs since those costs are particularly sensitive to it. When product value is expressed as a ratio to weight, some obvious cost trade-offs emerge that are useful in planning the logistics system. Figure 3-4 shows the trade-off.

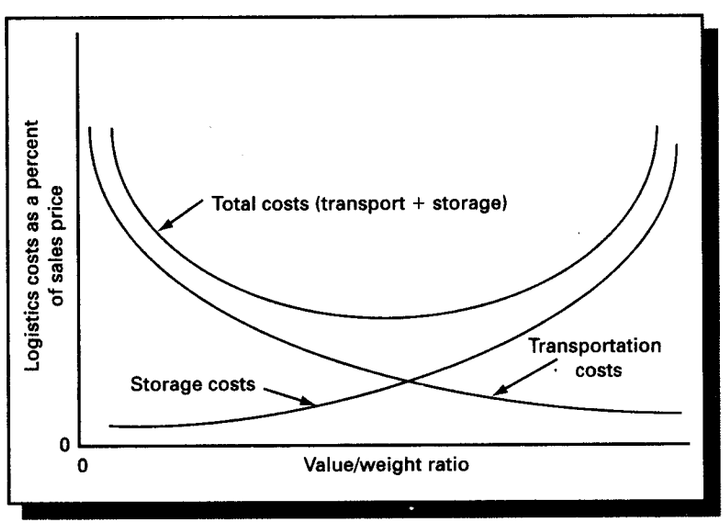


Figure 3-4
Generalized Effect of Product Dollar Density of Logistics Costs

[9]Available at http://www.hindmotor.com/collaborations.asp.
[10]*Business Line* (July 16, 2006), p. 3.
[11]*Business Standard* (June 29, 2006).

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

High value-weight ratio products (e.g., electronic equipment, jewelry, and musical instruments) show the opposite pattern, with higher storage and lower transport costs. This results in a U-shaped total logistics cost curve. Hence, firms dealing with low value-weight ratio products frequently try to negotiate more favorable transportation rates (rates are generally lower for raw materials than for finished products of the same weight). If the product has a high value-weight ratio, minimizing the amount of inventory maintained is a typical reaction. Of course, some firms attempt to adjust an unfavorable value-weight ratio by changing accounting procedures to alter value or by changing packaging requirements to alter weight.

Substitutability

When customers find little or no difference between a firm's product and those of competing suppliers, the products are said to be highly substitutable. That is, the customer is readily willing to take a second-choice brand when the first is not immediately available. Many food and drug products have a highly substitutable characteristic. As might be expected, suppliers spend great sums of money attempting to convince customers that such generic products as aspirin tablets and laundry soaps are not all alike. Distribution managers try to provide product availability at a level so that customers will not have to consider a substitute product.

In large part, the logistician has no control over a product's substitutability, yet he or she must plan for the distribution of products with varying degrees of substitutability. Substitutability can be viewed in terms of lost sales to the supplier. Higher substitutability usually means a greater chance for a customer to select a competing product, thus resulting in a lost sale for the supplier. The logistician generally deals with lost sales through transportation choices, storage choices, or both. To illustrate, consider Figure 3-5.

Figure 3-5(a) shows that improved transportation can be used to reduce lost sales. For a given average inventory level, a supplier can increase the speed and dependability of product deliveries and lower the incidence of loss and damage. The product becomes more readily available to the customer, and fewer product substitutions by the customer are likely to occur. Of course, the higher cost of premium transportation is in trade-off with the cost of lost sales. Figure 3-5(b) shows the same type of cost trade-off, except that the stock availability to the customer is controlled through the inventory level, with the transportation choice remaining constant.

In either case, the logistician is in a prime position to control the impact of product substitutability on the firm's profits.

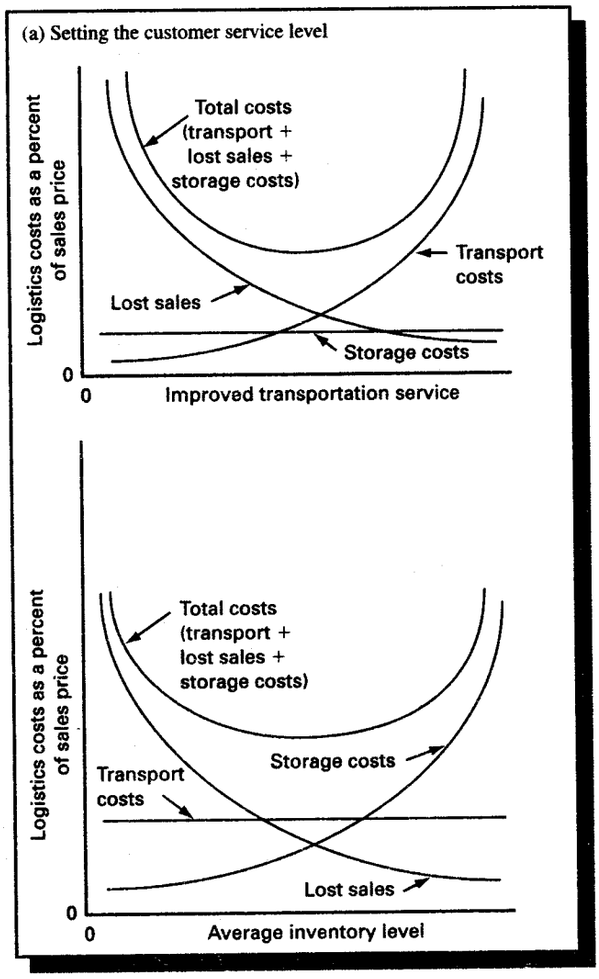


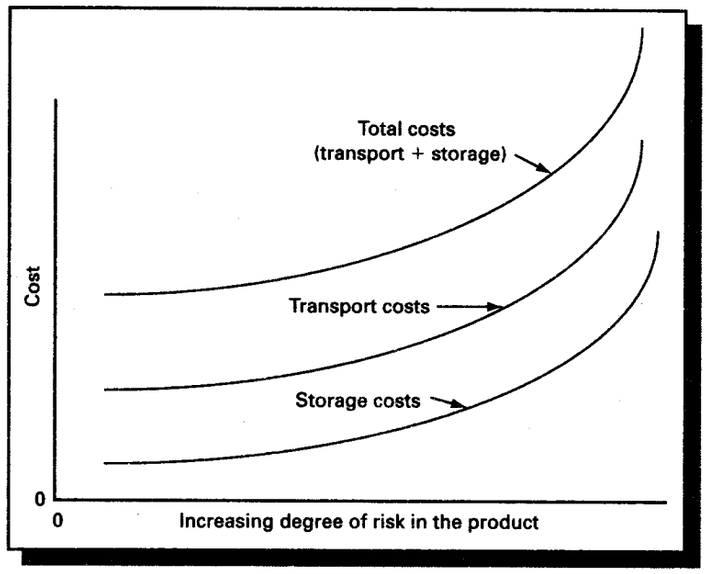
Figure 3-5
Generalized Effect of Transportation Service and Average Inventory Level on Logistics Costs for a Product with a Given Degree of Substitutability

Risk Characteristics

Product risk characteristics refer to features such 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 certain restrictions on the distribution system. Both transport and storage costs are higher in absolute dollars and as a percentage of the sales price, as shown in Figure 3-6.

Consider products, such as pens, watches, or cigarettes, that have a high risk of being stolen. Special care must be taken in their handling and transport. Inside warehouses, special fenced-in and locked areas are set up to handle these and similar

Figure 3-6
Generalized Effect of Product Risk on Logistics Costs



products. Highly perishable products (e.g., fresh fruits and whole blood) require refrigerated storage and transportation, and products that may have a tendency to contaminate fresh food products, such as automobile tires, cannot be stored near them in a warehouse. Whether in transportation, storage, or packaging, special treatment adds to the cost of distribution.

