Twelfth Edition

Global Edition

CONTEMPORARY LOGISTICS
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This edition of *Contemporary Logistics* reflects a business landscape that is characterized by geopolitical tensions in various parts of the world, steadily increasing trade among countries and across continents, supply chain vulnerabilities caused by severe natural disasters, and an unabated pace of technological advancement. Although these and other events present both challenges and opportunities for logistics managers, the logistics discipline still remains fun, exciting, and dynamic—characteristics that are reflected in our revision.

**WHAT’S NEW IN THIS EDITION?**

This edition reflects input from reviewers, adopters, and other interested parties in terms of structure, presentation, and content. Specific modifications include the following:

- This edition welcomes a new coauthor, A. Michael Knemeyer, currently Associate Professor of Logistics at the Fisher College of Business, The Ohio State University. Mike’s impressive blend of practical, academic, and consulting experience in logistics and supply chain management provides this edition with fresh insights and perspectives.
- This edition contains several new end-of-chapter cases, such as Cases 9.1 (“All-Indian Logistics Services”), 10.1 (“Fresh Produce Cross-docking Facility”), and 11.1 (“The Adelaide Dairy Company”). In addition, some content has been changed in Case 14.1 (“Nürnberg Augsburg Maschinenwerke (N.A.M.)”).
- Each chapter in this edition has been revised and incorporates new examples and references. For example, Chapter 1’s discussion of the globalization of trade reports the average growth rate of world trade between 1991 and 2011 (as opposed to between 1997 and 2007 in the tenth edition). As another example, Chapter 14’s discussion of Incoterms reflects the revisions associated with Incoterms 2010, which were effective at the beginning of 2011.
- New content has been added throughout this edition. For example, Chapter 1 now includes a discussion of the rapidly emerging topic of humanitarian logistics. In addition, the “Logistics Activity Measures” section in Chapter 3 contains an expanded discussion of warehousing and inventory management performance measurements. Chapter 6 has added a subsection, “Procurement Portfolio Approach,” that highlights Kraljic’s Portfolio Matrix.
- Tables and figures containing country and industry data have been either revised or updated. Examples include Table 1-1, “The Cost of the Business Logistics System in Relation to a Country’s Gross Domestic Product”; Figure 10-3, “2012 Liberty Mutual Workplace Safety Index Findings”; and Table 12-1, “Infrastructure Statistics in Several Countries.”
- The list of Key Terms at the end of each chapter has been modified, and each key term is defined in the Glossary. New Key Terms in this edition include humanitarian logistics, big data, Logistics Uncertainty Pyramid Model, near sourcing, and total cost of ownership, among others.
- The end-of-chapter Suggested Readings in the eleventh edition have been revised and over 60 percent of them have been published since 2009.
INSTRUCTOR SUPPLEMENTS

Supplements are available for adopting instructors to download at www.pearsonglobaleditions.com/murphy. Registration is simple and gives the instructor immediate access to new titles and new editions. Pearson’s dedicated technical support team is ready to help instructors with the media supplements that accompany this text. The instructor should visit support.pearson.com/getsupport for answers to frequently asked questions and for toll-free user support phone numbers. Supplements include the following:

- Instructor’s Manual
- PowerPoint Slides

The current edition of Contemporary Logistics has been prepared by Paul Murphy and Mike Knemeyer, and they welcome your comments and suggestions at drmurphy@jcu.edu (Paul) and knemeyer.4@osu.edu (Mike). Paul and Mike gratefully acknowledge the important contributions that the late Donald F. Wood, James C. Johnson, and Daniel L. Wardlow made to earlier editions.

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Part 1 of *Contemporary Logistics* introduces the many dimensions of the complex and dynamic subject of logistics. Chapter 1 presents an overview of logistics and introduces you to what logistics is and why it is important. The chapter covers the economic impact of logistics and discusses how logistics interacts with other functions, such as marketing, in an organization.

Chapter 2 provides an overview of the general types of information management systems that are applicable across each business function, and it provides examples of how these general types of information systems are specifically applied in logistics management. Chapter 2 also explores the Internet’s influence on logistics and looks at some of the challenges associated with information technology.

Chapter 3 discusses the strategic financial outcomes influenced by logistics decisions. It uses the strategic profit model to highlight how logistics activities influence the key corporate financial measures of net income, capital employed, and return on capital employed.

Chapter 4 examines organizational and managerial issues in logistics. The chapter begins by looking at organizational structure and organizational design for logistics. Chapter 4 also discusses select managerial issues in logistics such as productivity, theft and pilferage, and the impact of terrorism on logistics systems.
ECONOMIC IMPACTS OF LOGISTICS

Although the logistics discipline today is vastly different from what it was like when the first edition of this book was published in the 1970s, one thing that remains constant is the economic impact of logistics. Before defining what logistics is, we believe it is important to discuss the economic aspects of logistics; you might be surprised at its significant economic impact. From a macroeconomic perspective, Table 1.1 presents logistics costs in relation to gross domestic product (GDP) for a select group of countries. Although absolute and relative logistics costs in relation to GDP vary from country to country, logistics is most definitely an important component in any country’s economy.

More specifically, logistics can play an important role in a nation’s economic growth and development. For example, relatively high logistics costs (as a percentage of GDP) in the People’s Republic of China (China) continue to restrict the country’s economic development; in particular, the high costs of highway transportation have severely constrained the growth of China’s e-commerce market.\(^1\) In a similar fashion, the growth of e-commerce sales in India is challenged by logistical inefficiencies to include poor roads and inferior transportation equipment.\(^2\)

Apart from the previous examples of macrolevel economic impacts, the economic impacts of logistics can affect individual consumers such as you. These impacts can be illustrated through the concept of economic utility, which is the value or usefulness of a product in fulfilling customer needs or wants. The four general types of economic utility are possession, form, time, and place; logistics clearly contributes to time and place utilities.

Possession utility refers to the value or usefulness that comes from a customer being able to take possession of a product. Possession utility can be influenced by the payment terms associated with a product. Credit and debit cards, for example, facilitate possession utility by allowing the customer to purchase products without having to produce cash or a cash equivalent. Likewise,

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automotive leases allow customers to take possession of a more desirable model than would be possible with conventional automotive loans.

Form utility refers to a product’s being in a form that (1) can be used by the customer and (2) is of value to the customer. Although form utility has generally been associated with production and manufacturing, logistics can also contribute to form utility. For example, to achieve production economies (i.e., lower cost per unit), a soft-drink company may produce thousands of cases of a certain type of soft drink (e.g., diet cola). You’re not likely to purchase diet cola by the thousands of cases (unless you’re having a really big social event!) but rather in smaller lot sizes, such as a six- or twelve-pack. Through allocation, logistics can break the thousands of cases of diet cola into the smaller quantities that are desired by customers.

Place utility refers to having products available where they are needed by customers; products are moved from points of lesser value to points of greater value. Continuing with the diet cola example, place utility is increased by moving the soda from a point of lesser value (e.g., stored in a warehouse) to a point of greater value (e.g., on a supermarket shelf).

Closely related to place utility is time utility, which refers to having products available when they are needed by customers. It is important to recognize that different products have different sensitivities to time; three-day late delivery of perishable items likely has more serious consequences than three-day late delivery of nonperishable items.

Simultaneously achieving possession, form, place, and time utility goes a long way toward facilitating—but not guaranteeing—customer satisfaction. Consider the experience of a former student who placed an online order of Valentine’s Day flowers for his out-of-state girlfriend. The seller facilitated possession utility by allowing the student to pay by credit card, and a healthy arrangement of the correct bouquet (form utility) arrived at the girlfriend’s residence on Valentine’s Day (place and time utility). Although the seller provided possession, form, place, and timely utility, the buyer was quite unsatisfied with his purchase. The problem: The greeting card that accompanied the flowers had the wrong name for the girlfriend (but the right name for the boyfriend)!

**LOGISTICS: WHAT IT IS**

Now that you have been introduced to select economic impacts of logistics, it’s important to define what logistics is. This book adopts the definition promulgated by the Council of Supply Chain Management Professionals (CSCMP), one of the world’s most prominent organizations for logistics professionals. According to the CSCMP, “Logistics management is that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customers’ requirements.”

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Let’s analyze this definition in closer detail. First, logistics is part of supply chain management. We’ll talk about supply chains and supply chain management in greater detail in Chapter 5, but the key point for now is that logistics is part of a bigger picture in the sense that supply chain management focuses on coordination among business functions (such as marketing, production, and finance) within and across organizations. The fact that logistics is explicitly recognized as part of supply chain management means that logistics can affect how well (or how poorly) an individual firm—and its associated supply chain(s)—can achieve goals and objectives.

The CSCMP definition also indicates that logistics “plans, implements, and controls.” Of particular importance is the word and, which suggests that logistics should be involved in all three activities—planning, implementing, controlling—and not just one or two. Note that the CSCMP definition also refers to “efficient and effective forward and reverse flows and storage.” Broadly speaking, effectiveness can be thought of as, “How well does a company do what it says it’s going to do?” For example, if a company promises that all orders will be shipped within 24 hours of receipt, what percentage of orders are actually shipped within 24 hours of receipt? In contrast, efficiency can be thought of as how well (or poorly) company resources are used to achieve what a company promises it can do. For instance, some companies use premium or expedited transportation services—which cost more money—to cover for shortcomings in other parts of their logistics systems.

With respect to forward and reverse flows and storage, for many years logistics focused only on forward flows and storage, that is, those directed toward the point of consumption. Increasingly, however, the logistics discipline has recognized the importance of reverse flows and storage (reverse logistics), that is, those that originate at the point of consumption. Although the majority of the discussion in this book focuses on forward logistics, many companies today recognize the tactical and strategic implications of reverse logistics. Indeed, reverse logistics continues to grow in importance as individual companies, and select supply chains, recognize it as an opportunity for competitive advantage. One illustration of this is FedEx Corporation’s (a leading logistics service provider) 2015 acquisition of GENCO, a logistics service provider with long-standing expertise in reverse logistics.

The CSCMP definition also indicates that logistics involves the flow and storage of “goods, services, and related information.” Indeed, in the contemporary business environment, logistics is as much about the flow and storage of information as it is about the flow and storage of goods. The importance of information in contemporary logistics is captured by Fred Smith, CEO and chairman of FedEx, who believes that “information about the package is as important as the package itself.” Furthermore, an important contemporary logistics and supply chain axiom involves the ability to substitute information for inventory; for example, the cash register at many contemporary retailers also tracks what and when products are being purchased.

Finally, the CSCMP definition indicates that the purpose of logistics is “to meet customer requirements.” This is important for several reasons, with one being that logistics strategies and activities should be based on customer wants and needs, rather than the wants, needs, and capabilities of manufacturers or retailers. Contemporary information technology facilitates an understanding of customer wants and needs and this technology allows for real-time interactive communication with customers—a key to meeting customer requirements.

A second reason for the importance of meeting customer requirements is the notion that because different customers have different logistical needs and wants, a one-size-fits-all logistics approach (mass logistics)—in which every customer gets the same type and levels of logistics service—will result in some customers being overserved while others are underserved. Rather, companies should consider tailored logistics approaches, in which groups of customers with similar logistical needs and wants are provided with logistics service appropriate to these needs and wants.

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5Quote by Fred Smith, CEO and chairman of FedEx.

For example, one particular retailer might require all its suppliers to route products through the retailer’s distribution centers while another retailer might require its suppliers to send products directly to the retailer’s stores.

The principles in this textbook are generally applicable not only to for-profit situations, but also to governmental and not-for-profit situations. From a governmental perspective, logistics is quite germane to the armed forces, which shouldn’t be surprising, given that logistics was first associated with the military. Consider the potential consequences of a supply chain disruption. For example, in 2015 Russia officially closed the Northern Distribution Network—consisting of railway and road links—that provided a key logistics route into Afghanistan for countries that were fighting the Taliban insurgency.8

A community food bank provides one example of the relevance of logistics to not-for-profit situations. As an example, the Food Bank of New York City is responsible for delivering nearly 75 million pounds of food annually to more than 1,000 food assistance programs such as homeless shelters and food pantries. From a logistical perspective, the Food Bank of New York City is responsible for collecting, storing, repacking, and distributing food from its 90,000-square-foot warehouse.9

Furthermore, humanitarian logistics represents an emerging application of logistics to not-for-profit situations. Briefly, humanitarian logistics can be defined as the process and systems involved in mobilizing people, resources, skills, and knowledge to help people who have been affected by either a natural or man-made disaster.10 For example, natural disasters such as a catastrophic earthquake require food and medical supplies to be located, collected, transported, and distributed—and sooner, rather than later. Because of the increasing frequency (and severity) of disasters over the past 50 years, humanitarian logistics is likely to be an important topic into the foreseeable future.

THE INCREASED IMPORTANCE OF LOGISTICS

The formal study of business logistics, and predecessor concepts such as traffic management and physical distribution, has existed since the second half of the twentieth century. Quite frankly, from approximately 1950 to 1980, limited appreciation was shown for the importance of the logistics discipline. Since 1980, however, increasing recognition has been given to business logistics, in part because of tremendous—and rapid—changes in the discipline. Several key reasons for this are discussed next.

A Reduction in Economic Regulation

During the 1970s and 1980s, widespread reductions in economic regulation (commonly referred to as deregulation) relaxed government control of carriers’ rates and fares, entry and exit, mergers and acquisitions, and more. These controls were particularly onerous in the U.S. transportation industry in the sense that price competition was essentially nonexistent, and customers were pretty much forced to accept whatever service the carriers chose to provide. This meant that logistics managers had relatively little control over one of the most important cost components in a logistics system.

Reductions in economic regulation in the U.S. airfreight, railroad, and trucking industries allowed individual carriers flexibility in pricing and service. This flexibility was important to logistics for several reasons. First, it provided companies with the ability to implement the tailored logistics approach discussed earlier, in the sense that companies could specify different logistics service levels, and prices could be adjusted accordingly. Second, the increased pricing flexibility allowed large buyers of transportation services to reduce their transportation costs by leveraging large amounts of freight with a limited number of carriers.

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8 http://www.silkroadreporters.com/2015/06/19/central-asia-will-miss-the-northern-distribution-network
9 www.foodbanknyc.org
Although the preceding discussion has focused on lessened economic regulation in the United States, it appears that deregulation has had similar effects in other countries. For example, lessened economic regulation of transportation among European countries has resulted in lower prices for truck shipments in these countries. Likewise, privatization of commercial airports has been found to improve their operational efficiency relative to government-owned and/or government-operated airports.

Changes in Consumer Behavior

A common business adage suggests that “change is the only constant.” Although changes in consumer behavior are commonly the purview of the psychology and marketing disciplines, such changes have important logistical implications as well. Several examples of changes in consumer behavior (customized customer, changing family roles, and rising customer expectations) and their possible logistical implications are discussed next.

The customized customer signifies that the customer desires a product offering that is highly tailored to the customer’s exact preferences. One approach for addressing the customized customer is through mass customization, which refers to the ability of a company to deliver highly customized products and services that are designed to meet the needs and wants of individual segments or customers. Going forward, mass customization is likely to be facilitated by advances in 3D printing (additive manufacturing), a process of making three-dimensional solid objects from a digitized file.

Furthermore, the customized customer will not accept a “one size fits all” approach, and this means that logistics systems must be flexible rather than rigid. As an example, logistics service providers such as FedEx and UPS offer a variety of delivery options to prospective customers; customers can choose same-day delivery, next-day delivery by noon, next-day delivery by the close of business, or second-day delivery by noon, among others. As a general rule, the earlier the delivery time, the more expensive the transportation cost.