PRODUCT PACKAGING

With the exception of a limited number of items, such as raw materials in bulk, automobiles, and furniture items, most products are distributed in some kind of packaging. There are a number of reasons why a packaging expense is incurred. The reason may be to:

- Facilitate storage and handling
- Promote better utilization of transport equipment
- Provide product protection
- Promote the sale of the product
- Change the product density
- Facilitate the use of the product
- Provide reuse value for the customer[12]

[12]Adapted from Theodore N. Beckman, and William R. Davidson, *Marketing*, 8th ed. (New York: Ronald Press, 1967), p. 444.

Not all of these objectives can be met through logistics management. However, changing product density and protective packaging are of concern in this area. The need for changing product density to achieve more favorable logistics costs has already been discussed (recall Figure 3-3).

Protective packaging is a particularly important dimension of the product for logistics planning. In many respects, it is the package that must be the focus of planning, with the product itself of secondary concern. It is the package that has shape, volume, and weight. The product may not have the same characteristics. The point is that if a television set were removed from its shipping carton and replaced with shock-testing equipment, as is frequently done to test for damage during rough handling, the logistician would not treat the shipment differently, assuming that the change was not known. The package gives a revised set of characteristics to the product.

The protective package is an added expense that is counterbalanced with lower transportation and storage rates as well as fewer and less extensive damage claims. The logistician brings these costs into balance while working closely with sales and engineering to achieve the overall objectives for packaging.

Logistical considerations in package design can be important for marketing to achieve its objectives. Controlling product density can be critical to the success of a product.

Example

Johnson & Johnson identified a significant market among women for a product to handle incontinence. Using the technology developed for diapers, Johnson & Johnson created Serenity, a boat-shaped, cuplike product, packaged 12 or 24 to the box. When marketing personnel reviewed the product, the concern was that its bulky nature would limit sales. The product would have to compete for restricted shelf space in retail stores, causing frequent stockouts, thus limiting its exposure to customers. The logistics staff came through with the answer: *Change the product density*. By folding the product in half and further collapsing it in a pouch package, the size of the resulting box was less than one-half of its former dimensions. Not only did this satisfy marketing's shelf-space concern, it also saved on storage, transportation, and packaging costs.

These days Indian fast-moving consumer-goods (FMCG) companies are employing the services of professional industrial designers to give their product packaging a new look and design. The computational tools used by the designers help in changing the graphical designs of the existing products. The companies have to take care about the material used, texture, transparency, spillage, breakage during transportation, when a product packaging is being decided. The three-dimensional drawing created by using the CAD software gives an accurate view of the product design and immediate feedbacks can be obtained from the R&D department, retailers, and dealers. This is likely to help the FMCG companies to be competitive and fight for shelf space in supermarkets. They spend 7 percent of the total product development cost in design packaging.[13]

[13] *Express Computers* (March 13, 2006), p. 5.

PRODUCT PRICING

Along with quality and service, price also represents the product to the customer. Although the logistician is usually not directly responsible for setting price policy, he or she does have influence on pricing decisions. This is because product price often has a relationship to geography and because incentive prices often are pegged to transportation rate structures.

Pricing is a complex decision-making problem involving economic theory, buyer behavior theory, and theory of competition, among others. The discussion here is limited to methods of pricing that are geographically related and to incentive pricing arrangements that are derived from logistics costs.

Geographic Pricing Methods

Customers are not concentrated at a single point for most suppliers, but are usually dispersed over wide areas. This means that the total cost to distribute to them varies with their location. Pricing should be simple then? Not so! Companies can have customers numbering in the hundreds of thousands. Administering separate prices becomes overly burdensome as well as costly. Choice of a pricing method depends in part on balancing the detail in the pricing structure with the costs of managing it. There are a limited number of categories that define most geographic pricing methods. These pricing categories are f.o.b., zone, single or uniform, freight equalization, and basing point.

F.O.B. Pricing

To understand geographic pricing, it is best to begin by considering the f.o.b. pricing options. In a dictionary sense, f.o.b. stands for "free on board." In a practical sense, this policy simply denotes the location at which the price is effective. F.o.b. factory means that the price is quoted at the factory location. F.o.b. destination means that the price is quoted at the customer's location or in the vicinity. It is also implied that the customer takes title to the goods at the point designated. There are a great many alternatives under f.o.b. pricing. F.o.b. factory and f.o.b. destination are the most popular.

The *f.o.b. factory price* is a single price established at the factory location (shipment origin). Customers take ownership of the goods at this point and are responsible for transportation beyond this point. As a practical matter, the customers may have the suppliers make the shipping arrangements simply because the supplier may be better equipped and more skilled at it, or may be able to obtain lower shipping costs by combining the orders of several customers. Customers are then billed for the actual transportation costs.

Example

Automobiles are price-quoted at the factory or port of entry with a destination (transportation) charge in an amount depending on where the customer (automobile dealer) is located.

The *f.o.b. destination,* or *delivered price* is the price to the customer's location or in the general vicinity. Under this policy, transportation costs are already included in the price. It is expected that the supplier will make all of the transport arrangements. This policy recognizes that the supplier may be in a position to handle transportation more economically than the customer, or that the customer does not possess the desire or expertise to make such arrangements. There may be a net transportation cost advantage to the buyer if the buyer has insufficient shipping volume to secure transportation rates as low as those available to the supplier.

Example

Burger King prices its fast foods to the customer at the point of retail sale. All transportation charges for acquiring the products' raw materials are already included in the prices.

Many combinations of f.o.b. factory and destination pricing are possible, depending on how freight charges are paid. A variety of these arrangements is shown in Figure 3-7.

Zone Pricing

For those companies that must deal with thousands of customers, it is not necessarily the wisest policy to establish a different price for each customer. Suppliers of finished goods often cannot afford the administrative complexity of individual prices. Also, prices overall may have to be somewhat higher to support the cost of the complex administrative structure.

Zone pricing reduces administrative complexity by establishing a single price within a wide geographic area. Any number of areas may be defined, depending on the degree to which a company may want geographic price differences. For example, the Ball Corporation, a manufacturer of home canning equipment, created 89 geographic pricing zones throughout the country.

To illustrate zone pricing on a less grand scale, consider the pricing policy of Colonial Originals,[14] a manufacturer of colonial furniture in kit and finished form sold through a catalog and a Web site. The company is located in Boston. The furniture items are priced at Boston with a shipping charge added. This is a form of f.o.b. factory pricing, with the supplier arranging transportation. The variation is that the country is divided into eight zones according to postal zip code designations to achieve gradations in transportation costs. The prices effective for various zones throughout the country for a tavern table weighing 30 pounds and priced at

[14] A disguised name.