In terms of changing family roles, in the United States approximately 60 percent of families with children report that both parents work. One consequence of these dual-income families has been an increasing emphasis on the convenience associated with a family’s grocery shopping experiences. This convenience is manifested in various ways to include extended store hours, home delivery of purchased items, and ready-to-eat/ready-to-cook foods, and each of these has logistics-related implications. With extended store hours—some stores are now open 24 hours—retailers must address issues such as the optimal delivery times for replenishment trucks and when to replenish merchandise. For example, it wouldn’t be a good idea for a 24-hour grocery store to replenish the shelves when its stores are crowded with customers.

Although home delivery could be convenient for the purchaser, the time-sensitive nature of grocery products means that delivery should be made when the purchaser is at home. As such, scheduling home deliveries to coincide with the purchaser’s availability is paramount to avoiding dissatisfied customers. Finally, the growth in ready-to-eat/ready-to-cook foods means that some food processors have added high-volume cooking systems at their production facilities. From a logistics perspective, food processors continue to experiment with packaging alternatives that will extend the shelf life of ready-to-cook foods. For example, innovative vacuum packaging technology now allows for shelf lives of up to 45 days for chilled (and not frozen) forms of microwavable foods.

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13http://3dprinting.com/what-is-3d-printing
As for rising customer expectations, it should come as no surprise that customer expectations tend to increase over time, which means that a satisfactory level of performance in the past might not be considered so today. An excellent example of rising customer expectations is provided by Toyota Motor Company’s North American Parts Operations. In an effort to retain customers and to reduce losing customers to other automotive repair facilities, Toyota now offers same-day delivery (rather than one-day delivery) of automotive parts to certain Toyota dealerships located in major metropolitan areas. This same-day delivery has been facilitated by a redesign of Toyota’s automotive parts distribution network. In a similar vein, online retailer Amazon now provides same-day delivery in a number of U.S. cities, and some of these cities also offer one-hour delivery service.

Technological Advances

Prior to the start of every academic year, Beloit College in Wisconsin releases its annual Mindset list that details the world view of incoming first-year college students. The class of 2019, which assumes a 1997 birthdate, is particularly noteworthy because it has never lived in a world without access to Google. Tremendous technological advances during the course of your lifetime—from desktop computers to tablets, from second-generation mobile phones to fourth-generation mobile phones—have profoundly influenced business management and, by extension, business logistics. The following paragraphs will discuss several examples of the logistical impacts of technological advances.

Technological advances have influenced channel design by allowing companies to offer an alternate distribution channel (or alternate distribution channels) to already existing channels. In some cases, this alternate channel is direct (i.e., no intermediaries between the producer and final customer) in nature because the final customer orders directly from the producer rather than through an intermediary. The removal of intermediaries between producer and consumer—called disintermediation—can clearly affect the design of logistics systems in the sense that there could be changes in both the number and location of fixed facilities such as warehouses and distribution centers. In addition, the logistical considerations of a retailer’s online store (e.g., orders from numerous customers; orders for small quantities) are quite different from that retailer’s bricks-and-mortar stores (e.g., orders from a defined customer base; orders in larger quantities).

Technological advances can also improve the productivity of the order picking process, which we’ll discuss in greater detail in Chapter 7. Order picking traditionally involved paper pick tickets that listed the particular item(s) and quantity to be picked—and not necessarily the item’s location in a facility. Locating the items to be picked could be quite time-consuming, and paper picking often resulted in picking errors in part because of illegible pick orders. Today, by contrast, order picking can utilize radio frequency (RF) devices, voice-directed picking, as well as robotic picking. Although these technological picking advances are more costly than paper picking, they can lead to substantial improvements in picking efficiency. For example, RF terminals can reduce pick errors by approximately 60 percent compared to paper picking.

Shipment tracking provides another example of how technological advances have impacted logistics management. When one of the authors worked for a U.S. trucking company in the early 1980s, shipment tracking was a time-consuming, labor-intensive process that sometimes did not yield a location for the shipment in question. If we fast-forward to today, global positioning systems can provide real-time location information about a shipment (sometimes to within 10 feet of its exact location) as well as information about the vehicle’s temperature, humidity, and vibrations. Such information can be especially important to pharmaceutical and health-care companies.

18http://www.beloit.edu/mindset/2019/
Advances in Retailing

Retailing in the second decade of the twenty-first century is noticeably different than at the beginning of the twenty-first century, and the differences exemplify the importance of effective and efficient logistics for retailing success. Consider for example, so-called big-box retailers—stores with large amounts of both floor space and products for sale—such as Walmart, Carrefour, and Dick’s Sporting Goods. Many big-box retailers explicitly recognize superior logistics as an essential component of their corporate strategies, and because of this, their logistical practices are often viewed as a barometer for emerging logistics trends. Big-box retailers have also been trendsetters with respect to environmental and social issues in logistics. For example, two of Best Buy’s sustainability goals for 2020 are to recycle one billion pounds of consumer goods and reduce its carbon footprint by 20 percent (relative to 2009 performance).21, 22

Omnichannel retailing is a strategy that focuses on providing customers a seamless shopping experience regardless of sales channel. Retailers enable their customers to transact within and across any contract channel (online, in-store, mobile app, etc.) to enhance information availability and customer experience. Omnichannel retailing takes a number of different forms and if you have ordered something online and picked it up at a bricks-and-mortar store, then you have engaged in omnichannel retailing. What you might not have thought about in this situation is that the inventory used to fill your online order depletes that store’s inventory, and thus inventory visibility and accurate demand forecasting become essential for successful omnichannel retailing.23

Globalization of Trade

Although countries have traded with each other for thousands of years, globalization’s impact is greater today than ever before. Consider that world trade has grown at an average annual rate of approximately five percent since 1990, including the worldwide economic slowdown in 2008 and 2009.24 Looking forward, the annual growth in world trade between 2016 and 2020 is forecast to be between 3 and 4 percent.25 Many factors, such as rising standards of living and multicountry trade alliances, have contributed to the growth of global trade; logistics has played a key role, too. Indeed, the shipping container—a uniform sealed reusable metal box in which goods are shipped—is often championed as an important catalyst for the growth in global trade. The shipping container allows many different products to be securely transported long distances via water transportation—important because long-distance water transportation is much less expensive than long-distance air transportation.

We’ll look at international logistics in much greater detail in Chapter 14, but for now one should recognize that the international logistics created by global trade is much more challenging and costly than domestic logistics. With respect to challenges, the geographic distances between buyers and sellers are often greater (which may translate into longer transit times), and monitoring logistics processes is sometimes complicated by differences in business practices, culture, and language. As for costs, the greater geographic distances tend to result in higher transportation costs, and documentation requirements can be quite costly as well.

THE SYSTEMS AND TOTAL COST APPROACHES TO LOGISTICS

Logistics is a classic example of the systems approach to business problems. From a companywide perspective, the systems approach indicates that a company’s objectives can be realized by recognizing the mutual interdependence of the major functional areas of the firm, such as marketing, production, finance, and logistics. One implication of the systems approach is that the goals and objectives

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22http://searchcio.techtarget.com/definition/omnichannel
24https://www.wto.org/english/news_e/pres15_e/pr739_e.htm
25https://www.atkearney.com/documents/10192/5498252/Global+Economic+Outlook+2015-2020--Beyond+the+New+Mediocre.pdf/5c5c8945-00cc-4a4f-a04f-a8ddf094e90b8
of the major functional areas should be compatible with the company’s goals and objectives. This means that one logistics system does not fit all companies because goals and objectives vary from one firm to another. As such, the logistics system of an organization that emphasizes customer satisfaction is likely different from the logistics system of an organization that emphasizes cost minimization.

A second implication is that decisions made by one functional area should consider the potential implications on other functional areas. For example, one consequence of pursuing the marketing concept, which focuses on satisfying customer needs and wants, is often a marked increase in the number of stock-keeping units (SKUs) or line items of inventory (each different type or package size of a good is a different SKU) offered for sale by many companies. An increased number of SKUs provides customers with more choices, which customers often want.

Alternatively, from a logistics perspective, the proliferation of SKUs creates challenges such as more items to identify, more items to store, and more items to track, which increases the chances of mistakes—which customers don’t like. An example of misidentification involves a consumer products company that mistakenly assigned the same product code to a three-pack, six-pack, and twelve-pack of a particular product it sold. Imagine the reaction of the customer who ordered a three-pack of the product, only to receive a six-pack or a twelve-pack of it!

Just as the major functional areas of a firm should recognize their interdependence, so too should the various activities that comprise the logistics function (what we’ll call intrafunctional logistics). The logistics manager should balance each logistics activity to ensure that none is stressed to the point where it becomes detrimental to others.

This can be illustrated by referring to Figure 1.1, which indicates that business logistics is made up of materials management (movement into and storage of materials in a firm) and physical distribution.

![Figure 1.1 Control over the Flow of Inbound and Outbound Movements](image)

In this drawing, the circles represent buildings where inventories are stored, and the lines with arrows represent movement performed by carriers, a stop-and-start process. Current thought deals more with flows, possibly in different volumes and at different speeds, but without the inventory standing still. The supply chain extends to both the left and right of this diagram and includes the suppliers’ suppliers and the customers’ customers.
Intrafunctional logistics attempts to coordinate materials management and physical distribution in a cost-efficient manner that supports an organization's customer service objectives.

Materials management and physical distribution can be coordinated in many ways. One way is by using the same truck to deliver materials and component parts and to pick up finished goods. Although this may appear to be little more than common sense—and the authors believe that common sense is one of the keys to being an effective logistics manager—consider the case of the company that used the same trucking company to deliver materials and parts to one of its production plants as well as to take finished products from the facility. Unfortunately, one truck would arrive early in the morning to deliver the materials and parts, and another truck would arrive in the late afternoon to pick up the finished products. How could this happen? It's quite simple: The inbound logistics group and the outbound logistics group were unaware that they were using the same trucking company—the two groups never communicated even though they worked in the same building!

Logistics managers use the total cost approach to coordinate materials management and physical distribution in a cost-efficient manner. This approach is built on the premise that all relevant activities in moving and storing products should be considered as a whole (i.e., their total cost), not individually. Use of the total cost approach requires an understanding of cost trade-offs; in other words, changes to one logistics activity cause some costs to increase and others to decrease. Importantly, an understanding of logistical cost trade-offs recognizes that the costs of certain logistical activities generally move in opposite directions. As an example, a decrease in transportation costs is often associated with an increase in warehousing costs.

The key to the total cost approach is that all relevant logistical cost items are considered simultaneously when making a decision. For example, expedited transportation, such as air freight, will increase a company’s transportation costs. At the same time, expedited transportation leads to a faster order cycle, which allows the receiving company to hold lower levels of inventory, thus reducing both its inventory carrying costs and warehousing costs. The total cost approach evaluates if the decreased inventory and warehousing costs are greater than the increased costs of expedited transportation. If so, the company might consider using expedited transportation (assuming that customer satisfaction isn’t negatively impacted), because the total logistics costs (consisting, in this example, of transportation, inventory, and warehousing costs) are less than the total costs of the existing system.

When used in the logistics decision-making process, the total cost concept approach forms what is commonly called the total logistics concept. This concept is unique not because of the activities performed, but because of the integration of all activities into a unified whole that seeks to minimize distribution costs in a manner that supports an organization’s strategic objectives. The total logistics concept can be extended to include a firm’s suppliers and customers, such as in supply chain management, which will be covered in Chapter 5.

LOGISTICAL RELATIONSHIPS WITHIN THE FIRM

From a companywide perspective, the system and total cost approaches to logistics require an understanding of logistics and its relationships with other functional areas. Because Chapter 6 is devoted specifically to procurement (purchasing), our discussion here focuses on logistical relationships with finance, production, and marketing.

Finance

The finance staff is often charged with the responsibility of allocating the firm’s funds to projects desired by the various operating departments. As such, the finance department is often instrumental in approving capital budgeting decisions that affect logistics, such as the acquisition of materials handling equipment (e.g., forklifts) and packaging equipment (e.g., a shrink-wrap machine). In such
situations, finance personnel may decide between purchasing or leasing the relevant equipment, assuming they have approved the decision to acquire it.

Inventory is another area where finance and logistics can interact. A basic challenge for the two areas is that the finance department often measures inventory in terms of its cost or value in dollars, whereas logistics tends to measure inventory in terms of units. The differing ways of measuring inventory can create potential friction between the two groups, as illustrated in the following example. From a cash flow perspective, the finance department might prefer to sell two boxes of hair dryers worth $1,000 dollars than to sell 15 boxes of hair shampoo worth $900. Alternatively, from a productivity perspective such as the number of boxes handled per worker, the logistics department might prefer selling the 15 boxes of hair shampoo rather than the two boxes of hair dryers.

In addition, in times of inflation, identical items added to inventory at different times means that each unit has a different cost, and even though inventory levels are not affected, it makes a difference whether an organization uses historic cost or current value as an indicator of the inventory's total value. Furthermore, certain items of inventory (for example, automobiles and produce, among others) lose value over time, and the authors have had consulting experiences with companies that showed a particular SKU to have a market value of $0—while the companies’ warehousing facilities contained several hundred units of physical inventory of the particular SKU.

Production

One of the most common interfaces between production and logistics involves the length of production runs. In many cases, the production people favor long production runs of individual products because this allows the relevant fixed costs to be spread over more units, thus resulting in a lower production cost per unit. Having said this, long production runs generate large amounts of inventory, and it is often the logisticians’s responsibility to store and track the inventory. It’s generally much easier to store and track 5 unit of a product that to store and track 500 units of the product.

Another consideration with long production runs is that sometimes excess inventory for particular products occurs because of limited (or no) demand for them. At a minimum, these products add to a company’s inventory carrying costs and also take up space that could be used to store other products. Slow-selling (or non-selling) products may also increase a company’s handling costs, as illustrated by a situation in which forklift drivers would periodically move 150 refrigerators from one warehouse area to another, just to ensure that the company’s managers would not see the refrigerators sitting in the same place for an extended period of time! You may find it difficult to believe that these 150 refrigerators were moved throughout the warehouse for nearly five years before managers were alerted to the behavior.

Increasing utilization of the postponement concept (the delay of value-added activities such as assembly, production, and packaging until the latest possible time) also influences the interface between production and logistics. More specifically, some value-added activities (e.g., case packing, case labeling) that were traditionally performed at a production plant are now performed in warehousing facilities. As a result, warehousing facilities are adding new types of equipment and being configured differently to allow specific value-added activities to take place.

Marketing

Contemporary marketing places a heavy emphasis on customer satisfaction, and logistics strategies can facilitate customer satisfaction by reducing the cost of products, which can translate into lower prices as well as bringing a broader variety of choices closer to where the customer wishes to

26 Glossary, www.cscmp.org
buy or use the product. Logistics strategies offer a unique way for a company to differentiate itself among competitors, and logistics now offers an important route for many firms to create marketing superiority. The following discussion about the interactions between logistics and marketing focuses on the marketing mix, sometimes referred to as the *four Ps* of marketing (place, price, product, and promotion).

**PLACE DECISIONS**  Decisions regarding place involve two types of networks, namely, logistics and the marketing channel (which is discussed in greater detail later in this chapter). Logistics decisions concern the most effective way to move and store the product from where it is produced to where it is sold. An effective logistics system can provide positive support by enabling the firm to attract and utilize what it considers to be the most productive channel and supply chain members. Channel members are frequently in a position to pick and choose which manufacturer’s products they wish to merchandise. If a manufacturer is not consistently able to provide a certain product at the right time, in the right quantities, and in an undamaged condition, the channel members may end their relationship with the supplier or cease active promotion of the supplier’s product.