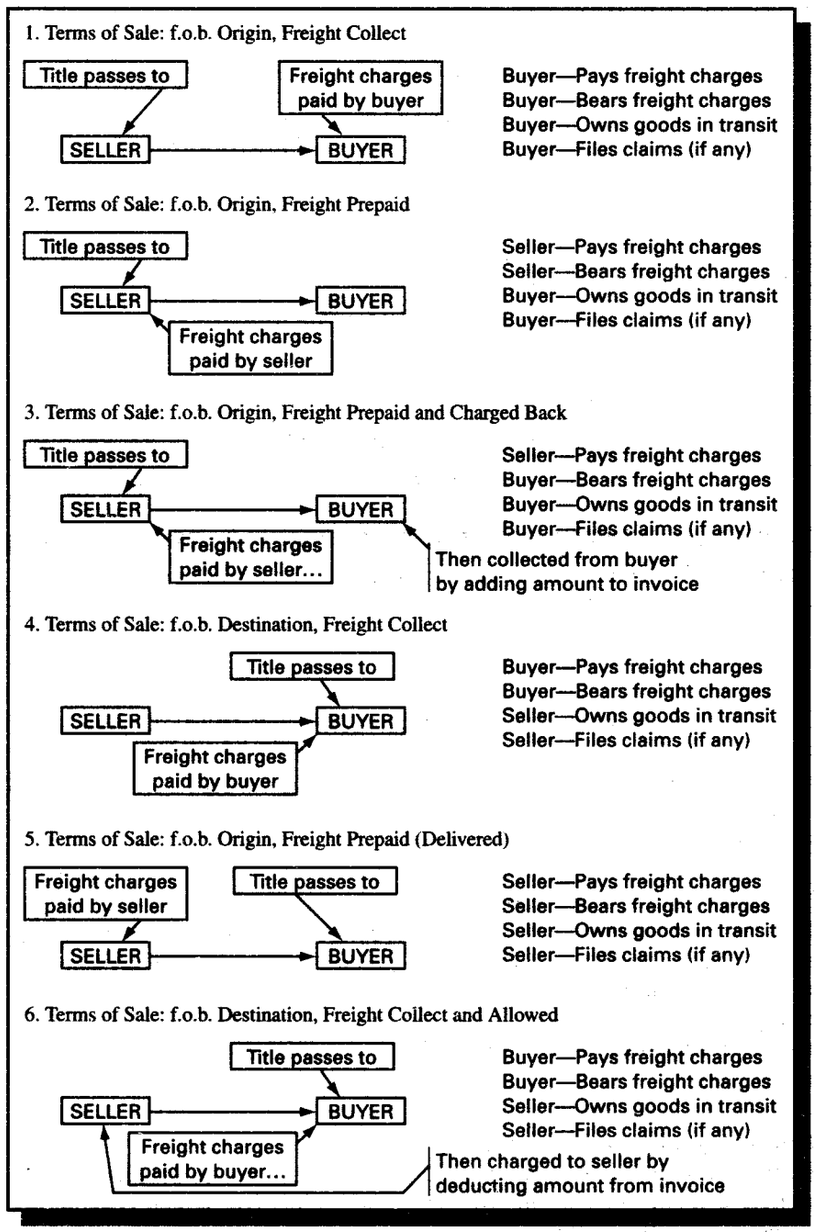


Figure 3-7 The Variety of F.O.B. Pricing Arrangements

Source: Edward J. Marien, "Making Sense of Freight Terms of Sale," *Transportation & Distribution* (September 1996), pp. 84–86.

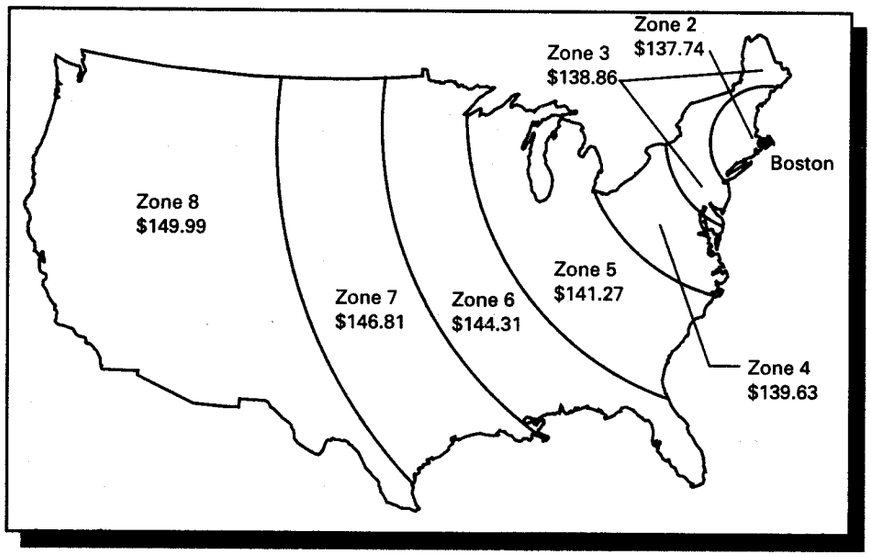


Figure 3-8 Zone Prices for a Tavern Table Shipped from Boston
Source: Table 3-3 and f.o.b. Boston table price.

$129.95 at the factory can be derived from Table 3-3. This table gives the shipping rates for each zone, by weight, for United Parcel Service's ground residential delivery service. The customer has a choice. Note that UPS has no zone 1. Using the table, the effective zone prices across the country may be developed for the tavern table (Figure 3-8).

Single, or Uniform, Pricing

The ultimate in pricing simplicity would be to have a single price for all customers, regardless of their location. This pricing method is used for many fair-trade items, first-class mail, and books. There is a certain appeal to customers in knowing that the same price for a product is charged everywhere. However, such a pricing policy masks the differences in costs of distributing to different customers. Such costs must be averaged.

Freight Equalization Pricing

The practical concerns of competition have an impact on pricing strategy. If two firms have equal efficiency in producing and selling, which results in the same product cost at the factory locations, then competitive pricing is a matter of transportation costs. If the markets are not equidistant from each factory location, the firm farthest from the marketplace may wish to absorb enough of the freight charges to meet the

price competition. This practice is referred to as *freight equalization* and results in different net returns for the firm engaging in it. Transportation as well as production costs across a number of producing locations are averaged.

Basing Point Pricing

As with freight equalization, the motives behind basing point pricing are competitive. Basing point pricing establishes some point other than the one from which the product is actually delivered as the point from which to compute price. Price is computed as if the product were delivered from the basing point. If the location chosen is the location of a major competitor, prices can be forced to be similar to the competitor's at every geographic customer location. This new location for price computation is referred to as a *basing point*. Firms may use single or multiple basing points.

The steel and cement industries were early leaders in the use of the basing point pricing method. This is understandable because basing point pricing is attractive when (1) the product has a high transportation cost relative to its overall value; (2) there is little preference among buyers as to the supplier of the product; and (3) there are relatively few suppliers and any price cutting leads to retaliation by rival firms. From the customer's perspective, the industries are located at the same points. Because this is in fact not true, the actual cost of supplying a given customer by each firm is different. Then how can a firm charge the same prices?

Some Legal Concerns

Whenever a pricing method generates prices that are not in line with the cost of producing, selling, and distributing the product, certain legal considerations result. For the logistician, unless actual transportation costs are reflected in the product to each customer, there is a degree of price discrimination. Single, zone, freight equalization, and basing point pricing methods are inherently discriminatory. For example, if the same price is charged throughout a zone, those customers nearest the point from where the goods are being delivered absorb more than their share of the transportation costs, or they are paying for some "phantom" freight. Those customers in the farthest reaches of the zone are subsidized. The extent of the freight subsidizing depends on zone size.

Although some methods of geographic pricing can be discriminatory, some discrimination can benefit all customers even though the benefits may not be uniform. The reduced costs associated with administering fewer prices may be enough to offset the phantom freight charges to the least favorably located customer.

The Federal Trade Commission has challenged some delivered pricing policies and freight absorption policies. However, such policies are not necessarily illegal as long as the seller is willing to sell on an f.o.b. basis at the purchaser's request; the seller maintains uniformity of price at all delivered points, as in the case of a single national price policy; the price after freight absorption is higher than that of a competitor; and the buyers and/or their customers are noncompetitive.

Table 3-3 Zone Shipping Rates from Boston (Zip Code 010) for United Parcel Service Residential Ground Service

Shipping Charges—To find shipping charges, first find in the Zone Chart the zone number that corresponds to the delivery destination zip code. Then, for the weight of the shipment, in the Shipping Charges chart find the charges that correspond to the zone number.

Zone Chart						Shipping Charges							
First 3 Digits of Zip Code	Zone No.	First 3 Digits of Zip Code	Zone No.	First 3 Digits of Zip Code	Zone No.	Weight Not to Exceed	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
004–005	2	300–322	5	550–555	6	1 lb.	$4.16	$4.27	$4.50	$4.56	$4.75	$4.79	$4.90
010–041	2	323–325	6	556–559	5	2 lb.	4.23	4.43	4.77	4.88	5.17	5.27	5.53
042–046	3	326	5	560–576	6	3 lb.	4.32	4.59	4.98	5.14	5.44	5.59	6.01
047	4	327–339	6	577	7	4 lb.	4.44	4.74	5.19	5.41	5.71	5.85	6.33
048–049	3	341–342	6	580–585	6	5 lb.	4.58	4.88	5.38	5.62	5.92	6.12	6.65
050–079	2	344	5	586–593	7	6 lb.	4.73	5.01	5.53	5.83	6.13	6.39	6.92
080–086	3	346–349	6	594–599	8	7 lb.	4.88	5.13	5.64	5.99	6.34	6.60	7.18
087–128	2	350–353	5	600–634	5	8 lb.	5.02	5.26	5.75	6.10	6.50	6.86	7.61
129–132	3	354	6	635	6	9 lb.	5.15	5.39	5.85	6.21	6.66	7.18	8.03
133–135	2	355–362	5	636–639	5	10 lb.	5.29	5.50	5.96	6.37	6.88	7.61	8.51
136	3	363–367	6	640–676	6	11 lb.	5.43	5.63	6.07	6.52	7.14	8.09	9.04
137–139	2	368	5	677–679	7	12 lb.	5.57	5.77	6.17	6.68	7.41	8.57	9.63
140–142	3	369	6	680–689	6	13 lb.	5.70	5.92	6.27	6.79	7.72	9.04	10.22
143	4	370–374	5	690–693	7	14 lb.	5.81	6.07	6.37	6.90	8.10	9.52	10.79
144–146	3	375	6	700–729	6	15 lb.	5.92	6.23	6.46	7.06	8.47	10.00	11.38
147	4	376–379	5	730–736	7	16 lb.	6.01	6.40	6.62	7.27	8.85	10.47	11.97

148–149	3	380–381	6	737	6	17 lb.	6.10	6.58	6.78	7.53	9.25	10.96	12.56
150–165	4	382–385	5	738–739	7	18 lb.	6.19	6.77	6.99	7.85	9.64	11.43	13.13
166–179	3	386–397	6	740–749	6	19 lb.	6.30	6.96	7.21	8.17	10.03	11.92	13.72
180–181	2	399	5	750–754	7	20 lb.	6.42	7.15	7.42	8.49	10.42	12.34	14.31
182	3	400–410	5	755–757	6	21 lb.	6.55	7.34	7.64	8.81	10.81	12.76	14.89
183	2	411–412	4	758–797	7	22 lb.	6.68	7.53	7.86	9.13	11.22	13.18	15.47
184–187	3	413–427	5	798–799	8	23 lb.	6.82	7.72	8.09	9.39	11.61	13.67	16.06
188	2	430–449	4	800–812	7	24 lb.	6.96	7.91	8.31	9.66	12.00	14.14	16.64
189–199	3	450–454	5	813–815	8	25 lb.	7.10	8.07	8.54	9.93	12.39	14.63	17.23
200–205	4	455–458	4	816–820	7	26 lb.	7.24	8.24	8.75	10.19	12.78	15.05	17.76
206–208	3	459–479	5	821	8	27 lb.	7.37	8.39	8.99	10.46	13.17	15.47	18.29
209	4	480–489	4	822–828	7	28 lb.	7.51	8.56	9.23	10.74	13.58	15.90	18.88
210–214	3	490–491	5	829–874	8	29 lb.	7.65	8.72	9.46	11.03	13.97	16.38	19.46
215	4	492	4	875–877	7	30 lb.	7.79	8.91	9.68	11.32	14.36	16.86	20.04
216–219	3	493–499	5	878–880	8	40 lb.	9.07	10.71	11.97	14.23	18.09	21.64	25.72
220–241	4	500–505	6	881	7	50 lb.	10.05	12.36	13.99	17.00	21.10	26.05	30.73
242	5	506–507	5	882–883	8	60 lb.	10.91	13.42	15.47	18.98	23.44	28.18	33.38
243–279	4	508–516	6	884	7	75 lb.	27.43	29.26	31.13	31.90	33.93	36.68	39.76
280–282	5	520–539	5	885–898	8	100 lb.	40.88	42.39	42.76	44.01	46.58	47.90	50.50
283–285	4	540	6	900–961	8	125 lb.	50.02	51.69	52.33	53.05	56.40	58.26	60.86
286–299	5	541–549	5	970–994	8	150 lb.	59.05	60.99	61.89	62.09	66.24	68.62	71.23

Source: Zones and shipping charges from Internet Web site for United Parcel Service, http://www.ups.com.

INCENTIVE PRICING ARRANGEMENTS

Logistics costs are often a driving force behind price incentives. Two common types of price incentives are the quantity discount and the "deal."

Quantity Discounts

Economic theory teaches that the more goods that are handled during a single transaction, the lower the cost on a per-unit basis. The principle is known as *economies of scale*, where fixed costs spread over an increasing number of units reduce per-unit costs. This idea has led many firms to use purchase volume as a way of offering lower prices to buyers and increasing the supplier sales. The buyer benefits from a lower price if the larger purchase can be absorbed, and the supplier benefits through increased profits.

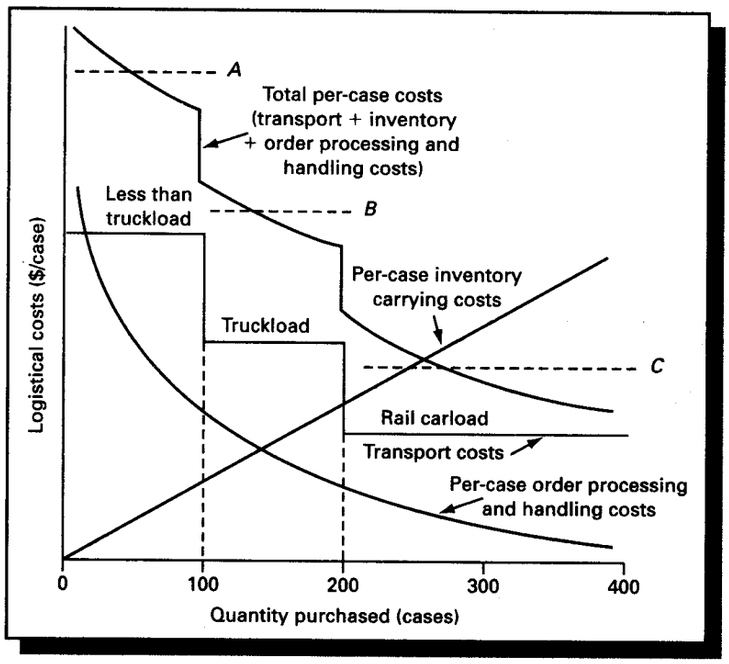
Legal restrictions have complicated the use of quantity discounts as a sales stimulant. Some firms are discouraged from using them altogether. The thrust of the Robinson-Patman Act, directed at competitive practices, is that it is unlawful to discriminate in price between different buyers if the effect is to lessen competition or to create a monopoly. Quantity discounts potentially create this discrimination but can be justified in terms of the cost savings obtained in the manufacturing, selling, and delivery activities. In practice, it is difficult to argue convincingly that cost savings in manufacture and sale in fact take place on a by-sale basis. Logistics costs, on the other hand, which are largely composed of transportation costs, have well-known volume-cost breaks. If transportation is purchased outside a company, documentation of the cost savings is readily available in public records. Hence, logistics costs become a key factor in support of a discount schedule, as can be illustrated in the following example for a manufacturer of glass products.

Example

Glass jars used for home canning are sold primarily through distributors. These distributors may purchase in various case quantities. The component costs of total logistics costs for the manufacturer are shown as they vary with the quantity purchased in Figure 3-9. Transportation costs are the key to determining at what quantity the price break will occur and how large the price break will be.