From a marketing perspective, place decisions may also involve new strategies for reaching customers. A popular contemporary marketing strategy involves co-branding, which refers to an alliance that allows customers to purchase products from two or more name-brand retailers at one store location. Examples of co-branding include Starbucks coffee shops located within Marriott hotels, Subway restaurants located within some Walmart stores, and co-located Dunkin’ Donuts and Baskin-Robbins stores. From a marketing perspective, co-branding offers potential customers convenience by allowing for one-stop shopping as well the opportunity to purchase brand-name, rather than private-label (proprietary), products. From a logistical perspective, one decision involves product delivery to the particular retail locations. Should, for example, each co-branding party deliver its respective products to a particular location, or should the co-branding parties co-load vehicles to minimize the number of deliveries that arrive at a particular location? While the former might result in higher delivery costs because of multiple deliveries, the latter requires a higher degree of coordination between the co-branding parties.

**PRICE DECISIONS**  A key price-related decision for marketers involves how a product’s transportation costs should be reflected in its selling price, and this has proved to be a particularly vexing issue for some online merchants. For example, should a company’s selling price reflect its product’s landed cost, which refers to the price of a product at the source plus transportation costs to its destination? On the one hand, a selling price that is based on a product’s landed cost allows the seller to offer “free” delivery of the product to prospective customers, because the transportation costs associated with delivery are captured in the landed cost. On the other hand, a selling price that is based on a product’s landed cost could result in a substantial increase in a product’s selling price, and a higher selling price tends to decrease buyer demand for most products. One way that some online merchants address this conundrum is to require a minimum order amount (e.g., $50) to qualify for “free” delivery.

In addition to transportation considerations, logistics managers may play an important role in product pricing. They are expected to know the costs of providing various levels of customer service and therefore should be consulted to determine the trade-offs between costs and customer service. Because many distribution costs produce per unit savings when larger volumes are handled, the logistics manager can also help formulate the firm’s quantity discount pricing policies.

**PRODUCT DECISIONS**  A number of potential interfaces are possible between marketing and logistics in terms of product decisions. For example, as noted earlier, the marked increase in product offerings—which allows for more customer choice—creates logistical challenges in terms of identification, storage, and tracking.

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Another product interface between marketing and logistics involves the amount of particular SKUs to hold. Marketers often prefer to carry higher quantities of particular items because this reduces the likelihood of stockouts (being out of an item at the same time there is demand for it). However, from a logistics perspective, higher quantities of inventory (1) necessitate additional storage space and (2) increase inventory carrying costs.

Product design, which is often the purview of marketers, can also have important implications for logistical effectiveness and efficiency. For example, long-necked glass beverage containers might be more distinctive than aluminum cans; however, from a logistics perspective, long-necked bottles take up more space and are more likely to be damaged than aluminum cans.

In addition, marketers’ growing emphasis on offering sustainable products—products that meet present needs without compromising the ability of future generations to meet their needs—can also impact logistical decisions. Consider, for example, fair trade products, those that guarantee a better deal for producers in the developing world through fair and stable prices as well as teaching farming methods that are environmentally sustainable. From a marketing perspective, customer demand for fair trade products, such as coffee or chocolate, has resulted in some companies establishing distinct fair trade brands. From a logistical perspective, an organization’s commitment to selling fair trade products, such as coffee or chocolate, may result in changed sourcing requirements for the necessary raw materials.

**PROMOTION DECISIONS** Many promotional decisions require close coordination between marketing and logistics. One important situation concerns the availability of highly advertised products, particularly when a company is running pricing campaigns that lower the price of certain items. Few things are more damaging to a firm’s goodwill than being stocked out of items that are heavily promoted in a sales campaign. In addition, in some instances, imbalances of product supply and demand can be viewed as bait-and-switch tactics—that is, enticing customers with the promises of a low-priced product, only to find that it is unavailable, but that a higher-priced substitute product is readily available.

Moreover, once a decision is made to promote the introduction of a new product, the logistics staff assumes responsibility for having the product in place on the scheduled release date—not earlier, not later. The complexity of so doing is well illustrated by looking at how Apple manages the release of new versions of the iPhone. Because the iPhone is manufactured in China, Apple pre-purchases space on airfreight carriers such as FedEx in order to move the devices to distribution centers in various parts of the world. In order to minimize opportunities for theft and other glitches, Apple security personnel will accompany the shipments from the factory floor to the different distribution centers.

**MARKETING CHANNELS**

Another concept that is useful in studying the marketing relationships between and among firms is to look at marketing channels, which refer to “a set of institutions necessary to transfer the title to goods and to move goods from the point of production to the point of consumption and, as such, which consists of all the institutions and all the marketing activities in the marketing process.” The principal traditional institutions in the marketing channel are the manufacturer, the wholesaler, and the retailer. These channel members work together in several different channel arrangements—ownership channel, negotiation channel, financing channel, promotions channel, and logistics channel—and we’ll look more closely at how manufacturers, wholesalers, and retailers interact in these five channels.

The ownership channel covers movement of the title to the goods, and the goods themselves might not be physically present or even exist. If a good is in great demand, such as a commissioned piece of art or a scarce new consumer product, one might have to buy it before it is produced. Sometimes, a product

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31 American Marketing Association Dictionary, www.marketingpower.com
will not be made until there are sufficient financial commitments; this is often the case with new models of commercial airplanes. The party owning the good almost always has the right to trade or sell it and bears the risks and costs associated with having it in inventory. Also, while owning the good, one can use it as collateral for a loan, although this may place some restrictions on its use or movement.

The negotiations channel is the one in which buy and sell agreements are reached. This could include transactions face-to-face or by telephone, e-mail, electronic data interchange, or almost any other form of communication. In many situations, no actual negotiations take place; the price for the product is stated, and one either buys at that price or does not. In some trades, auctions are used; in others, highly structured, organized trading takes place, such as markets for some commodities. One part of the negotiations covers how activities in the other channels are to be handled. For example, each buying party will specify the point and time of delivery and the point and time of payment. Even packaging design may be negotiated. (An old Henry Ford story is that suppliers of some parts were directed to ship in wooden crates built of good lumber and to very exacting specifications. It turned out that the empty crates were then partially disassembled and became floorboards in Ford Model Ts.)

The financing channel handles payments for goods. More importantly, it handles the company’s credit. The multiple participants in the channel have different financial strengths, and often one must help another to keep the entire channel alive. For example, a newly opened retail store may have some of its goods placed on consignment, meaning that the wholesaler, not the store, owns them. The retailer will reimburse the wholesaler only for goods sold; the wholesaler bears nearly all the financial risks. Sometimes, in an effort to develop what it believes is a necessary new product line, a wholesaler will assist the manufacturer by putting up cash in advance along with an order. Alternatively, the wholesaler will place a large, guaranteed order, and the manufacturer can take that order to a bank and use it as a basis for receiving a loan.

Credit is important to all parties in the channel, who frequently receive or extend it, and credit becomes an integral part of the negotiations. If bills are not paid when due or if credit is over-extended, collection becomes a financing channel function. Indeed, a lingering aftereffect of the 2007–2009 economic recession is that some large companies are taking longer to pay their bills. More specifically, some larger companies now pay their bills within 90 days, as opposed to 30 to 60 days prior to the recession. While beneficial to the larger companies, these lengthened payment cycles negatively impact their suppliers.

The promotions channel is concerned with promoting a new or an existing product, and it can be related to the financing channel because monetary allowances are often part of the promotion effort. In addition, the promotions channel and the logistics channel are linked in several ways. First, there may be special advertising materials, such as coupon books, floor advertising posters, or displays, which must be distributed with the promoted product. Second, some of the cartons or consumer packs may have special labeling, and their placement at retailers must coincide with other promotional efforts. Third, because logistics personnel handle order processing, they have instantaneous records of actual sales, which indicate the initial success of the promotional efforts.

As mentioned previously, the logistics channel, its components, and its functioning are the main topics of this book. The most significant contribution that the logistics channel makes to the overall channel process is the sorting function, which bridges “the discrepancy between the assortment of goods and services generated by the producer and the assortment demanded by the consumer.” The sorting function has four steps, which are important to understanding the concept of goods flowing through the logistics channel:

- **Sorting out** is sorting a heterogeneous supply of products into stocks that are homogeneous.
- **Accumulating** is bringing together similar stocks from different sources.
- **Allocating** is breaking a homogeneous supply into smaller lots.
- **Assorting** is building up assortments of goods for resale, usually to retail customers.

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33 American Marketing Association Dictionary.
These steps take place between the manufacturer and the consumer, which means that they are performed by the wholesaler, the retailer, or specialist intermediaries.

In addition to the major actors or primary participants in a logistics channel, many less-well-known actors, called facilitators or channel intermediaries, play minor but essential roles. Intermediaries make the entire system function better and should only be used when they add value to a transaction. They spring up and flourish in areas where communications and other interactions between major parties are not well meshed. In international transactions, for example, translators may be an important intermediary. Intermediaries also function in areas needing orderly routines, such as order processing, and in searching, for example, when customers are looking for products or producers are looking for customers. Intermediaries fill niches, they are very well focused, and they serve as buffers between various channel members. Usually, they do not take an ownership position in the products or goods being handled.

The five channels discussed previously show where intermediaries function and fit. For example, in the ownership channel, a common intermediary is the bank or finance company, which may assume temporary or partial ownership of goods as part of an ongoing transaction. Often, this is a condition for the extension of credit. Banks routinely loan funds to all parties in a channel, making it possible for goods to be manufactured, marketed, and sold.

Brokers, who are associated with the negotiation channel, are independent contractors paid to arrange a particular transaction. A broker can be used by either a buyer or seller and is often used to arrange truck transportation for either the buyer (shipper/receiver) or seller (trucker). A broker can add value for a trucker in the sense that an individual trucker believes that his or her time is more profitably spent driving, rather than being on the phone or Internet trying to negotiate for the next load. In a similar fashion, a broker adds value for a shipper/receiver because of the broker’s knowledge of potential transportation options.

Banks and finance companies are prominent intermediaries in the financing channel, and both parties supply the credit necessary for a deal to be finalized. For big-ticket items, such as ships or warehouses, the buyer almost always borrows money to finance part of the purchase. Sometimes insurance is also a requirement in the agreement, so insurance companies may also serve as intermediaries.

The promotions channel has intermediaries that aid with promotions, such as firms that design, build, and transport product exhibits for display at trade shows. Advertising agencies can handle the preparation and media placement of advertising materials, and firms often use public relations agencies to represent them to the news media. Some companies choose to outsource their personal selling functions by hiring an intermediary to provide them with a contract sales force. These promotion efforts handled by intermediaries must be coordinated with the firm’s overall marketing communication activities.

The logistics channel has many intermediaries, and many are mentioned in this book. A commonly used intermediary is the freight forwarder, whose function is to assemble small shipments into larger shipments and then tender them in truckload or railcarload quantities to truck lines or to railroads. In international logistics, intermediaries abound, and more than a hundred different types could be listed. One example is cargo surveyors who specialize in coffee; these specialists examine and arbitrate damage claims involving shipments of coffee beans.

**ACTIVITIES IN THE LOGISTICAL CHANNEL**

To successfully apply the systems and total cost approaches to logistics, it is essential to understand the various logistics activities. Keep in mind that because one logistics system does not fit all companies, the number of activities in a logistics system can vary from company to company. Activities that are considered to be logistics related include, but are not limited to, the following:

- Customer service
- Facility location decisions
- Inventory management
- Demand forecasting
- International logistics
- Materials handling

**Learning Objective 1.7**
Order management  
Procurement  
Transportation management  

Packaging  
Reverse logistics  
Warehousing management

**Customer Service**

There are many definitions of customer service, such as “keeping existing customers happy.” Customer service involves making sure that the right person receives the right product at the right place at the right time in the right condition and at the right cost. Customer service is discussed in greater detail in Chapter 7.

**Demand Forecasting**

Demand forecasting refers to efforts to estimate product demand in a future time period. The growing popularity of the supply chain concept has prompted increasing collaboration among supply chain partners with respect to demand forecasting. Such collaboration can enhance efficiency by reducing overall inventory levels in a supply chain. We discuss demand forecasting in Chapter 7.

**Facility Location Decisions**

It’s often said that the success of a retail store depends on three factors: location, location, and location. It can also be said that the success of a particular logistics system is dependent on the location of the relevant warehousing and production facilities. Facility location decisions are increasingly important as the configuration of logistics systems is altered due to the impacts of multinational trade agreements. Facility location decisions are covered in Chapter 9.

**International Logistics**

International logistics, which refers to the logistics activities associated with goods that are sold across national boundaries, is much more costly and challenging than domestic logistics. We will take a closer look at international logistics in Chapter 14.

**Inventory Management**

Inventory refers to stocks of goods that are maintained for a variety of purposes, such as for resale to others, as well as to support manufacturing or assembling processes. When managing inventory, logisticians need to simultaneously consider three relevant costs—the cost of carrying (holding) product, the cost of ordering product, and the cost of being out of stock. Chapter 8 provides further discussion concerning inventory management.

**Materials Handling**

Materials handling refers to the short-distance movement of products within the confines of a facility (e.g., plant, warehouse). Materials handling considerations are presented in Chapter 11.

**Order Management**

Order management refers to management of the activities that take place between the time a customer places an order and the time it is received by the customer. As such, order management is a logistics activity with a high degree of visibility to customers. Order management is discussed in Chapter 7.

**Packaging**

Packaging can have both a marketing (consumer packaging) and logistical (industrial packaging) dimension. Industrial (protective) packaging refers to packaging that prepares a product for storage and...
transit (e.g., boxes, crates). Packaging has important interfaces with the materials handling and warehousing activities. Chapter 11 discusses packaging in conjunction with materials handling.

**Procurement**

Procurement refers to the raw materials, component parts, and supplies bought from outside organizations to support a company’s operations. Procurement’s direct link to outside organizations means that its strategic importance has increased as supply chain management has become more popular. Procurement is discussed in more detail in Chapter 6.

**Reverse Logistics**

Products can be returned for various reasons, such as product recalls, product damage, lack of demand, and customer dissatisfaction. The challenges associated with reverse logistics can be complicated by the fact that returned products often move in small quantities and may move outside forward distribution channels. Reverse logistics is examined in Chapter 4.

**Transportation Management**

Transportation can be defined as the actual physical movement of goods or people from one place to another, whereas transportation management refers to the management of transportation activities by a particular organization. Transportation can account for up to 50 percent of a firm’s total logistics costs and thus represents the most costly logistics activity in many organizations. Transportation considerations are discussed in Chapter 12. Transportation management is discussed in Chapter 13.

**Warehousing Management**

Warehousing refers to places where inventory can be stored for a particular period of time. As noted previously, important changes have occurred with respect to warehousing’s role in contemporary logistics and supply chain systems. Warehousing is discussed in Chapter 10.

**LOGISTICS AND SUPPLY CHAIN CAREERS**

The job market for logisticians and supply chain managers continues to be strong at both the undergraduate and MBA levels. Entry-level jobs include logistics (supply chain) analyst, consultant, customer service manager, and fulfillment supervisor. Second-level positions include international logistics manager, supply chain software manager, purchasing manager, transportation manager, and warehouse operations manager. There are a variety of possible career paths available and, unlike when the first edition of this book was published, no glass ceiling exists for managers with expertise in logistics or supply chain management. Indeed, Tim Cook headed up Apple’s supply chain before becoming the company’s Chief Executive Officer.

Because of the growing importance of logistics and supply chain management, a number of professional organizations are dedicated to advancing the professional knowledge of their members. One rationale for these professional associations is that the state of the art is changing so rapidly that professionals must educate and re-educate themselves on a regular basis. Several prominent professional logistics and supply chain management organizations are summarized in the appendix to this chapter.

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35 www.cscmp.org
Summary

This chapter introduced the topic of logistics, which the CSCMP defines as “that part of Supply Chain Management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customers’ requirements.”