If fewer than 100 cases are purchased at any one time, the order must be shipped at less-than-truckload rates. With the addition of inventory-carrying costs needed to support an order of that size and the per-unit costs of handling the order, the total per-unit costs would average out to be A in Figure 3-9. Purchasing in quantities ranging from 100 to 199 cases allows for truckload rates and a total average per-unit cost of B. Purchasing in quantities of 200 cases or more up to a practical limit of 400 cases has an average total cost of C. Therefore, if price were brought in line with costs, no price discounts would be offered for a purchase order of 0–99 cases. The maximum discount for the purchase of 100–199 cases would be $(A - B)/A$. If A is \$2.20/case and B is \$2.00/case, the transportation costs could be reduced by $(2.20 - 2.00)/2.20 = .09$, or 9 percent. For the range of 200 to 400 cases, with an average cost of C or

Figure 3-9
Per-Case Logistics Costs As a Justification for Price Discounts



$1.70/case, the discount on transportation costs could be as much as $(A - C)/A$, or $(2.20 - 1.70)/2.20 = .23$, or 23 percent. If the remaining manufacturing and sales costs, including markup, of $10 per case are now added to logistics costs, the price to the purchaser would be

Quantity Cases	Purchase Price, $/case	Price Discount; %
0–99	$12.20	0%
100–199	12.00	1.6[a]
Over 200	11.70	4.1

[a](12.20 – 12.00)/12.20 = 0.016, or 1.6%

THE DEAL

Occasionally, some companies offer reduced product prices for a short time in exchange for larger than normal purchase quantities from its customers. A selling company may wish to reduce its inventories, maintain output levels, or encourage sales as the motivation for lowering price. From the buyer's perspective, whether to accept purchases under the price incentive and how

much to buy if it does requires trading off the benefit of the price reduction with costs that it incurs, which are generally logistical in nature. The buyer must weigh the effect of a larger than normal buying quantity with its benefit of lower price against common logistics costs of transportation, inventory carrying, and storage. Determining the size of the special buying quantity is discussed in Chapter 10.

Concluding Comments

Understanding the nature of a product, whether it is a good or a service, in its economic environment provides useful insights for logisticians planning a strategy for supply and distribution. Therefore, this chapter has examined such important concepts as product classification, product life cycle, the 80-20 curve, and a set of product characteristics.

Product classification helps to group products according to how customers behave toward them. Customers of finished goods require different logistics services than do industrial customers. Even customers within the same customer class have marked differences in service needs. Often, a good distribution strategy can be obvious from a careful identification and classification of the product.

The product life cycle describes the sales activity level that most products achieve over time. The four life cycle stages—introduction, growth, maturity, and decline—are well documented. Each stage may require a different distribution strategy.

The 80-20 curve expresses the relationship that 80 percent of a firm's sales are derived from 20 percent of its product items. This curve is simply a result of the products being in different stages of their life cycles. This disproportionality between sales and the number of products becomes very useful when deciding where to locate products within the distribution system and which products should be inventoried at any given stocking point.

The product characteristics focus on certain physical and economic features of the product that influence logistics system design to a substantial extent. These characteristics are weight-bulk ratio, value-weight ratio, substitutability, and risk.

Two additional dimensions of the product have been discussed: (1) the package, which can alter a product's physical characteristics and, therefore, the requirements for a distribution system and (2) with customers dispersed geographically and costs varying on a geographic basis, certain pricing aspects of the product are of concern to the logistician. Although the logistician normally might not be concerned with pricing matters, the fact that incentive pricing is perhaps more easily justified on the grounds of logistics cost than any other forces him or her into the pricing arena.

QUESTIONS

1. Indicate whether you think the following types of firms handle convenience, shopping, or specialty goods.
   a. Jack Spratt's Woodwind Shop sells musical instruments and supplies nationwide, to professional woodwind musicians.
   b. Hart, Schaffner, and Marx produces and sells, nationally, top-of-the-line, ready-to-wear men's suits.
   c. Edward's Bakery produces and sells, regionally, a line of baked goods, mainly bread. Distribution is primarily through food retail chain stores.

   Describe what you think an efficient distribution system should be in each case, as might be dictated by the product characteristics in each situation.
2. Contrast the product life cycle of a brand of laundry detergent with that of the works of a contemporary artist. Suggest how the physical distribution of these might be handled at each stage of their life cycles.
3. A drug retailer has two ways that he can replenish his shelf merchandise: directly from vendors or through the company's warehouse. Items with high sales volume and high replenishment quantity usually have a cost advantage if they can be purchased directly from vendors because no extra warehouse storage and handling are required. The remaining items are more efficiently handled through warehousing. The retailer has heard of the 80-20 principle and thinks that it might be a useful way of separating the product line into high and low volume groups to achieve the greatest supply economies.

   There are 12 items in a particular drug class. Annual sales data have been collected as noted here.

Product Code	Dollar Sales
10732	$ 56,000
11693	51,000
09721	10,000
14217	9,000
10614	46,000
08776	71,000
12121	63,000
11007	4,000
07071	22,000
06692	14,000
12077	27,000
10542	18,000
Total	$391,000

   If the order size closely follows sales level, use the 80-20 principle to determine the items that should be purchased directly from vendors. Use 20 percent of the items as the break point.

4. Identify several products that have extreme characteristics as to weight-bulk ratio, value-weight ratio, substitutability, and risk. Some suggestions are assembled bicycles, sand for glassmaking, and prescription drugs sold at retail, but you should choose different examples. Explain how knowledge of the product's characteristics can be used to specify or alter the way in which the products are distributed.
5. Explain the role the product package plays in the design of a supply or distribution strategy.
6. Suppose that a customer were to purchase from Colonial Originals a furniture kit that has a catalog price of $99.95 and a shipping weight of 26.5 pounds.
   a. Using Table 3-3, determine the total cost of the kit if delivery is to be made by UPS residential ground service to one of the following zip code areas in the United States:
      (i) 11101, (ii) 42117, (iii) 74001, (iv) 59615
   b. What can you say about the fairness and efficiency of this pricing arrangement?
7. What is the motivation of a basic steel products manufacturer to use the freight equalization pricing method?
8. Why are uniform and zone pricing schemes fair for customers on the whole but discriminatory and unfair for a great many of them individually?
9. Why are logistics costs, and especially transportation costs, so important in developing incentive pricing arrangements?
10. Describe how transportation charges are paid under the following terms of sale:
    a. F.o.b. destination, freight prepaid
    b. F.o.b. origin, freight prepaid
    c. F.o.b. destination, freight collect and allowed
    d. F.o.b. origin, freight prepaid and charged back
    e. F.o.b. origin, freight collect

    If the pricing policy is such that a firm's customers pay for the freight, should the supplying firm consider such costs in making warehouse location, transportation service selection, and similar decisions?
11. Davis Steel Distributors is planning to set up an additional warehouse in its distribution network. Analysis of item-sales data for its other warehouses shows that 25 percent of the items represent 75 percent of the sales volume. The company also has an inventory policy that varies with the items in the warehouse. That is, the first 20 percent of the items are the *A* items and are to be stocked with an inventory turnover ratio of 8. The next 30 percent of the items, or *B* items, are to have a turnover ratio of 6. The remaining *C* items are to have a turnover ratio of 4. There are to be 20 products held at the warehouse with sales on the warehouse forecasted to be $2.6 million annually. What dollar value of average inventory would you estimate for the warehouse?
12. Beta Products is planning to add another warehouse. Ten products from the entire line are to be stored in the new warehouse. These products will be the *A* and *B* items. All *C* items are to be served out of the plant. Forecasts of annual sales that are expected in the region of the new facility are 3 million cases (*A*, *B*, and *C* items). Historical data show that 30 percent of the items account for 70 percent of

the sales. The first 20 percent of the entire line are designated as *A* items, the next 30 percent as *B* items, and the remaining 50 percent as *C* items. Inventory turnover ratios in the new warehouse are projected to be 9 for *A* items and 5 for *B* items. Each inventory item, on the average, requires 1.5 cubic feet of space. Product is stacked 16 feet high in the warehouse.

What effective storage space is needed in square feet excluding aisle, office, and other space requirements?