The economic impacts of logistics were discussed along with reasons for the increased importance of logistics in recent years. Systems and total cost approaches to logistics were discussed, as were logistical relationships within a firm, with a particular focus on various interfaces between marketing and logistics. A short description of a number of logistics activities was presented. The chapter concluded with a brief look at logistics careers.

Key Terms

- 3D printing
- Big-box retailer
- Co-branding
- Container
- Cost trade-offs
- Disintermediation
- Economic utility
- Form utility
- Humanitarian logistics
- Landed cost
- Logistics
- Marketing channels
- Mass logistics
- Materials management
- Omnichannel retailing
- Physical distribution
- Place utility
- Possession utility
- Postponement
- Sorting function
- Stock-keeping units (SKUs)
- Stockouts
- Sustainable products
- Systems approach
- Tailored logistics
- Time utility
- Total cost approach

Questions for Discussion and Review

1.1 Did it surprise you that logistics has such an important economic impact? Why or why not?
1.2 Distinguish between possession, form, time, and place utility.
1.3 How does logistics contribute to time and place utility?
1.4 How can a particular logistics system be effective but not efficient?
1.5 How do changing patterns of consumer behavior impact logistical decisions?
1.6 How do you view the statement “logistics is not equivalent to supply chain management”?
1.7 “Logistics function has a solely profit orientation.” Evaluate this statement.
1.8 Differentiate between mass and tailored logistics.
1.9 What are some ways in which technology has impacted logistics management?
1.10 Why is logistics an imperative component in retailing?
1.11 What is the systems approach to problem solving? How is this concept applicable to logistics management?
1.12 Explain what is meant by the total cost approach to logistics.
1.13 Define what is meant by a cost trade-off. Do you believe that this concept is workable? Why or why not?
1.14 What are several areas in which finance and logistics might interface?
1.15 Discuss the postponement concept as it relates to the production and logistics interface.
1.16 What is co-branding and how does it affect logistical decisions?
1.17 Define what is meant by a landed cost and explain its relevance for pricing decisions.
1.18 Briefly discuss the ownership, negotiations, financing, promotions, and logistics channels.
1.19 Explain the importance of the sorting function in logistics.
1.20 Discuss five activities that might be part of a company’s logistics department.
Suggested Readings


CASE

**CASE 1.1 KIDDIELAND AND THE SUPER GYM**

KiddieLand is a retailer of toys located in the Midwest. Corporate headquarters is in Chicago, and its 70 stores are located in Minnesota, Wisconsin, Michigan, Illinois, Indiana, Ohio, Iowa, and Kentucky. One distribution center is located in Columbus (for Kentucky, Indiana, Michigan, and Ohio) and one in Chicago (for Illinois, Iowa, Minnesota, and Wisconsin).

KiddieLand markets a full range of toys, electronic games, computers, and play sets. Emphasis is on a full line of brand-name products together with selected items sold under the KiddieLand brand. KiddieLand’s primary competitors include various regional discount chains. A comprehensive product line, aggressive pricing, and self-service have been key to KiddieLand’s success.

Donald Hurst is KiddieLand’s logistics manager. He is responsible for managing both distribution centers, for transportation management, and for inventory control. Don’s primary mission is to make sure all stores are in stock at all times without maintaining excessive levels of inventory.

One morning in late January, while Don was reviewing the new year’s merchandising plan, he discovered that starting in March, KiddieLand would begin promoting the Super Gym Outdoor Children’s Exercise Center. Don was particularly interested that the new set would sell for $715. In addition, the Super Gym is packaged in three boxes weighing a total of 450 pounds. “Holy cow!” thought Don.

“There must be some mistake,” thought Don as he walked down the hall to the office of Olga Olsen, KiddieLand’s buyer for play sets. Olga was new to her job and was unusually stressed because both of her assistant buyers had just resigned to seek employment on the West Coast. As soon as Olga saw Don, she exclaimed, “Don, my friend, I have been meaning to talk to you.” Don knew right then that his worst fears were confirmed.

The next morning Don and Olga met with Randy Smith, Don’s transportation manager; A. J. Toth, general manager for KiddieLand’s eight Chicago stores; and Sharon (continued)
Rabiega, Don’s assistant for distribution services. Because the previous year had been unusually profitable, everyone was in a good mood because this year’s bonus was 50 percent larger than last year’s.

Nevertheless, A. J. got to the point: “You mean to tell me that we expect somebody to stuff a spouse, three kids, a dog, and 450 pounds of Super Gym in a small sedan and not have a conniption?”

Randy chimed in, “Besides, we can’t drop ship Super Gyms from the manufacturer to the consumer’s address because Super Gym ships only in quantities of 10 or more.”

Olga was now worried. “We can’t back out of the Super Gym now,” she moaned. “I have already committed KiddieLand for 400 sets, and the spring–summer play set promotion went to press last week. Besides, I am depending on the Super Gym to make my gross margin figures.”

“What about SUVs?” asked Toth. “They make up half the vehicles in our parking lots. Will the three packages fit inside them?”

By now the scope of the problem had become apparent to everyone at the meeting. At 3 p.m. Don summarized the alternatives discussed:

1. Purchase a two-wheel trailer for each store.
2. Find a local trucking company that can haul the Super Gym from the KiddieLand store to the customer.
3. Stock the Super Gym at the two distribution centers and have the truck that makes delivery runs to the retail stores also make home deliveries.
4. Charge for delivery if the customer cannot get the Super Gym home.
5. Negotiate with the Super Gym manufacturer to ship directly to the customer.

Everyone agreed to meet the following Monday to discuss the alternatives. On Sunday evening a record-breaking blizzard hit Chicago. KiddieLand headquarters was closed Monday and Tuesday because of the blizzard. The group finally met again on Wednesday.

Don started the meeting. “Okay,” Don began, “let’s review our options. Sharon, what did you find out about buying trailers for each store?”

“Well,” Sharon began, “the best deal I can find is $1,800 per trailer for 70 trailers, plus $250 per store for an adequate selection of bumper hitches, and an additional $50 per year per store for licensing and insurance. Unfortunately, bumpers on the newest autos cannot accommodate trailer hitches.”

“Oh, no,” moaned Olga, “we only expect to sell 5.7 sets per store. That means $368 per Super Gym for delivery,” she continued as she punched her calculator, “and $147 in lost gross margin!”

Next, Randy Smith summarized the second option. “So far we can get delivery within 25 miles of most of our stores for $38.21 per set. Actually,” Randy continued, “$38.21 is for delivery 25 miles from the store. The rate would be a little less for under 25 miles and about $1.50 per mile beyond 25 miles.”

A. J. Toth chimed in, “According to our marketing research, 85 percent of our customers drive less than 25 minutes to the store, so a flat fee of $40 for delivery would probably be okay.”

Randy continued, “Most delivery companies we talked to will deliver twice weekly but not daily.”

Sharon continued, “The motor carrier that handles shipments from our distribution centers is a consolidator. He said that squeezing an 18-wheeler into some subdivisions wouldn’t make sense. Every time they try, they knock down a couple of mailboxes and leave truck tracks in some homeowner’s lawn.”

Olga added, “I talked to Super Gym about shipping direct to the customer’s address, and they said forget it. Whenever they have tried that,” Olga continued, “the customer gets two of one box and none of another.”

“Well, Olga,” Don interrupted, “can we charge the customer for delivery?”

Olga thought a minute. “Well, we have never done that before, but then we have never sold a 450-pound item before. It sounds like,” Olga continued, “our choice is to either absorb $40 per set or charge the customer for delivery.”

“That means $16,000 for delivery,” she added.

“One more thing,” Don said. “If we charge for shipping, we must include that in the copy for the spring–summer brochure.”

Olga smiled. “We can make a minor insert in the copy if we decide to charge for delivery. However,” she continued, “any changes will have to be made to the page proofs—and page proofs are due back to the printer next Monday.”
QUESTIONS

1. List and discuss the advantages and disadvantages of purchasing a two-wheel trailer for each store to use for delivering the Super Gyms.

2. List and discuss the advantages and disadvantages of having local trucking companies deliver the Super Gym from the retail stores to the customers.

3. List and discuss the advantages and disadvantages of stocking Super Gyms at the distribution centers and then having the truck that makes deliveries from the distribution center to the retail stores also make deliveries of Super Gyms to individual customers.

4. List and discuss the advantages and disadvantages of charging customers for home delivery if they are unable to carry home the Super Gym.

5. Which alternative would you prefer? Why?

6. Draft a brief statement (catalog copy) to be inserted in the firm’s spring–summer brochure that clearly explains to potential customers the policy you recommended in question 5.

7. At the first meeting, A. J. asked about SUVs, but there was no further mention of them. How would you follow up on his query?
The logistics discipline has been through many changes since the first edition of this book was published in the mid-1970s. The first edition, for example, primarily focused on physical distribution management, and the corresponding definition emphasized the movement and storage of goods. The current edition of this book, by contrast, is focused on logistics and its role in supply chain management. Moreover, the corresponding definition of logistics (see Chapter 1) mentions the flows and storage of goods, services, and related information.

The effective and efficient utilization of information can be quite beneficial to logistics and supply chain management, and four of the more prominent benefits include the following:

- Greater knowledge and visibility across the supply chain, which makes it possible to replace inventory with information
- Greater awareness of customer demand via point-of-sale data, which can help improve planning and reduce variability in the supply chain
- Better coordination of manufacturing, marketing, and distribution through enterprise resource planning (ERP) systems
- Streamlined order processing and reduced lead times enabled by coordinated logistics information systems

Successful implementation and exploitation of the right information technologies is critical to maintaining competitiveness. Additionally, the effective and efficient use of information allows organizations to simultaneously reduce their costs and improve customer satisfaction in the sense


that organizations stock the inventory that will be demanded by customers. For example, several U.S.-based grocery chains have carefully studied Hispanic consumers and learned that they place greater emphasis on fresh produce than do other ethnic groups. As such, grocery stores located in heavily Hispanic areas often stock more fresh produce than do grocery stores located in other areas. Similarly, a U.S.-based retailer of home goods used demographic data to localize product assortments to better align with customer tastes and was able to achieve an 18 percent revenue lift in their fashion bedding category.3

Before proceeding further, it’s important to distinguish between data and information: “data are simply facts—recorded measures of certain phenomena—whereas information is a body of facts in a format suitable for decision making.”4 Advances in technological hardware and software now allow logisticians access to abundant amounts of data in relatively short periods of time. In attempting to manage these data, managers must first determine which data are relevant for their purposes. Next the data need to be organized and analyzed; once analyzed, managers should make the appropriate decision or decisions. In today’s competitive business environment, these actions must be completed in as short a time period as possible.

One contemporary issue for logisticians to consider is the emergence of what industry has termed big data—the collection of large amounts of near-real-time data collected through a variety of sources, such as sensors, smart phones, RF tags, and business-to-business data exchanges. Logisticians will need to develop strategies for how they can manage the flood of data that will be available to help them manage assets, increase visibility, and enhance communications across the supply chain. The opportunity will be to use these data to sense changes in demand and then use logistics activities to effectively and efficiently respond to these changes.5

However, big data works hand-in-hand with analytics to provide logistics managers with actionable information. Logistics managers have traditionally used analytics for vehicle routing and scheduling. GPS-enabled big data telematics and route optimization have proven to provide significant cost savings.6 UPS, a global logistics company, uses an analytics tool called ORION (On-Road Integrated Optimization and Navigation) to allow its drivers to determine optimal routing in their delivery areas.7 Further, analytics can be used to improve productivity by optimizing driver behavior, vehicle routing, equipment maintenance, and fuel usage.8

The next section of this chapter will provide an overview of general types of information management systems that are applicable across each business function. In addition, examples of how these general types of information systems might be specifically applied in logistics management are provided. This will be followed by an explanation of the Internet’s influence on logistics, and the chapter will conclude with a look at select contemporary information technology issues.

**GENERAL TYPES OF INFORMATION MANAGEMENT SYSTEMS**

Professor Steven Alter has identified six different types of information systems that are applicable to every business function.9 These six categories, summarized in Figure 2.1, form the basis of this section.

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Office Automation Systems

*Office automation systems* provide effective ways to process personal and organizational business data, to perform calculations, and to create documents. Included in office automation systems are general software packages—word processing, spreadsheet, presentation, and database management applications—that most of you probably use in your daily lives. The most relevant general software package for logisticians is the spreadsheet. Whereas early spreadsheet programs for personal computers were little more than speedy calculators, today’s spreadsheets have a multitude of capabilities that allow managers to solve a variety of complex business problems relatively quickly and inexpensively.

The most relevant general software package for logisticians is the spreadsheet. Whereas early spreadsheet programs for personal computers were little more than speedy calculators, today’s spreadsheets have a multitude of capabilities that allow managers to solve a variety of complex business problems relatively quickly and inexpensively.

Indeed, logistics spreadsheet applications into the early 1990s tended to reflect the rather limited capabilities of the existing software packages. For example, representative topics included economic order quantity (EOQ) calculations, warehouse sizing, transportation modal and carrier decisions, production planning, and center of gravity location decisions, among others. As we moved through the 1990s, increased spreadsheet capabilities allowed organizations to analyze issues that had traditionally been solved by specially designed computer programs. In this vein, the classic issue of transportation cost minimization—transporting products from multiple sources to multiple destinations, at a minimum transportation cost—could be analyzed using spreadsheet software.

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**Figure 2.1 General Types of Information Management Systems**  

<table>
<thead>
<tr>
<th>System type</th>
<th>Logistics examples</th>
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</thead>
<tbody>
<tr>
<td>Office automation system: provides effective ways to process personal and organizational business data, to perform calculations, and to create documents</td>
<td>Spreadsheet applications to calculate optimal order quantities, facility location, transport cost minimization, among others</td>
</tr>
</tbody>
</table>
| Communication system: helps people work together by interacting and sharing information in many different forms | Virtual meetings via computer technology  
Voice-based order picking |
| Transaction processing system (TPS): collects and stores information about transactions; controls some aspects of transactions | Electronic data interchange  
Automatic identification technologies such as bar codes  
Point-of-sale systems |
| Management information system (MIS) and executive information system (EIS): converts TPS data into information for monitoring performance and managing an organization; provides executives information in a readily accessible format | Logistics information system |
| Decision support system (DSS): helps people make decisions by providing information, models, or analysis tools | Simulation  
Application-specific software such as warehouse management systems  
Data mining |
| Enterprise system: creates and maintains consistent data processing methods and an integrated database across multiple business functions | Logistics modules of enterprise resource planning systems |

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Today spreadsheets have developed to the point that they are able to solve for basic logistics optimization models. **Logistics optimization models** utilize spreadsheet software and add-ins to help logisticians make complex judgments and decisions about key logistics issues at strategic, tactical, operational, and collaborative levels.\(^{13}\) For example, at a strategic level global consumer products company P&G uses spreadsheets with the add-in package “What's Best” to help them make decisions regarding plant location and size decisions.\(^{14}\) Logistics optimization models differ from traditional operations research in that they are typically focused on the practical implementation instead of pure optimization.\(^{15}\) Thus, the use of spreadsheets provides a method for logisticians to conduct a variety of “what-if” analyses in support of their logistics decision making.

### Communication Systems

*Communication systems* help various stakeholders—employees, suppliers, customers—work together by interacting and sharing information in many different forms.\(^{16}\) From a logistical perspective, the importance of well-defined and well-executed communication systems was highlighted by the events of September 11, 2001, especially for companies that use or provide airfreight services. Because of the total shutdown of the U.S. aviation system for several days following the terrorist attacks, many air shipments were diverted onto trucks, thus delaying many deliveries. As such, airfreight providers such as FedEx worked feverishly to inform customers when their shipments would be arriving.\(^{17}\)

Many advances in telecommunications technology—such as fax machines, personal computers, electronic mail, cellular phones, tablets and smart phones, among others—have occurred since the first edition of this book was published in the 1970s. As recently as the 1990s, some of these technologies were considered workplace “luxuries.” Today, by contrast, many of these technologies are essential for enabling the contemporary logistician to perform in the workplace.

Electronic data interchange, or EDI (to be discussed in the next section), was viewed by many experts as the measuring stick for logistics information technology in the 1990s. By contrast, **wireless communication** emerged as the measuring stick during the first decade of the twenty-first century.\(^{18}\) For our purposes, wireless communication refers to communication without cables and cords and includes infrared, microwave, and radio transmissions, among others.

Although wireless communication has many logistical applications, we’ll take a look at one of the more popular types, namely, global positioning systems. **Global positioning systems (GPS)** refer to a network of satellites that transmits signals that pinpoint the exact location of an object. You might be familiar with global positioning systems in the form of personal navigation devices that provide maps or voice instructions as you drive your automobile.

Global positioning systems have become quite valuable to the transportation component of logistics because of high fuel costs and the relentless pressure to improve efficiency and productivity. Indeed, transportation companies that have implemented global positioning systems have reported an increase in worker productivity, reduced operating costs, and improved customer relations. More specifically, one study found that GPS implementation allows transportation companies to recapture nearly one hour per day of their drivers’ time, which translates into labor savings of approximately $5,500 per employee. The same study also reported that GPS implementation allows companies to reduce vehicle travel by about 230 miles per week, for an annual fuel savings of approximately $52,000.\(^{19}\)

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15 Bartolacci et al., “Optimization Modeling for Logistics.”


Tables, such as Apple’s iPad, are also becoming important contributors to logistics decision making. The use of these types of consumer-grade mobile devices in an industrial setting, such as a warehouse or port, may require the device to become “ruggedized” in order to withstand the conditions that exist in these locations.  

For example, Markley Enterprises, a manufacturer of marketing support products, uses iPads along with third-party apps to enhance the productivity of its warehouse workers, improve pick accuracy, and eliminate paperwork. Similarly, Cleveland-based Arhaus Furniture placed iPads in its delivery trucks, which has led to savings in paperwork costs, increased truck utilization, and improved customer service.

Continuing advances in hardware and software have resulted in dramatic cost reductions for wireless communication, and one implication is that the technology is no longer limited to those companies with the deepest financial resources. Moreover, hardware and software cost reductions have shortened the relevant investment payback period and GPS implementations can pay for themselves within one year.

Transaction Processing Systems (TPS)

A transaction processing system, or TPS, collects and stores information about transactions and may also control some aspects of transactions. The primary objective of a TPS is the efficient processing of transactions, and to this end, organizations can choose to do batch or real-time processing. With batch processing, data are collected and stored for processing at a later time, with the later time perhaps being based on schedule (e.g., process every six hours) or volume (e.g., process once 25 transactions have accumulated) considerations. Real-time processing, not surprisingly, means that transactions are processed as they are received. Although batch processing might be somewhat out of step with the contemporary emphasis on speed and time reduction, it can be quite effective when real-time processing is not necessary. Moreover, in comparison with real-time systems, batch processing tends to be less costly and easier for employees to learn.

A prominent example of a logistics-related TPS is electronic data interchange (EDI), the computer-to-computer transmission of business data in a structured format. Because EDI provides for the seamless transmission of data across companies (assuming technological compatibility), it can facilitate the integration of, and coordination between, supply chain participants. Thus, firms with strong EDI links to both suppliers and customers might have a substantial advantage over supply chain arrangements without such implementations. Common uses of EDI include invoicing, submission of purchase orders, pricing, advanced shipment notices, electronic funds transfer, and bill payment.

EDI has a number of benefits, including reductions in document preparation and processing time, inventory carrying costs, personnel costs, information float, shipping errors, returned goods, lead times, order cycle times, and ordering costs. In addition, EDI may lead to increases in cash flow, billing accuracy, productivity, and customer satisfaction. Potential drawbacks to EDI include a lack of awareness of its benefits, high setup costs, lack of standard formats, and incompatibility of computer hardware and software.

Despite these drawbacks and a perception that EDI is an “old” technology, EDI continues to be an important logistics technology tool in the twenty-first century. Moreover, while the Internet was viewed by some as a possible replacement or substitute for EDI, time has shown that the Internet can serve as a complement to, rather than a replacement or substitute for, EDI. For example, Walmart was one of the first companies to adopt Internet-based EDI (I-EDI) in place of Value

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24Alter, Information Systems, Chapter 5.
Added Network (VAN)-based EDI. Importantly, I-EDI’s significantly lower setup costs than VAN-based EDI make I-EDI more affordable for smaller companies, thus expanding EDI’s scope.26

*Automatic identification technologies,* another type of logistics-related TPS, include optical character recognition (which can read letters, words, and numbers), machine vision (which can scan, inspect, and interpret what it views), voice-data entry (which can record and interpret a human voice), radio-frequency identification (which can be used where there is no line of sight between scanner and label), and magnetic strips.

Automatic identification systems are an essential component in point-of-sale (POS) systems and the idea behind POS systems is to provide data to guide and enhance managerial decision making. Operationally, POS systems involve scanning Universal Product Code (UPC) labels, either by passing the product over an optical scanner or recording it with a handheld scanner. The UPC is read and recorded into a database that supplies information such as the product’s price, applicable taxes, whether food stamps can be used, and so on. The specific price of each product and its description are also flashed on a monitor screen positioned near the counter. When all the products have been recorded, the customer receives verification that lists the products purchased, the price of each article, and the total bill.

Bar code scanners currently remain the most popular automatic identification system in use. They work to integrate suppliers and customers along the supply chain because all parties read the same labels; in addition, the transfer of goods between parties can be recorded by simple electronic means. Traditionally, laser scanners have been used to read bar codes. The scanners record inventory data and may be directly attached to a computer that uses the data to adjust inventory records and track product movement.

*Radio-frequency identification (RFID)* technology is another automatic identification technology that has received considerable attention in the first part of the twenty-first century. Conceptually, RFID involves the use of radio frequency to identify objects that have been implanted with an RFID tag. Operationally, RFID consists of three components: a scanning antenna, an RFID tag (chip) that conveys the relevant data, and a transceiver that interprets the data. As an RFID tag passes within the scanning antenna’s range, the tag’s data are picked up by the scanning antenna and interpreted by the transceiver. Compared to bar codes, RFID (1) does not require clear line of sight between an object and RFID hardware, (2) can store much larger quantities of data, and (3) can offer both read and write capabilities.

A major catalyst for RFID usage in logistics was a Walmart mandate that by January 1, 2005, its top 100 suppliers deploy RFID tags on shipments into one particular Walmart distribution center in Texas. While this goal has not been realized, Walmart’s mandate jumpstarted a technology that had existed since the 1940s but that had not been widely used by organizations. As a result, there has been significant improvement in the technology and costs are coming down. The apparel and healthcare industries are approaching a critical mass of users. Many large retail companies are using RFID to track individual items of clothing and roughly 10 percent of hospitals in the United States have some form of RFID system installed.27

A number of benefits have been reported by adopters of RFID technology. For example, dramatic reductions (between 20 percent and 50 percent) in inventory stockouts have been reported by Walmart and some of its suppliers.28 In addition, RFID reduced the time needed to count inventory by 80 percent and improved the accuracy of inventory counts at one clothing retailer.29 Despite the potential benefits associated with RFID, various challenges must be addressed before the technology becomes more widely used in logistics. A major drawback to more widespread RFID

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adoption involves the costs of installing the related hardware and software, which can range from $100,000 for smaller companies to $20 million for larger companies.

Another drawback to RFID involves privacy concerns, such as the inappropriate use of the technology. For example, a major retailer embedded RFID chips into a particular line of cosmetic products, and consumers who selected this product from the store shelf were beamed, via webcam, to the manufacturer’s headquarters! Yet another drawback is that data accuracy can be lower in items with high moisture content, such as fruits and vegetables.

Management Information Systems (MIS) and Executive Information Systems (EIS)

These systems convert TPS data into information for monitoring performance and managing an organization, with the objective of providing managers and executives with the information they really need. To this end, a logistics information system (LIS) can be defined as “the people, equipment, and procedures to gather, sort, analyze, evaluate, and distribute needed, timely, and accurate information to logistics decision makers.”

As shown in Figure 2.2, an LIS begins with a logistics manager requesting information and ends with the manager receiving regular and customized reports. For logistics managers to receive needed information, it’s important that they be fairly specific when submitting requests. For example, a logistics manager who wants information about a specific warehouse or distribution center needs to request information on, say, “the Chicago warehouse,” rather than information on “corporate warehouses.”

Timely information would appear to be incumbent on the effectiveness and efficiency of a company’s particular LIS and timely information can encompass several dimensions. However, timely can refer to the up-to-date status of information, which can be influenced by a company’s collection and analysis procedures. Information collection should emphasize both internal and external sources; unfortunately, internal sources of logistics information are not always as plentiful as desired. Indeed, research into the business value attributable to logistics discovered that “logistics measurement is happening much less frequently than one might imagine.” External sources focus on information from

Figure 2.2 Structure and Function of a Logistics Information System

outside the company and include information about customers, competitors, and suppliers, along with information about economic, technological, political, legal, and sociocultural environments.

*Timely* also can refer to how quickly managers receive the information requested; this is affected by each company’s retrieval and dissemination procedures. A manager’s ability to quickly receive information can be influenced by technology hardware and software, and faster and more powerful technology has helped reduce retrieval and dissemination times. Alternatively, retrieval and dissemination can be slowed by hardware and software glitches, including incompatible hardware or software, power outages, system crashes, and computer viruses.

*Accurate* information may also reflect the effectiveness and efficiency of a company’s logistics information system. As such, an LIS must be concerned with the nature and quality of the relevant data; for instance, although the Internet can provide access to tremendous amounts of external information at a very low cost, the validity of some Internet information is suspect. Keep in mind the *GIGO*—garbage in/garbage out—principle: Information that is erroneous, misrepresented, or unclear will likely result in poor decisions by logisticians.

**Decision Support Systems (DSS)**

*Decision support systems* help managers make decisions by providing information, models, or analysis tools, and they can be widely applied and used by logisticians. Specific uses of DSS in logistics include, but are not limited to, vehicle routing issues, inventory control decisions, developing automatic order picking systems, and optimization models for buyer–seller negotiations. Several of the more prominent logistics-related DSS techniques are discussed in the following paragraphs.

*Simulation* is a technique that models a real-world system, typically using mathematical equations to represent the relationships among the system’s components. Simulation reliability is achieved by making the model as akin to the real world as possible. Although simulation can be a powerful analytic tool, a poorly constructed simulation involving bad data or inaccurate assumptions about the relationships among variables can deliver suboptimal or unworkable solutions to logistics problems.

The primary advantage of simulation is that it enables the firm to test the feasibility of proposed changes at relatively little expense. In addition, it prevents firms from experiencing the public embarrassment of making a major change in their logistics system that might result in a deterioration of customer service levels or an increase in total operating expense.

A second type of DSS, which can be broadly labeled as application-specific software, has been developed to help managers deal with specific logistics processes or activities. Traditionally, application-specific software often involved customers purchasing a particular software package and then having the software installed (i.e., so-called “purchase and install”) on their computer(s). The purchase and install option was quite expensive in the sense that the software costs can approach $500,000 while implementation costs can run into the several millions of dollars.

An increasingly popular option for application-specific software is on-demand software (also referred to as software-as-a-service or cloud computing), or “software that users access on a per-use basis instead of software they own or license for installation.” A major advantage of on-demand vis-à-vis purchase and install software is on-demand’s pay-per-use model allows customers to avoid high capital investment costs (we’ll look more closely at on-demand software later in the chapter).

*Transportation management systems (TMS) and warehouse management systems (WMS)* are two prominent examples of logistics-related application-specific software. Indeed, an annual software survey conducted by *Logistics Management* magazine has consistently found that TMS and WMS software are the most likely applications to be purchased or upgraded. Due to their importance as logistical decision support systems, we’ll take a brief look at transportation management systems and warehouse management systems.

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A transportation management system is a software package that automates the process of building orders, tendering loads, tracking shipments, audits, and payments. Table 2.1 presents a representative list of 15 tasks that might be performed by a TMS package. Organizations that have implemented TMS software have reported decreases in empty vehicle miles, reduced fuel consumption, and reduced transportation expenditures.

The demand for TMSs continues to grow driven by several factors. These factors include the following: older TMS systems needing upgrades, the growth of intermodal transportation, the improvement of TMS capabilities beyond just execution, the emergence of the previously described “big data,” and a desire for more holistic solutions. In addition, the use of a TMS is now seen as one way for an organization to improve the environmental sustainability of its logistics activities. By using the information provided, companies can get their freight to where and when it is needed in a more environmentally efficient manner.

Warehouse management systems are software packages that provide oversight of the storage and flow of materials within a company’s operations. Activities that can be controlled by a WMS include inventory management, product receiving, determination of storage locations, order selection processes, and order shipping. Potential benefits of a warehouse management system include dramatic reductions in data entry errors as well as dramatic reductions in the travel distances for order picking. Other benefits of a WMS include reduced operating expenses, fewer stockouts, increased inventory accuracy, and improved service to customers.

Research has shown that firms that have adopted and implemented a WMS have significantly more efficient logistics processes than nonadopters. Adopters were found to spend less on their overall logistics processes, even though the costs of the WMS affected the costs of operating their warehouse. The results are largely driven by the increased visibility that is provided by the WMS.

Because of the many different TMS and WMS options that are available to a logistics manager, it’s important that an organization utilizes a software package that best suits its needs, as opposed to one from a “name” provider or one that offers many unneeded options. Moreover, the installation of a TMS or WMS can cause organizational upheaval in the sense that the organization will change its established approach to managing transportation and warehousing, and current employees will need varying degrees of training to become proficient with the new system.

<table>
<thead>
<tr>
<th>Task Capability</th>
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<tbody>
<tr>
<td>Asset tracking</td>
<td>Carrier selection</td>
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<tr>
<td>Claims management</td>
<td>Driver management</td>
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<td>Freight payment</td>
<td>Load planning</td>
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<td>Load tendering</td>
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<td>Rating</td>
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<td>Real-time route reporting</td>
<td>Route optimization</td>
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<td>Shipment consolidation</td>
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</tbody>
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Data mining, which can be defined as “the application of mathematical tools to large bodies of data in order to extract correlations and rules,”\(^\text{42}\) is a DSS technique that has grown in popularity in recent years. Data mining utilizes sophisticated quantitative techniques to find “hidden” patterns in large volumes of data; these patterns allow managers to improve their decision-making abilities as well as enhance their organization’s competitive advantage. Although data mining has been characterized as a “fishing expedition” of sorts—in the sense of applying sophisticated quantitative techniques merely to find relationships, whether meaningful or not—data mining, in reality, should follow a well-defined methodology.\(^\text{43}\)

Efficient data mining is dependent on data warehouses, that is, a central repository for all the relevant data collected by an organization. Walmart, which is acknowledged to have one of the world’s foremost data warehouses, and its vendors make extensive use of data mining to improve logistical effectiveness and efficiency. For example, data mining has allowed Walmart to discover that when hurricanes are projected to hit the state of Florida, demand dramatically increases for two products, beer and Kellogg’s Pop Tarts (a toasted pastry product)! So, when a hurricane is projected to hit Florida, Walmart makes sure that additional stocks of beer and Pop Tarts are available in its stores there.