13. An analysis of the product line items in the retail stores of the Save-More Drug chain shows that 20 percent of the items stocked account for 65 percent of the dollar sales. A typical store carries 5,000 items. The items accounting for the top 75 percent of the sales are replenished from warehouse stocks. The remainder is shipped directly to stores from manufacturers or jobbers. How many items are represented in the top 75 percent of sales?
14. The costs associated with producing, distributing, and selling a domestically produced automotive component to Honda in Japan can be summarized as follows:

Cost Type	Cost per Unit, $
Purchased materials	25
Manufacturing labor	10
Overhead	5
Transportation	Varies by shipment size
Sales	8
Profit	5

Transportation costs vary as follows. If the purchase (shipping) quantity is 1,000 units or less, the transportation cost is $5 per unit. For more than 1,000 units but less than or equal to 2,000 units, the transportation cost is $4.00 per unit. For more than 2,000, the transportation cost is $3.00 per unit.

Construct a price schedule, assuming the vendor would like to pass the transportation economies on to the customer. Indicate the discount percentage the customer will receive through buying at various quantities.

package, providing customer service for the end user and handling the possible return of the goods.[4]

These definitions and descriptions of customer service are broad and need further refinement if we are to use them effectively.

Customer Service Elements

From a corporate-wide perspective, customer service has been viewed as an essential ingredient in marketing strategy. Marketing has often been described in terms of an activity mix of four Ps—*p*roduct, *p*rice, *p*romotion, and *p*lace, where place best represents physical distribution. Which elements constitute customer service and just how they impact on buyer behavior has been the focus of much research throughout the years.[5] Because customers cannot easily identify what motivates their behavior, precisely defining customer service will remain elusive. However, some insight can be gained through several customer surveys.

A comprehensive study of customer service, sponsored by the National Council of Physical Distribution Management,[6] identified the elements of customer service according to when the transaction between the supplier and customer took place.[7] These elements, listed in Figure 4-1, are grouped into pretransaction, transaction, and posttransaction categories.

Pretransaction elements establish a climate for good customer service. Providing a written statement of customer service policy, such as when goods will be delivered after an order is placed, the procedure for handling returns and back orders, and methods of shipment, let customers know what kind of service to expect. Establishing contingency plans for times when labor strikes or natural disasters affect normal service, creating organizational structures to implement customer service policy, and providing technical training and manuals for customers also contribute to good buyer-supplier relations.

Transaction elements are those that directly result in the delivery of the product to the customer. Setting stock levels, selecting transportation modes, and establishing order-processing procedures are examples. These elements, in turn, affect delivery times, accuracy of order filling, condition of goods on receipt, and stock availability.

Posttransaction elements represent the array of services needed to support the product in the field; to protect consumers from defective products; to provide for the return of packages (returnable bottles, reusable cameras, pallets, etc.); and to handle claims, complaints, and returns. These take place after the sale of the product, but they must be planned for in the pretransaction and transaction stages.

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[4]James E. Doctker, "Basics of Fulfillment," *Proceedings of the Council of Logistics Management* (New Orleans, LA: Council of Logistics Management, Sept. 24–27, 2000), p. 356.
[5]Francis G. Tucker, "Creative Customer Service Management," *International Journal of Physical Distribution & Logistics Management*, Vol. 24, No. 4 (1994), pp. 32–40.
[6]Renamed the Council of Logistics Management.
[7]Bernard J. LaLonde and Paul H. Zinszer, *Customer Service: Meaning and Measurement* (Chicago: National Council of Physical Distribution Management, 1976).

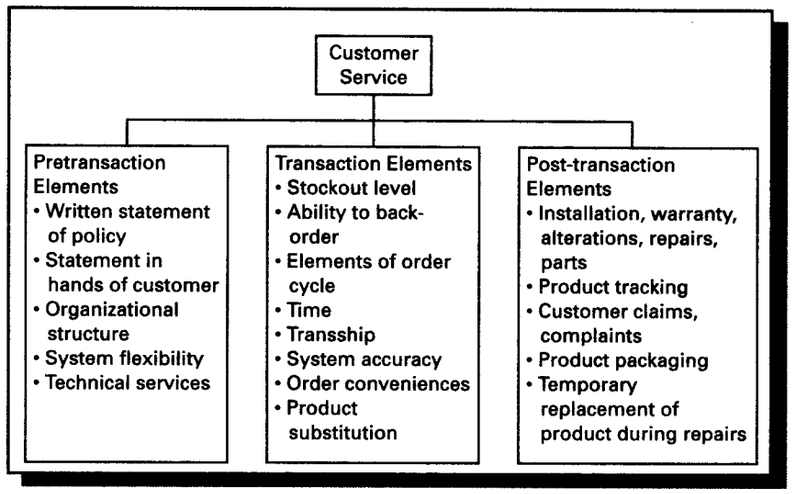

Figure 4-1 Elements of Customer Service

Source: Adapted from Bernard J. LaLonde and Paul H. Zinszer, "Customer Service As a Component of the Distribution System," Working Paper Series WPS 75-4 (Columbus, OH: The Ohio State University, College of Administrative Science, February 1975).

Corporate customer service is the sum of all these elements because customers react to the total mix. Of course, some elements are more important than others. Given this, which of the elements would seem most important to manage? Research has shown some interesting results.

Relative Importance of Service Elements

Sterling and Lambert studied the office systems and furniture industry and the plastic industry in some depth. From a large number of variables (99 and 112, respectively) representing product, price, promotion, and physical distribution, they were able to determine those that were most important to the buyers, customers, and influencers of purchases from these industries. Based on mean scores of importance, as indicated by respondents on a one to seven point scale, they rank ordered the service elements in each of these industries, as shown in Table 4-1. For the office systems and furniture industry, they concluded the following:

> The research showed that physical distribution (PD/customer service) is an integral and necessary component of the marketing mix, and that it offers a significant opportunity for firms to gain differential advantage in the marketplace. Evaluation of the 16 variables rated as most important by dealers, end users, and architectural and design firms disclosed that at least one-half were physical distribution/customer service variables.[8]

[8]Jay U. Sterling and Douglas M. Lambert, "Customer Service Research: Past, Present, and Future," *International Journal of Physical Distribution & Materials Management*, Vol. 19, No. 2 (1989), p. 17.

Table 4-1 Customer Service Variables Ranked by Order of Importance for Two Industries

Office Systems and Furniture Industry			Plastics Industry		
Mean/Std. Dev.[a]	Marketing Mix Component	Description	Mean/Std. Dev.[a]	Marketing Mix Component	Description
6.5/.8	Logistics	Ability of manufacturer to meet promised delivery date	6.6/.6	Product	Supplier's resins are of consistent quality
6.3/.8	Logistics	Accuracy in filling orders	6.5/.8	Promotion	Quality of sales force—honesty
6.2/.9	Product	Overall manufacturing and design quality relative to price	6.4/.8	Logistics	Accuracy in filling orders (correct product is shipped)
6.1/1.0	Price	Competitiveness of price	6.4/.9	Price	Competitiveness of price
6.1/1.0	Logistics	Advance notice on shipping delays	6.4/.9	Product	Processability of resin
6.1/.9	Promotion	Timely response to requests for assistance from manufacturer's representatives	6.3/1.0	Product	Supplier's resins are of consistent color
6.0/1.0	Logistics	Action on customer service complaints	6.3/.8	Logistics	Consistent lead times (vendor consistently meets expected delivery date)
5.9/1.1	Logistics	Order cycle consistency (small variability)	6.3/.9	Product	Supplier's resins are of consistent melt flow
5.9/1.0	Logistics	Accuracy of manufacturer in forecasting estimated ship dates	6.3/.9	Logistics	Ability to expedite emergency orders in a fast responsive manner
5.9/.9	Product	Overall aesthetics and finish	6.2/.9	Logistics	Information provided when order is placed—projected shipping date
5.9/1.0	Product	Continuity (nonobsolescence of products)	6.2/1.0	Logistics	Advance notice of shipping delays
5.9/1.0	Logistics	Manufacturer's willingness to accept returns of damaged products	6.1/1.0	Price	Adequate quality of resin relative to price
5.8/1.2	Logistics	Length of promised lead time for quick-ship orders	6.1/1.1	Product	Overall quality of resin relative to price
5.8/1.1	Logistics	Completeness of contract orders	6.1/1.1	Logistics	Information provided when order is placed—projected delivery date
5.8/1.1	Logistics	Completeness of quick-ship orders	6.1/1.0	Logistics	Actions on complaints (e.g., order servicing, shipping, product, etc.)
5.8/1.1	Price	Realistic, consistent pricing policy	6.1/1.0	Logistics	Length of promised lead times (from order submission to delivery—in-stock products)
			6.1/1.0	Promotion	Quality of sales force—prompt follow-up
			6.0/1.2	Logistics	Information provided when order is placed—inventory availability

[a]Scored on a scale of 1 to 7.

Source: Douglas M. Lambert and Thomas C. Harrington, "Establishing Customer Service Strategies Within the Marketing Mix: More Empirical Evidence," *Journal of Business Logistics,* Vol. 10, No. 2 (1989), p. 50.

For the plastics industry, nine of the 18 variables rated as most important were related to logistics. Of the remaining variables, five related to product quality, two to price, and two to the sales force.[9]

The Sterling-Lambert research certainly suggests that logistics customer service is dominant in the minds of customers in the office systems and furniture industry and the plastics industry. Although such a small sample of industries may not be overly convincing, others have observed the same phenomenon. In a similar study of the auto glass after market, Innis and LaLonde found that six out of the top ten customer service attributes were logistical in nature.[10] Notably, high *fill rates, frequency of delivery,* and information on *inventory availability,* projected *shipping date,* and projected *delivery date* at the time of order placement received high ratings among the retail customer base. Further, LaLonde and Zinszer found that *product availability* (order completeness, order accuracy, and stocking levels) and *order-cycle time* (order-transit time and time for assembly and shipping) were dominant in the minds of users, being most important to 63 percent of the respondents in their study.[11] Marr also surveyed a number of firms with the following conclusions:

1. Only one respondent mentioned cost of service.
2. Of the top seven elements, only one was outside the control of distribution management.
3. The most important service element was speed of delivery.[12]

Shycon Associates surveyed purchasing and distribution executives across a large cross section of American industry, asking them to rate their suppliers.[13] Figure 4-2 shows what the respondents felt were the most common service failures. Late delivery, a logistics customer service variable, accounted for nearly half of the mentioned service infractions, while product quality mistakes represented about a third.

Jackson, Keith, and Burdick were able to show how service elements take on different degrees of importance, depending on the product type being purchased.[14] They surveyed 254 purchasing agents in 25 companies about the importance of 6 physical distribution service elements. Their results are shown in Table 4-2. Again, note the relative importance of lead-time and delivery time consistency.

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[9]Thomas C. Harrington and Douglas M. Lambert, "Establishing Customer Service Strategies Within the Marketing Mix: More Empirical Evidence," *Journal of Business Logistics,* Vol. 10, No. 2 (1989), pp. 44–60.
[10]Daniel E. Innis and Bernard J. LaLonde, "Customer Service: The Key to Customer Satisfaction, Customer Loyalty, and Market Share," *Journal of Business Logistics,* Vol. 15, No. 1 (1994), pp. 1–27.
[11]LaLonde and Zinszer, "Customer Service: Meaning and Measurement."
[12]Norman E. Marr, "Do Managers Really Know What Service Their Customers Require?," *International Journal of Physical Distribution & Logistics Management,"* Vol. 24, No. 4 (1994), pp. 24–31.
[13]Steven G. Baritz and Lorin Zissman, "Researching Customer Service: The Right Way," *Proceedings of The National Council of Physical Distribution Management,* Vol. II (New Orleans, LA: October 25, 1983), pp. 608–619.
[14]Donald W. Jackson, Janet E. Keith, and Richard K. Burdick, "Examining the Relative Importance of Physical Distribution Service Elements," *Journal of Business Logistics,* Vol. 7, No. 2 (1986), pp. 14–32.

Figure 4-2
Common Customer Service Complaints

Source: Steven G. Baritz and Lorin Zissman, "Researching Customer Service: The Right Way," *Proceedings of the National Council of Physical Distribution Management*, Vol. II (New Orleans, LA: October 25, 1983), p. 611.

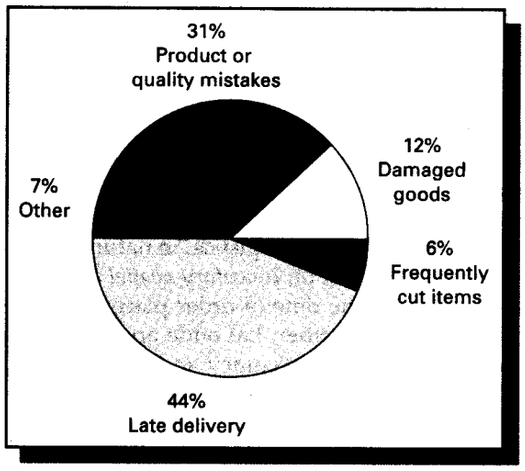


Table 4-2 Ranking of Six Physical Distribution Service Elements by Product Type (1 = Most Important)

	Product Type				
	Major Capital[a]	Minor Capital[b]	Materials[c]	Component Parts[d]	Supplies[e]
In-stock performance	2	1	3	3	1
Lead time	3	3	2	2	3
Consistency of delivery	1	2	1	1	2
Order progress information	4	5	5	5	5
Protective packaging	6	6	6	6	6
Cooperation in handling shipping problems	5	4	4	4	4

[a]Major capital items are goods that have a useful life of more than one year, do not become part of the firm's final product, and cost more than $10,000 per unit.
[b]Minor capital items are goods that have a useful life of more than one year, do not become part of the firm's final product, and cost between $1,000 and $10,000 per unit.
[c]Materials are goods that become part of the final product, but need further processing before they do.
[d]Component parts are goods that become part of the final product without further processing.
[e]Supplies are goods that do not become part of the final product, but are used to support their creation.

Source: Adapted from Donald W. Jackson, Janet E. Keith, and Richard K. Burdick, "Examining the Relative Importance of Physical Distribution Service Elements," *Journal of Business Logistics*, Vol. 7, No. 2 (1986), p. 23.

In summary, the following are considered the most important logistics customer service elements.

- On-time delivery
- Order fill rate
- Product condition
- Accurate documentation[15]

ORDER CYCLE TIME

The primary elements of customer service that the logistician can control are captured within the concept of order (or service) cycle time. *Order cycle time* can be defined as

> the elapsed time between when a customer order, purchase order, or service request is placed and when the product or service is received by the customer.

The order cycle contains all the time-related events that make up the total time required for a customer to receive an order. An illustration of the components that make up a typical order cycle is presented in Figure 4-3. Note that individual order cycle time elements are order transmittal time, order processing time, order assembly time, stock availability, production time, and delivery time. These elements are directly or indirectly controlled through choice and design of order transmittal methods, inventory-stocking policies, order processing procedures, transport modes, and scheduling methods.

The order transmittal time may be composed of several time elements, depending on the method used for communicating orders. A salesperson–electronic communication system would have an order transmittal time composed of the length of time the salesperson and the sales office retain the order before transmitting it, and the length of time the order is in the transmission channel. A customer-prepared order plus electronic transmission would have a total transmittal time essentially of a telephone call, facsimile, electronic data interchange, or Web site use. At times, it may be important to factor into order cycle time the customer's time for filling out an order or the time between salespersons' visits.