An emerging technology that can assist logistics managers in using this increasing amount of available data is machine learning. This computer-based discipline leverages algorithms that can “learn” from data. These algorithms use data to build and constantly update their prediction models for activities such as forecasting. A machine learning system could use indicators such as Web page visits, time on site, and social media activity to better plan logistics activities.\(^\text{44}\) In addition, machine learning has been used as an early warning system for potential machine downtime. As such, machine learning has the potential to support logistics decision making from both a supply and demand side.

### Enterprise Systems

Enterprise systems, the final general type of information management system to be described, create and maintain consistent data processing methods and an integrated database across multiple business functions.\(^\text{45}\) The most prominent example of enterprise systems is probably enterprise resource planning (ERP) systems, which “lets a company automate and integrate the majority of its business processes, share common data and practices across the enterprise, and produce and access information in a real-time environment.”\(^\text{46}\) In theory, ERP systems (such as those offered by Oracle and SAP) allow all prospective users access to a single database when making decisions. The attractiveness of ERP systems comes from their potential for lowering costs (such as inventory reductions), as well as increasing productivity and customer satisfaction.

Although contemporary ERP systems encompass a firmwide perspective, their origins can be traced back to logistics and manufacturing in the form of inventory control and materials requirement planning programs.\(^\text{47}\) Unlike these earlier programs, today’s ERP systems (conceptually, at least) provide an opportunity for all functional areas within a firm to access and analyze a common database—which might not have been previously possible because (1) certain data were proprietary to a particular functional area and (2) of insufficient or slow computing capabilities.

One of the most frequently mentioned shortcomings of ERP systems involves the costs of installation. It is common knowledge that ERP software is relatively expensive; however, the software is only one part of ERP implementation costs. For example, the vast amounts of data necessary for ERP systems may necessitate new or upgraded computer hardware. Other hidden or frequently


overlooked costs of ERP implementation include employee training, data conversion (converting existing data into a usable and consistent format), integrating and testing a new system, maintenance costs, and consultant fees. Indeed, consultant fees can quickly ratchet up ERP implementation costs; there are suggestions that consultant fees may be three times more costly than the software itself. When all relevant costs are factored in, ERP installation costs can easily reach into the tens of millions of dollars, and installation costs in the hundreds of millions of dollars are not out of the question.

A second shortcoming is that implementation of ERP systems can be a very time-consuming process. Indeed, many of the hidden costs of ERP implementation mentioned in the previous paragraph are the result of hidden time associated with ERP implementation. For instance, employee training, data conversion, and integrating and testing the new system all require time beyond the installation of the ERP software itself. A general rule of thumb is that actual time to implement ERP systems may range from two to four times longer than the time period specified by the ERP vendor.

A third shortcoming of ERP systems is that they initially lacked strong application-specific logistical capabilities such as TMS or WMS. Many companies addressed this challenge by adding so-called “best of breed” (i.e., the best product of its type) logistical applications to their ERP programs, but the process associated with adding the respective software could be costly and time-consuming. In recent years, however, ERP vendors have begun to provide high-quality application-specific logistical capabilities, particularly with respect to WMS.

Given the preceding discussion on time and implementation costs, it is not surprising that some ERP installations do not go as smoothly as desired, and these ERP glitches occasionally have a logistical component to them. For example, ERP implementation problems at a leading manufacturer of home medical products caused the company to lower its revenue estimates for several time periods. From a logistical perspective, the ERP-related problems meant that the company missed shipment deadlines, could not respond to customer inquiries, and had limited information about order status. The order-related problems, in turn, resulted in a higher-than-normal level of returns associated with incorrect orders, and the missed shipment deadlines caused the company to spend more money for expedited transportation.

THE INTERNET’S INFLUENCE ON LOGISTICS

Although the Internet may appear to be a ubiquitous technology today, the reality is that only about 49 percent of the world’s population currently uses the Internet, up from approximately 5 percent of the world’s population at the beginning of the twenty-first century. Just as the Internet’s usage continues to expand during the twenty-first century, so does its influence on the logistics discipline. Although it is not possible to present a comprehensive discussion of the Internet’s influence on logistics, this section will discuss four specific influences—online retailing, cloud computing, electronic procurement, the Internet of things—of the Internet on the logistics discipline.

Online Retailing

It should be noted that there are logistical similarities between online retailing and in-store retailing. For example, many logistical functions and activities—such as transportation, warehousing, materials handling, and order management—occur in both. Likewise, both may use the same type of equipment and materials, such as bar coding and warehouse management systems.

Alternatively, meaningful differences exist between online and in-store retailing with respect to the execution of logistics activities. For example, the orders associated with online shopping tend

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51 www.internetworldstats.com
to be more plentiful and in much smaller quantities than those associated with in-store retailing. As such, online retailing requires an order management system capable of handling high volumes of orders, and it’s also essential that the information management system be capable of correctly transmitting each order so that it can be filled in a timely fashion.

In addition, because of smaller order quantities, online shopping is characterized by open-case, rather than full-case, picking; open-case picking is facilitated by materials handling equipment, such as totes and push carts. Moreover, open-case picking necessitates that products be slotted (placed) in locations that facilitate picking effectiveness and efficiency. Not surprisingly, online retailer’s smaller order quantities have important packaging implications as well, in the sense that companies need containers—small cartons, envelopes, bags—that are well suited to holding small quantities of product.52 Some companies that engage in both online and in-store retailing choose to outsource online’s pick-and-pack activities because they are so different than for in-store retailing.53

Two other key logistical considerations for online retailing involve transportation and returned orders. The smaller order quantities associated with online retailing tend to favor transport companies with extensive delivery networks and expertise in parcel shipments. This, in turn, suggests that outbound shipments tend to be picked up at a loading dock by small-capacity vehicles, such as delivery vans. Moreover, many online retailers are challenged by “last-mile” considerations (those related to delivering product to the customer) such as congestion, frequent stops, and return trips if the customer is not available to accept the delivery. Another emerging consideration is the use of same-day delivery of online orders. Companies such as Amazon, eBay, and Walmart are all looking at ways to offer their online customers the ability to receive their products the same day.54 In fact, Amazon is now offering a service called Prime Now in selected markets. This subscription service promises free 2-hour delivery for a subset of their home products and 1-hour delivery from Amazon affiliated-restaurants.55 While still in the pilot stage, the logistical implications of this strategy are immense.

Although returned orders are an issue in all types of retailing, the return rates associated with online shopping tend to be much higher than with other types of retailing; one estimate suggests 10 percent return rates for traditional forms of retailing, compared to approximately 30 percent for online purchases.56 Because many of these returns are from individual customers, not businesses or organizations, online retailers should attempt to make the return process as painless as possible. As such, when online customers receive their orders, they might also receive information on how to return the order, a return label, as well as a return container such as an envelope or bag. A relatively smooth and painless returns process not only improves return effectiveness and efficiency, but can also be an effective way of building and maintaining customer loyalty.57

Furthermore, it’s important to note that a “one size fits all” logistics strategy is not likely to facilitate the effectiveness and efficiency of online shopping. Rather, a variety of logistics strategies might need to be applied, and it is important to recognize the potential trade-offs associated with the different strategies. For example, one way of addressing the last-mile issue of customer unavailability would be to install some type of receptacle (e.g., a drop box) for the product at the customer’s residence. However, these receptacles might not be feasible for large items (such as a refrigerator), for perishable items (such as certain types of food), or for extremely valuable items (such as jewelry).

UPS, a global logistics provider, plans to install self-service parcel lockers in 300 locations across the United States. This is in direct response to a research study it commissioned which indicated that 35 percent of avid on-line shoppers desire deliveries at locations with extended hours and not at their

55www.amazon.com
56Saenz, “Picking the Best Practices.”
The challenges of implementing the appropriate logistics strategy, or strategies, for online shopping are exacerbated by the fact that (1) a particular customer may require vastly different levels of service depending on the product ordered and (2) a particular product may require vastly different levels of service depending on the customer ordering it. The previously mentioned cloud computing (an umbrella term including both on-demand software and software as a service) has experienced meteoric growth since the beginning of the twenty-first century. In fact, the worldwide public cloud services market—where software, services, or information are shared via the Internet without the users having control over the technology infrastructure—has grown significantly. There are a myriad of logistics-related applications for cloud computing, including collaborative forecasting and inventory optimization, with transportation management systems emerging as the most popular on-demand application.

One reason for cloud computing’s popularity is that its pay-per-use formula allows customers to avoid high capital investment costs, which speeds up return on investment for the software. In addition, because cloud computing involves operational as opposed to capital expenditures, it becomes a viable option for many companies that could not afford to purchase, install, and maintain application-specific software such as transportation management systems and warehousing management systems. Moreover, the worldwide economic slowdown that began in 2007 has caused many organizations to slash their information technology expenditures, thus benefiting cloud-based applications. Other advantages to cloud computing include faster and less-costly installation, a smaller information technology staff, and regular upgrades and updates from the software provider. As such, companies such as Red Prairie, a provider of productivity software, are now offering cloud-based deployment of TMSs and WMSs.

Although cloud computing appears to be quite attractive, particularly from a financial perspective, it has several potential drawbacks. For example, the regular software upgrades and updates mentioned earlier can sometimes be too numerous and too frequent, and customers can struggle to keep up with them. Moreover, cloud-based software allows for a limited amount of customization, meaning that customers need to fit what they’re doing to what the software can achieve. And, because the Internet is the primary transaction medium for cloud-based software, security issues such as data protection have been identified as a key concern.

Electronic procurement (e-procurement) uses the Internet to make it easier, faster, and less expensive for an organization to purchase goods and services. The types of benefits that come from electronic procurement include transactional benefits, compliance benefits, management information benefits, and price benefits. Transactional benefits are a measure of the benefits of enhanced transactional efficiency (e.g., a reduced invoice-to-payment time) associated with e-procurement. Compliance benefits focus on the savings that come from adherence to established procurement policies. Management information benefits encompass those that result from management information, customer satisfaction, and supplier satisfaction levels after implementation of electronic procurement. Price

64Hannon, “On-Demand Brings Spend Control.”
**Internet of Things**

The **Internet of things (IoT)** refers to the sensors and data-communication technology that is built into physical objects that enables them to be tracked and controlled over the Internet. The IoT concept has been around since the early 2000s, but has recently emerged as an important area of focus for the logistics discipline. While the traditional Internet connected computers to one another, the IoT extends this connection to other types of physical objects. These new connections can provide valuable information and business insights that can be used by logistics managers to reduce costs and improve service.

The potential benefits of the IoT extend across all types of logistics activities, including such areas as warehousing, transportation, and last-mile delivery. For example, a forklift being used within a warehouse setting to move products can now be the source of valuable information accessed via the Internet. This forklift can be equipped with wireless connectivity, data storage, and sensors that can provide a variety of operational data about itself and the environment it operates within. For example, the forklift could alert a warehouse manager to potential mechanical or safety issues prior to anything occurring. The forklift could also provide enhanced visibility of inventory within the warehouse. Thus, the forklift moves beyond just moving a product, to become a mobile information hub that collects and processes information for enhanced logistics performance.

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68 Ibid.
70 Ibid.
Part I • Overview of Logistics

Research suggests that the IoT has the potential to generate approximately $8 trillion worldwide in value over the next decade. The supply chain and logistics area is expected to contribute an estimated $1.9 trillion to this number. In particular, the IoT is expected to drive value in the supply chain and logistics disciplines through improvements in employee productivity and enhanced customer interactions.\textsuperscript{71} While the number of things connected to the Internet is expected to triple in the next five years, this still only represents a tiny fraction of all the physical objects that could ultimately be connected. Thus, the IoT is still defining the ways and the extent to which it will influence the logistics discipline.

INFORMATION TECHNOLOGY CHALLENGES

Thus far, this chapter has presented various challenges associated with specific types of information technology. We conclude this chapter with a discussion of several macro-level information technology challenges, or those challenges that might be faced regardless of the type(s) of information technology being utilized.

One macro-level challenge is the recognition that information technology is a tool that can help managers address organizational problems and is not a panacea or a be-all/end-all solution for organizational problems. This can be illustrated by the situation of a senior manager whose disorganization caused him to often miss regularly scheduled meetings with various constituencies. The senior manager and his boss decided to “solve” the missed meeting problem by providing the manager with a smart phone that contained a calendar detailing the time and place of his various meetings. Unfortunately, the senior manager continued to miss regularly scheduled meetings because he occasionally failed to (1) carry the smart phone with him; (2) have the smart phone turned on; and (3) upload the meeting information into the smart phone’s calendar. In this situation, the technological “solution” could not address—and may have actually exacerbated—the manager’s disorganization.

Security concerns represent another macro-level information technology challenge, and these security concerns have many dimensions. For example, research indicates that information security is the most important technology issue that companies face today.\textsuperscript{72} Moreover, the theft of proprietary information for an “average” company is estimated to cost approximately $300,000 annually.\textsuperscript{73} Increasing reliance on the Internet for logistics activities such as ordering and shipment tracking makes it essential that websites are as secure as possible from computer viruses or computer hackers that could compromise a customer’s access to those websites.

Yet another security concern involves the decreasing size and increasing portability of technology devices such as laptop computers, flash drives, and smart phones. These smaller technology devices are more susceptible than larger technology devices to loss or theft, and it’s important to recognize that the loss or theft of small, portable technology devices cause an organization to lose both the device and the data stored on the device. A particularly noteworthy example involved an intern for the state of Ohio who had a laptop computer, containing personal data on approximately 1 million residents of Ohio, stolen from her car.

A third information technology challenge involves human resource issues. Importantly, people-related factors such as employee resistance have been identified as a major cause of information technology implementation failure.\textsuperscript{74} Technology addiction, another human resource issue, is a growing concern in society. Underscoring the potential seriousness of technology addiction is whether an employer can be held liable for an employee’s technology addiction.

\textsuperscript{71}www.dhl.com/content/dam/Local_Images/g0/New_aboutus/innovation/DHLTrendReport_Internet_of_things.pdf
Summary

This chapter discussed key issues of logistics and information technology. Six general types of information management systems were examined, with a particular emphasis on relevant logistical applications. Topics discussed include global positioning systems, electronic data interchange, application-specific software, and enterprise resource planning systems. The chapter also looked at the Internet's influence on logistics in terms of four issues: online retailing, cloud computing, electronic procurement, and the Internet of things. A discussion of information technology challenges—such as the recognition that information technology is a tool and not a panacea—concluded the chapter.

Key Terms

- Application-specific software
- Big data
- Cloud computing
- Data
- Data mining
- Data warehouses
- Electronic data interchange (EDI)
- Electronic procurement (e-procurement)
- Enterprise resource planning (ERP) systems
- Global positioning systems (GPS)
- Information
- Internet of things (IoT)
- Logistics information system (LIS)
- Logistics optimization models
- Machine learning
- On-demand software (also referred to as software-as-a-service)
- Radio-frequency identification (RFID)
- Reverse auction
- Simulation
- Transportation management systems (TMS)
- Warehouse management systems (WMS)
- Wireless communication

Questions for Discussion and Review

2.1 In what ways can information be helpful in logistics and supply chain management?

2.2 List the six general types of information management systems, and give one logistics application for each one that you've named.

2.3 Do you view the spreadsheet as the most relevant general software package for logisticians? Why or why not?

2.4 How can communication systems facilitate logistics management in the aftermath of situations such as terrorist attacks and natural disasters?

2.5 What are some of the advances in telecommunications technology that have occurred since this book was first published? How do these advances help logistics managers?

2.6 Discuss how global positioning systems have become quite valuable in transportation management.

2.7 Discuss the benefits and drawbacks of EDI.

2.8 Discuss the relationship between automatic identification technologies and point-of-sale systems.

2.9 Why are some companies hesitant to adopt RFID technology?

2.10 Discuss the importance of timely and accurate information to a logistics information system.

2.11 What benefits are associated with transportation management and warehouse management systems?

2.12 What is data mining? How might it be used in logistics?

2.13 Discuss advantages and disadvantages of enterprise resource planning systems.

2.14 Refer back to the logistical activities listed in Chapter 1; select one that you're interested in and research how they have been influenced by the Internet. Are you surprised by your findings? Why or why not?

2.15 From a logistical perspective, what are some of the differences between online and in-store retailing?

2.16 Why is a “one size fits all” logistics strategy not likely to facilitate effective or efficient online shopping?

2.17 Discuss the advantages and disadvantages of cloud computing.

2.18 Discuss the benefits and drawbacks to electronic procurement.

2.19 What is the Internet of things (IoT)? How can it potentially affect logistics management?

2.20 What are some of the macro-level information technology challenges that managers face?

Suggested Readings


Hazen, Benjamin T. and Terry Anthony Byrd. “Toward Creating


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**CASE**

**CASE 2.1 TO INVEST OR NOT TO INVEST? THAT IS THE QUESTION**

Dean Pallotta was president and CEO of a medium-sized firm that manufactured highly customized tiny homes (Mini) in Toledo, Ohio. The firm had expanded from a local Midwest market to a national one, including Southern California and New England. As markets had expanded, so too had sources of supply for the company, with major suppliers of key building components located in Southern California, the Pacific Northwest, and Michigan. Additionally, smaller suppliers of building components were located around the globe. The decision to manufacture the Mini in Ohio had been made for two reasons: Dean’s former associates in the auto industry were close by in Detroit, and the largest single component of the Mini—the truck or van chassis on which the rest of the home is built—was purchased from one of the U.S. light-truck makers with a plant in Michigan.

Like others in the field, Dean’s company actually manufactured very few of the building components it used to manufacture the Mini. Virtually the entire home was assembled from components sourced from outside vendors. There was, however, a well-defined order in which the building components could most efficiently be assembled. Recently, it had become clear to Dean that warehouse and inventory costs associated with all of the required building components were a relatively large portion of his expenses and that they might be ripe for a substantial reduction. In particular, he had been considering a decision to invest in a warehouse management system (WMS) to increase his visibility of the large amount of inventory in his warehouse which was located next to his production plant. Transportation costs were an emerging secondary concern, as it had become increasingly difficult to plan shipments as they expanded into new markets and sourced from a larger number of suppliers. Thus, he was also intrigued about the potential benefits of implementing a transportation management system (TMS).

In response to these challenges, Dean had assembled a cross-functional team to look at some potential technology-based solutions. The team was made up of himself, Jason Shea (VP of Logistics), Stephanie Zinger (Director of Purchasing), Ethan Mathews (Plant Manager), Jason Paul (Inventory Planner), and Augie Augustson (Warehouse Manager). Some of the potential benefits the team had identified for implementing a WMS included:

1. Enhanced productivity for warehouse labor management
2. Increased visibility and traceability of inventory
3. Fewer picking errors
4. Improved responsiveness to the production plant
5. Less paperwork
In terms of the TMS, potential benefits were considered to be:

1. Increased service to customers, particularly on the West Coast
2. Potential to pool inbound shipments to reduce costs
3. Potential inventory reductions from more reliable deliveries
4. Cash flow improvements from enhanced freight payment
5. Improved warehouse efficiency on inbound shipments

In addition, several members of the team were advocating the idea of implementing both technologies together so as to increase the potential to optimize both areas jointly. The argument was that these technologies tended to be implemented in silos and that the real value would be obtained by aligning them in support of overall company goals.

As they discussed their options, the team also raised a number of concerns. Dean was very concerned about the possible issues that might arise as he had previously worked at a company that had gone through a difficult ERP implementation. In particular, he had experienced first-hand the challenges of implementation. So, while the potential benefits were exciting, the idea of embarking on a WMS and/or TMS implementation was daunting to the team. Not only was their apprehension about the significant capital investment required to purchase the software, but the potential difficulty in implementing the software was a major concern. In particular, they worried about the time it would take and how the employees would react to the changes.

<table>
<thead>
<tr>
<th>TMS Project</th>
<th>WMS Project</th>
<th>WMS/TMS Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Benefits</td>
<td>$573,000</td>
<td>$245,000</td>
</tr>
<tr>
<td>NPV</td>
<td>$409,938</td>
<td>$172,902</td>
</tr>
<tr>
<td>ROI</td>
<td>85%</td>
<td>75%</td>
</tr>
<tr>
<td>Payback Period (months)</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Profitability Index</td>
<td>673%</td>
<td>590%</td>
</tr>
<tr>
<td>Upfront Costs</td>
<td>$100,000</td>
<td>$50,000</td>
</tr>
<tr>
<td>Risk</td>
<td>Medium</td>
<td>Low</td>
</tr>
</tbody>
</table>

With regard to their suppliers, Stephanie often had the opportunity, in the volatile mini-motor-home market, to buy out parts and component supplies from manufacturers that were going out of business. Those components could be obtained at a substantial savings, with the requirement that inventory in the particular parts be temporarily increased or that purchases from existing vendors be temporarily curtailed. She wondered how these opportunities would affect the potential benefits of the technology investments.

Ethan operated with the (generally tacit) assumption that there would be some defective components purchased and that there would likely be something wrong with his product when it first came off the assembly line. For this reason, the Minis were extensively tested (Their advertising said, “We hope you’ll never do what we do to your Mini.”), as were the building components prior to installation. To the extent that only a few of a particular type of component were on hand or that the lead time became less certain, the interruption in the production schedule would be that much greater. It might entail expensive rush orders for replacement components or equally expensive downtime for the entire plant.

Despite these concerns, Dean was painfully aware that ignoring the warehousing and transportation problems would be a mistake. Something had to be done. While they were currently feeling the strain in the warehouse, the transportation issues were beginning to be a bigger issue. As an aid to making the decision on whether to invest in a WMS and/or a TMS, Dean had worked with the team to draw up a table that summarized the anticipated impacts of implementing the technologies (see Exhibit 2.A). The figures are based on input from the potential technology providers, forecasts from his marketing department, cost projections from their IT department, and inputs from...
the team members. As Dean reviewed the information in preparation for the next team meeting, he wondered what decision they should make.

QUESTIONS

1. Should the team take into account any other costs or benefits from implementing the WMS? If so, what are they?

2. Should the team take into account any other costs or benefits from implementing the TMS? If so, what are they?

3. What are the advantages and disadvantages of implementing both technologies simultaneously?

4. If both technologies are adopted, what changes, if any, should occur in the relationships between Pallotta’s firm and his suppliers of components? His transportation providers? Discuss.

5. What would you recommend the team decide to do? Why?
As was described in Chapter 1, an effective and efficient logistics function plays a crucial role within most organizations. Shorter product lifecycles, increasing customer expectations, technological advancements, rising shareholder demands, and the globalization of corporate supply chains are all pushing firms to develop efficient, effective, and differentiated logistics activities. Research has continuously demonstrated that logistical activities can be an important consideration for achieving exceptional levels of customer service and ultimately contributing to firm financial performance.

For example, housewares retailer Williams-Sonoma was able to significantly increase its profits through logistics gains from implementing enhanced distribution accuracy programs that helped improve customer service levels and reduce inventory shrinkage.

Management of reverse logistics provides another potential way for managers to make decisions that influence their firm’s financial performance. Improvements to one’s reverse logistics system could provide cost improvements and/or revenue enhancement opportunities. Depending on the industry and product type, reverse logistics costs as a percent of revenue can range between 3 and 6 percent. Estée Lauder (a manufacturer of cosmetics, skin care, and fragrances) made an investment of $1.3 million to build a system of scanners and other technologies to assist its reverse logistics efforts. With respect to cost improvements, this system enabled Estée Lauder to sharply reduce the percentage of returned goods that it dumped into landfills while also providing half a million dollars in labor cost savings. In terms of revenue enhancements, the system is a key part of a $250 million product line based on returned cosmetics. Estée Lauder collects items and then sells them to seconds stores or to retailers in developing countries.

Learning Objectives

3.1 To understand how logistics decisions can influence an organization’s strategic financial outcomes
3.2 To review basic financial terminology used by logistics managers
3.3 To explain organizational financial reporting requirements affected by logistics activities
3.4 To employ the strategic profit model to highlight the financial impact of logistics activities
3.5 To consider the value of utilizing the Balanced Scorecard approach for examining the performance of a logistics system
3.6 To compare some of the common performance measures for logistics activities

Another example of how logistics strategy connects to corporate strategy and financial performance can be seen in the area of transportation. Logistics managers are adapting their approaches to transportation in response to financial pressures caused by oil price volatility and shipping capacity constraints. In an effort to maintain profit margins, organizational leaders are considering strategic changes such as shifting from offshoring to nearshoring; integrating consideration of the ability to ship a product into product design; and applying a lean perspective to both inventory and transportation policies. Each of these logistics-related strategic decisions helps address financial issues resulting from today’s dynamic business environment.

Developing financial fluency is a critical skill for contemporary logistics managers. Dr. Jarrod Goentzel and James Rice from MIT provide several suggestions on areas for logistics managers to focus on when first developing this fluency. To start, it is important to understand the financial impact of logistics activities. An understanding of the key financial statements outlined in this chapter can serve as a starting point. Second, logistics managers need to be able to distinguish the role of profitability and turnover in creating financial returns. This can be achieved through an understanding of the strategic profit model discussed later in the chapter. Third, it is important to recognize that accounting is an inexact science. Thus, logistics managers should work with their colleagues in accounting to understand the methods used in their company in order to understand the dependability of the information they are provided. Fourth, activity-based costing is challenging to implement, but offers significant benefits. This approach to costing is described in Chapter 7, and the value for customer profiling is highlighted. Fifth, it is important to recognize the nuances of inventory carrying costs. Details on how to consider these costs are covered in Chapter 8. Sixth, an understanding of cash flows is relevant for logistics managers. The description of the Statement of Cash Flows in this chapter provides guidance. Finally, logistics managers should have an appreciation for how their activities affect working capital. As such, understanding how logistics decisions influence inventory management, accounts receivable, and accounts payable is valuable.

This chapter provides an overview of how an organization’s strategic financial outcomes are influenced by logistics decisions. We begin with a description of the connection of functional logistics strategy to overall corporate strategy and ultimately financial performance. Next, a general overview of key financial terminology will be presented. Financial reporting requirements that affect logistics managers are then described. This is followed by an examination of how the strategic profit model can be used to highlight how logistics activities influence the key corporate financial measures of net income, capital employed, and return on capital employed. The chapter concludes with a description of the Balanced Scorecard and common logistics performance measures in the areas of transportation, warehousing, and inventory.

**CONNECTING STRATEGY TO FINANCIAL PERFORMANCE**

A recurring theme in the logistics discipline is that an organization’s logistics capabilities need to be directly connected to objective (as opposed to subjective) firm performance measures. In addition, this viewpoint asserts that logistics managers must continue to find ways to effectively communicate how their firm’s logistics capabilities provide value and ultimately support corporate strategy and success in financial terms. In fact, an international survey of manufacturing firms reported that

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logistics performance was important or very important for achieving competitive advantage by almost 70 percent of the respondents.\(^9\)

Strategy can be formulated at a corporate level, a business unit level, and a functional level. Corporate level strategy is focused on determining the goals for the company, the types of businesses in which the company should compete, and the way the company will be managed. Typically, organizations strive to create value by effectively managing a portfolio of businesses and ensuring that each of these businesses is financially successful.

Strategy at a business unit level is primarily focused on the products and services provided to customers and on finding ways to develop and maintain a sustainable competitive advantage with these customers. Renowned strategist Michael Porter has identified three generic strategies that can be pursued by an organization, namely, cost leadership, differentiation, and focus. A \textit{cost leadership strategy} requires an organization to pursue activities that will enable it to become the low cost producer in an industry for a given level of quality. A \textit{differentiation strategy} entails an organization developing a product and/or service that offers unique attributes that are valued by customers and that the customers perceive to be distinct from competitor offerings. Finally, a \textit{focus strategy} concentrates an organization's effort on a narrowly defined market to achieve either a cost leadership or differentiation advantage.\(^10\) Logistics leverage can help firms achieve a competitive advantage from each of these strategies.\(^11\)

The functional level of the organization is where logistics resides. The strategic issues at this level are related to business activities that support the achievement of the higher-level goals set by the business unit and corporation. This \textit{hierarchy of strategy} entails the functional units of an organization providing input into the other levels of strategy formulation. This input could take the form of information on the resources and capabilities available to the organization. After the corporate level and business unit strategies are developed, the functional units must translate these strategies into discrete action plans they must accomplish for the higher-level strategies to succeed.

Functional level strategies will exist in such areas as marketing, finance, manufacturing, procurement, and logistics. Logistics strategy decisions involve issues such as the number and location of warehouses, the selection of appropriate transportation modes, the deployment of inventory, and investments in technology that support logistics activities. In addition to being influenced by the goals of the corporate and business unit strategies, logistics strategy is directly influenced by strategic decisions in the functional areas of marketing, finance, manufacturing, and procurement. Marketing goals in areas such as product availability, desired customer service levels, and packaging design directly influence logistics decisions that must be made to support achievement of these goals or to provide information for strategy formulation in these areas. Financial hurdle rates of return may affect the decision to manage one's own warehouse or use a third-party provider. Similarly, a strategic decision by manufacturing to implement a just-in-time system would affect logistics decisions in areas such as warehousing, transportation, and inventory management. In terms of the connection to procurement strategy, the decision to move from domestic to global sourcing would naturally affect logistics activities such as the potential use of new modes of transportation and port selection.

With respect to logistics organizational forms, Professors Bowersox and Daugherty identified three orientations that can be used in isolation or in combination when developing a logistics strategy. These orientations include: \textit{process strategy} (management of logistics activities with a focus on cost); \textit{market strategy} (management of logistics activities across business units with a focus on reducing complexity for customers); and \textit{information strategy} (management of logistics activities with the goal of achieving coordination and collaboration through the channel).\(^12\) These strategies have been


found to remain stable over time and provide a basis for meeting organizational goals. Although most firms will have a dominant orientation that represents their strategic thrust, these forms are likely to interact.

The ability of the logistics function to ultimately influence the overall financial success of an organization is based on the ability of logistics managers to develop and implement strategies that are aligned with the overall corporate strategy. Research has shown the positive affect of this alignment of functional level strategies with higher-level strategies on financial performance. Specifically, logistics strategy must be designed to optimally support the requirements of the business and the corporation in order to positively affect the financial outcomes of an organization. Thus, an appreciation for this interconnectedness and need for alignment of strategies is important for every logistics manager.

As an example, omnichannel commerce is a business trend that is affecting all levels of strategy in the retail industry. An omnichannel strategy allows retail customers to order products anywhere, any time, and on any device, while also allowing them to take delivery when and where they want. Retailers report motivations for pursuing this strategy as being driven by their desire to increase sales, increase market share, and improve customer loyalty. The ability to build a profitable omnichannel commerce system that provides this level of ordering and delivery flexibility requires support from all business functions, with the logistics function providing support through transportation, warehousing, and order fulfillment decisions.

### Basic Financial Terminology

Logistics managers in every organization are expected to use financial information to help them make decisions, allocate resources, and budget expenses. Having a basic understanding of financial terminology is important knowledge in assisting logistics managers to formulate intelligent questions for other functions as well as understanding how logistical activities can help improve their company’s financial performance. In addition, an ability to communicate the financial implications of logistics decisions to upper-level management is an important skill for managers to develop. Some of the more important financial terms are described in the following sections.