Another major component of order cycle time is the time for order processing and assembly. Order processing involves such activities as preparing shipping documents, updating inventory records, coordinating credit clearance, checking the order for errors, communicating with customers and interested parties within the company on the status of orders, and disseminating order information to sales, production, and accounting. Order assembly includes the time required to make the shipment ready for delivery after the order has been received and the order information has been made available to the warehouse or shipping department. It involves picking the order from stock, moving the order to the outbound point in the warehouse, any necessary packaging or light manufacturing, and consolidation with other orders moving

[15]James E. Keebler and Karl B. Manrodt, "The State of Logistics Performance Measurement," *Proceedings of the Council of Logistics Management* (New Orleans, LA: Council of Logistics Management, Sept. 24–27, 2002), pp. 275–281; and Robert Miller, Logistics Tip of the Week, Tips@logfac.com (January 8, 2002).

in the same direction. If no inventories are available, then processing may include manufacturing.

To a degree, order processing and assembly take place concurrently, so the total time expended for both activities is not the sum of the times required by each. Rather, both activities overlap, with order processing taking place slightly ahead of order assembly, due to error checking and initial handling of the paperwork. Shipping document preparation and inventory updating can be carried out while assembly operations occur.

Stock availability has a dramatic effect on total order cycle time because it often forces product and information flows to move out of the established channel. A normal channel may be to supply customers through a warehouse, as shown in Figure 4-3. When stock is not available in warehouse inventories, a second, or

Figure 4-3 Components of a Customer Order Cycle

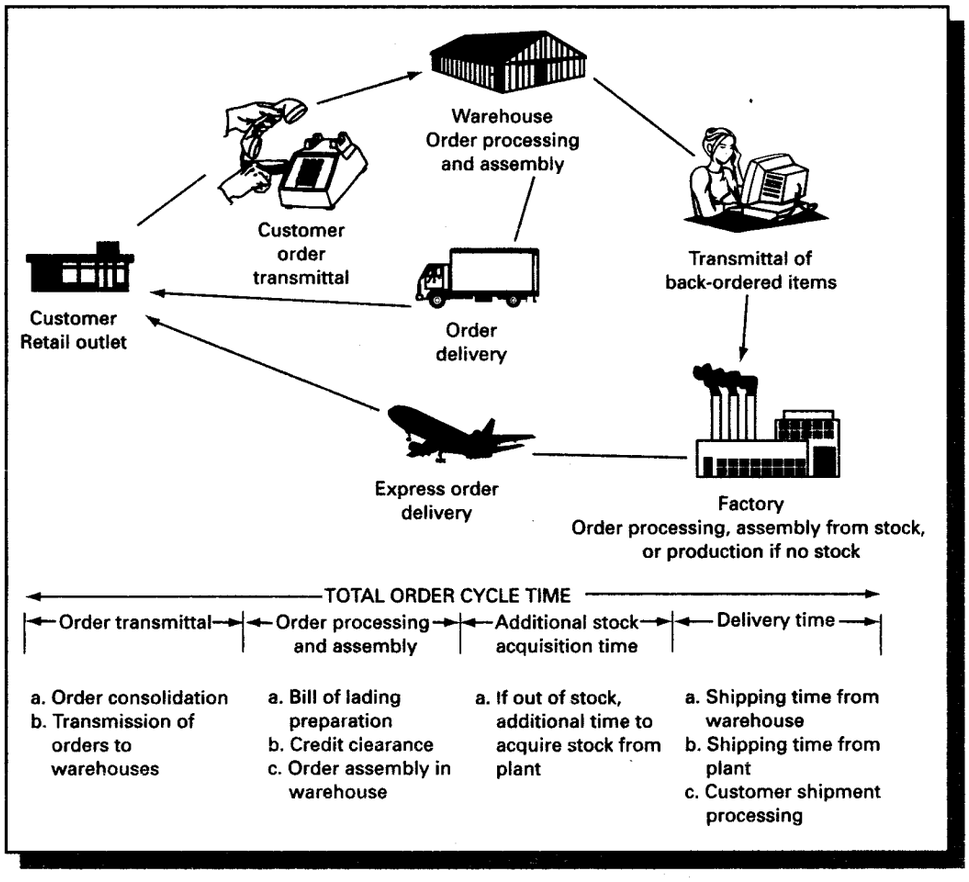
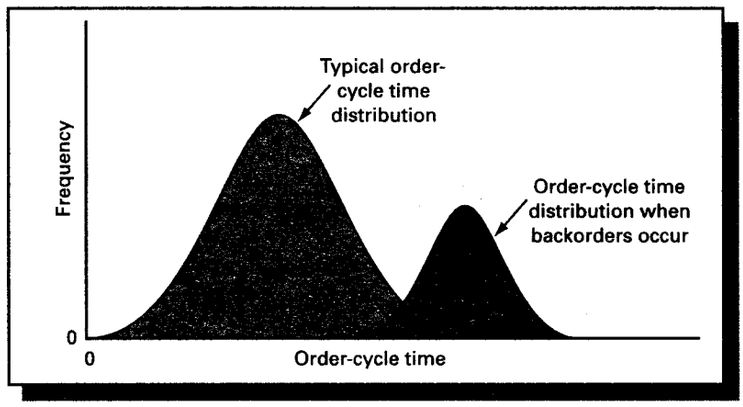


Figure 4-4
Frequency Distribution for Total Order Cycle Time When Out-of-Stock Situations Occur



backup, distribution channel may be used. For example, a back order for the out-of-stock item would be transmitted to the plant to be filled from plant stocks. If there is no plant stock available, a production order is prepared and stock is produced. Delivery is then made directly from the plant to the customer. Other possible backup systems are transshipping back-ordered goods from a secondary warehouse or simply holding back orders at the primary stocking point. The backup scheme shown in Figure 4-3 is for a specialty chemical company selling highly substitutable products.

The final primary element in the order cycle over which the logistician has direct control is the delivery time—the time required to move the order from the stocking point to the customer location. It may also include the time for loading at the origin point and unloading at the destination point.

For any one customer, the time to receive an order is expressed in terms of a bimodal frequency distribution, as shown in Figure 4-4. The frequency distribution is a result of the individual distributions for each of the order cycle elements. The second hump in the distribution reflects the longer order cycle time that can result when a significant number of out-of-stock situations occur. Order cycle time may be expressed quantitatively in such usual statistical terms as the mean, the standard deviation, and the frequency distribution form.

Example

A firm produces a product in the United States and delivers it to a stocking point in Sao Paulo, Brazil, for supplying the local customers. Order filling requires order processing, product manufacture or order filling from warehouse stocks, shipment consolidation, inland transport, ocean transport, and customs clearance. Tracing the total order cycle from stock replenishment order placement to delivery in Brazil shows the following cycle time elements and their estimated times. Constructing the

order cycle in this manner reveals that order entry and order filling at plants and warehouses are consuming the majority (50 percent) of the order cycle time and should be the target for significant order cycle time reduction.

	Time in Days		
Distribution Time Elements	Min.	Max.	Avg.
Order entry and production/warehouse processing	1	86[a]	36
Transport to consolidation point	1	5	2
Freight consolidation	2	14	7
Freight pickup	0	1	1
Transport to port	1	2	1
Vessel waiting	1	4	2
Ocean transit	17	20	18
Deconsolidation	3	4	4
Customs clearance	1	4	2
Inland transport to inventory point	0	2	1
Totals	27	142	74

[a] 90th percentile

Adjustments to Order Cycle Time

Until this point in the discussion, it has been assumed that the elements of the order cycle have been operating without constraint. At times, however, customer service policies will distort the normal order cycle time patterns. Several of these policies relate to order processing priorities, order condition, and order size constraints.

Order Processing Priorities

Order cycle time for an individual customer may vary greatly from the company standard, depending on the priority rules, or lack of them, that have been established for processing incoming orders. Distinguishing one customer from another may be necessary when backlogs occur.

Example

In processing orders from its industrial customers, a medium-size paper manufacturer noted that when order backlogs occurred and pressure was applied to reduce them, order-processing personnel had a tendency to process the smaller and less-complicated orders first. This relegated the orders from the larger and more-valued customers to a time later than they normally would have been handled. The company was increasing its order cycle time to its larger customers during periods of order backlog because arbitrary priority rules for processing orders were unconsciously being applied.