#### Income Statement

The income statement shows revenues, expenses, and profit for a period of time, and an example is presented in Figure 3.1. It can also be referred to as a profit and loss statement (P&L). In general, the income statement measures the profitability of the products and/or services provided by a company. It reports the revenues generated by company activities during a given period of time, the expenses associated with achieving these revenues, and the profit or loss that is a result of these activities. Revenues, also referred to as sales, provide a dollar value of all the products and/or services an organization provides to their customers during a given period of time. Expenses, also referred to as costs, provide a dollar value for the costs incurred in generating revenues during a given period of time.

Logistics managers need to understand how logistics costs influence the profits or losses being incurred by their firm so that they can make appropriate decisions. While it is not always possible for a logistics manager to directly correlate logistics service improvements with an increase in sales, there should be no doubt that superior logistics service can have a positive influence on an organization’s financial performance.

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More obvious direct correlations of logistics decisions occur across the expense categories of the income statement. Specifically, cost of goods sold may be influenced directly by procurement decisions and inbound transportation costs that are part of a product acquisition agreement. In addition, the potential to reduce several of the operating cost categories associated with logistics can be significant. Because a large percentage of costs for a typical organization are driven by logistics decisions, many organizations spend considerable time focusing on this connection between logistics and financial performance.15

More efficient and effective decisions in the areas of transportation, warehousing, and inventory costs offer great potential for logistics managers to directly influence overall financial performance. Referring to Figure 3.1, a decrease in transportation, warehousing, and/or inventory costs (assuming no change in logistics service performance) translates into lower total operating costs and higher earnings before interest and taxes. In addition, the ability of logistics managers to do more with less in areas such as inventory, plant, and equipment can ultimately affect the interest and tax expense categories on the income statement. As can be seen in Figure 3.1, the ability to lower these costs will fall directly to the bottom line (i.e., higher net income).

**Balance Sheet**

The balance sheet reflects the assets, liabilities, and owners’ equity at a given point in time. The balance sheet equates assets with liabilities plus owners’ equity. Assets are what a company owns and come in two temporal forms: current assets that can be easily converted to cash (such as stock) and long-term assets that have a useful life of more than a year (such as a company-owned warehouse). Liabilities are the financial obligations a company owes to another party. Similar to assets, liabilities come in two temporal forms: current liabilities which need to be paid in less than a year and long-term liabilities that are due over an extended period of time. Owners’ equity is the difference between what a company owns and what it owes at any particular point in time.

Figure 3.2 is an example of a basic balance sheet. As is the case with the income statement, logistics can affect the balance sheet of an organization in several distinct ways. Order cycle time, order completion rate, and invoice accuracy can influence the speed in which one’s customers pay their invoices, thus directly affecting the cash and accounts receivables categories on the balance sheet. Clearly, inventory management decisions that raise or lower inventory levels show up in the

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Part I • Overview of Logistics

inventory category. Expansion of company-owned warehouses and/or acquiring additional equipment to use in one’s warehouses will flow through to the fixed assets category. In terms of liabilities, procurement’s purchase order quantities are reflected in current liabilities, and financing options for inventory, plant, and equipment could impact long-term debt levels.16

Statement of Cash Flows

The statement of cash flows details how an organization generates cash and where cash is used during a defined period of time. Positive cash flow enables an organization to continue daily operations, make investments for growth, meet financial obligations, and ultimately remain in business. This financial report contains information from the income statement and balance sheet, but is formatted to highlight the sources and uses of cash in an organization’s operations, investing, and financing activities. Accounts payable, accounts receivable, revenue growth, gross margin, sales—general and administration, capital expenditures and inventory are all areas that affect cash flows within an organization. As such, logistics activities can have important implications for an organization’s cash management within each of these areas. In terms of the statement of cash flows, the connections between logistics activities and cash flows occur primarily in the operating and financing areas.

Figure 3.3 is an example of a basic statement of cash flows. Within the operations section, logistics connections related to the cash paid for inventory purchases and wages paid to warehouse personnel can be seen. Inventory sits in warehouses and ties up cash, while also draining cash through obsolescence and shrinkage. In terms of investing activities, both receipt or payment of cash for logistics-related property and equipment can be identified. Investments in private transportation fleets, building or acquiring new warehouses, or purchasing new software to help manage logistics activities are all examples of expenditures that require significant amounts of cash to finance the decision.

REPORTING REQUIREMENTS

The Sarbanes-Oxley Act (SOX) was instituted on July 30, 2002 in response to business misconduct in the late 1990s and early 2000s. The act focused on restoring investor confidence by providing increased transparency in financial reporting for public companies. Three primary areas where SOX has implications for logistics managers are internal controls, off balance sheet obligations, and timely reporting of material events. In terms of internal control, timely and accurate accounting of inventory

Learning Objective 3.3

Balance Sheet 2016

<table>
<thead>
<tr>
<th>Assets</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>$20,000</td>
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<tr>
<td>Accounts Receivable</td>
<td>$35,000</td>
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<tr>
<td>Inventory</td>
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</tr>
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<td>Total Current Assets</td>
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<tr>
<td>Net Fixed Assets</td>
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<tr>
<td>Total Assets</td>
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</table>

<table>
<thead>
<tr>
<th>Liabilities</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Current Liabilities</td>
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<tr>
<td>Long-term Debt</td>
<td>$30,000</td>
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<td>Total Liabilities</td>
<td>$90,000</td>
</tr>
<tr>
<td>Shareholders’ Equity</td>
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</tr>
<tr>
<td>Total Liabilities and Equity</td>
<td>$150,000</td>
</tr>
</tbody>
</table>

Figure 3.2 Example Balance Sheet

16Ibid.
is expected. With respect to off balance sheet obligations, compliance with SOX can involve providing transparency of external relationships with suppliers to manage inventory and/or purchasing agreements. Finally, timely reporting of material events involves the need to provide visibility of late supplier deliveries and/or the inability of suppliers to provide the products or services that are expected to drive revenue for the organization.

### STRATEGIC PROFIT MODEL

Several general measures of performance reflect on an organization’s financial results and should be understood by logistics managers. As was discussed in the income statement section, profit is a basic financial measure that represents the difference between revenues and expenses. While a raw number such as profit would seem to be adequate, there are issues with reporting financial figures without an appropriate context. Therefore, many financial measures are reported as ratios that indicate the relationship of one number to another. Ratios provide a point of comparison and can provide management with more information than raw numbers alone. For example, the **current ratio**, which is calculated by dividing **total current assets** by **total current liabilities**, measures how well an organization can pay its current liabilities by using only current assets.

Profitability analysis is an important means of assessing logistics activities and proposed changes to a firm’s logistics system. Profitability analysis goes beyond just focusing on logistics costs by attempting to also include the revenue effect of logistical activities. For example, an improved level of service provided by higher levels of safety stock should bring about increased revenue as customers respond to improved in-stock availability. These revenue effects must be built into the analysis of logistics performance.

A common measure of organizational financial success is Return on Investment (ROI), which can be measured by Return on Net Worth (RONW) or Return on Assets (ROA). RONW measures the profitability of the funds that have been invested in the business, and is most likely of primary interest to investors. ROA provides a more operational perspective by providing insight on how well

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managers utilize operational assets to generate profits. Thus, ROA becomes a key managerial tool for logistics profitability analysis.

**Return on assets (ROA)** indicates what percentage of every dollar invested in the business ultimately is returned to the organization as profit. Logistics managers are inherently concerned with assets such as inventory and equipment used to support logistics activities. Although these types of assets will show up on the balance sheet, ROA will allow managers to understand how effective their organization is in using these assets to generate profit. The formula for ROA is:

\[ \text{ROA} = \frac{\text{Net Profit Margin}}{\text{Asset Turnover}}. \]

The **Strategic Profit Model (SPM)** provides the framework for conducting ROA analysis by incorporating revenues and expenses to generate net profit margin, as well as an inclusion of assets to measure asset turnover. **Net profit margin** measures the proportion of each sales dollar that is kept as profit, while **asset turnover** measures the efficiency of the capital employed to generate sales. Together, they form the basis for computing ROA. Figure 3.3 provides the general framework for how to develop a SPM to better understand how a logistics manager’s decisions can impact net profit margin, asset turnover, and ultimately, ROA. Suppose, for example, that a logistics manager is able to eliminate some unnecessary inventory; this would reduce the value of current assets as well as total asset value. As a result, sales divided by total assets—asset turnover, would be higher, as would the organization’s return on assets.

The SPM has the advantage of assisting logistics managers in the evaluation of cash flows and asset utilization decisions. It provides a way for managers to examine how a proposed change to their logistics system influences profit performance and ROA. However, it fails to consider the timing of cash flows, is subject to manipulation in the short-run, and fails to recognize assets that are dedicated to specific relationships.\(^\text{18}\)

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Logistics Connections to Net Profit Margin

Operationally, net profit margin is net profit divided by sales, and looking at net profit and sales as reported on the income statement suggests multiple ways in which net profit margin can be influenced by managerial decisions. The most relevant categories for logistics managers to consider are sales, costs of goods sold, and total expenses.

**Sales** are the dollar value of all the products or services an organization provides to its customers during a given period of time. The primary influence of logistics activities on sales would be through the improvement of customer service. For example, one logistics decision that could be made by an e-commerce company would be to provide overnight delivery to its customers at no cost. While this type of decision would need to consider the cost implications of providing this level of service, it would be expected that the move would have a positive influence on customer retention and sales.

**Cost of Goods Sold** is one category of expenses. It includes all the costs or materials and labor directly involved in producing a product or delivering a service. A significant part of this expense category is the cost of materials that are used to make a product. As such, logistics can influence these costs through procurement activities (e.g., purchasing at volume discounts, reverse auctions) or through any logistics-related efficiency improvements that enable labor to be more productive (e.g., enhanced materials handling processes on a production line).

**Total Expenses** are made up of the variable and fixed costs that are not directly related to making the product or delivering a service. This expense category could include logistics-related activities in areas such as transportation, warehousing, and inventory. For example, a logistics decision to reduce the number of less-than-truckload shipments through a consolidation strategy would show up in the transportation costs category that is part of variable expenses. A decision to sell a company-owned warehouse could directly affect the fixed expenses of running the facility. In addition to understanding the financial effects of a logistics cost reduction, any potential cost increases should also be analyzed. For example, a decision to increase inventory levels in response to a marketing request would increase inventory carrying costs that flow to the variable expense category.

Logistics Connections to Asset Turnover

**Asset turnover** is computed by dividing total sales by total assets and provides information on the efficiency of capital employed to support the business. The most relevant logistics asset is typically inventory. In addition, logistics decisions can influence the speed at which invoices are paid as reflected in accounts receivable on the balance sheet.

**Inventory** can represent a significant part of an organization’s current assets. Logistics decisions affect all types of inventory within an organization from raw materials, to work-in-progress inventory, to finished goods. Logistics strategy on inventory levels and stocking locations will directly influence this category. For example, a decision by a retailer to move to a system of vendor-managed inventory where a supplier of a product maintains control and ownership over an inventory item can result in a significant reduction of the amount of inventory on an organization’s balance sheet. Similarly, the use of premium transportation may also enable a firm to reduce lead time and ultimately reduce pipeline inventory that would show up on the balance sheet.

**Accounts Receivable** is the amount of money customers owe to an organization. It is all the promises to pay that have not been collected yet. Logistics decisions can influence this category by accurately communicating and completing transactions with customers. For example, a decision to invest in an EDI system that would increase invoice accuracy should enable customer payments to be received in a timely fashion. Customers that receive inaccurate invoices will tend to hold payment until these issues are worked out.

**BALANCED SCORECARD**

The Balanced Scorecard (BSC) is a strategic planning and performance management system used extensively in industry, government, and nonprofit organizations. It is based on the belief that management should evaluate their business from four distinct perspectives: customers, internal business pro-
LOGISTICS ACTIVITY MEASURES

Performance measures are critical for effectively managing logistics activities. A continuing challenge for logistics managers is to develop and maintain an effective set of measures to help make decisions and support the achievement of financial success. As detailed in our description of the Balanced Scorecard, both financial and nonfinancial measures should be leveraged. In addition, the measures can be at a strategic, tactical, or operational level. While it is not possible to cover all potential logistics measures in this section, we will highlight some of the more common measures related to a few key areas of logistics management. The section will conclude by providing some guidance on how best to design and implement a system of logistics measures in an organization.

Logistics measurement systems have been traditionally designed to include information on five types of performance: (1) asset management, (2) cost, (3) customer service, (4) productivity, and (5) logistics quality. Several measures are designed and implemented in each of these categories to manage logistics activities such as transportation, warehousing, and inventory management. Research suggests that leading-edge organizations are highly focused on performance measurement across these five areas, and this serves as a platform on which competitive position, value-adding capabilities, and supply chain integration can grow.

Transportation Measures

The major transportation measures focus on such things as labor, cost, equipment, energy, and transit time. The diversity of equipment types, sizes, and products carried will complicate the performance measurement in this area of logistics. Measurements in this area include items such as return on investment (investments in transportation equipment), outbound freight costs, transportation labor productivity, on-time deliveries, and in-transit damage frequency, to name a few.

Many companies have turned to using scorecards to measure and improve transportation performance. In fact, one study found that while most of the companies they examined produced transportation scorecards monthly, Best in Class companies were twice as likely to be producing daily...
scorecards.\textsuperscript{23} Use of these scorecards reduced shipper complacency and enabled shippers to increase competition on lanes that led to freight cost savings.

\textbf{Warehousing Measures}

Performance measurement in warehousing is used to identify design and operations options that provide benefits in terms of increased speed or reduced costs.\textsuperscript{24} The primary warehousing measures include such things as labor, cost, time, utilization, and administration. As was the case with transportation, the diversity of warehouse types, sizes, and products carried will complicate the performance measurement in this area. Some common macrolevel measurements focused on warehousing include return on investment (investments in warehousing facilities or equipment), warehouse order processing costs, and warehouse labor productivity.

Common operational activities in a warehouse include: receiving, storage, picking, and shipping. There are a variety of metrics that could be used for each of these activities. For receiving, measures such as volume received per man-hour, cases processed per day, or receiving dock door utilization percentage may be appropriate. In terms of storage, measures such as percentage of location and cube occupied, pilferage costs, or storage cost per item could be used. Cost of picking per order line, pick accuracy percentage, or order lines picked per hour are examples of some of the picking measures that managers could track. Finally, measures such as shipping dock door utilization percentage, cases shipped per day, and cost of shipping per order could be utilized.

\textbf{Inventory Measures}

Inventory management measures tend to relate to the inventory service levels to customers as well as controlling inventory investment across an organization’s logistics system. Some common performance measures include obsolete inventory, inventory carrying cost, inventory turnover, and information availability.

Two organizational-level performance measures directly connected to inventory are cash-to-cash cycle and gross margin return on inventory (GMROI). Cash to cash cycle looks at how long an organization’s cash is tied up in receivables, payables, and inventory. It is equal to the number of receivable days plus the number of inventory days minus the number of payable days. In comparison, GMROI is a common metric used by retailers and distributors that examine inventory performance based on margin and inventory turn. The formula for GMROI is as follows: $\text{GMROI} = \frac{\text{Gross Profit in Dollars}}{\text{Sales in Dollars}} \times \frac{\text{Sales in Dollars}}{\text{Average Inventory at Cost}}$.

\textbf{Design and Implementation of Measures}\textsuperscript{25}

Although the number and types of measures to use can seem daunting to a logistics manager, several suggestions have emerged from research to provide some guidance. Some of the key things to consider when applying performance measures to logistics activities include:

1. Determination of the key measures should be tailored to the individual organization and level of decision making.
2. Data collection and analysis are a major part of a performance measurement system in logistics. This complexity is increased in global settings.
3. Behavioral issues should be considered when establishing and implementing a system of logistics measures. Top management support can help tremendously in this area.
4. Frequent communication and constant updating of the measures are necessary conditions for ensuring they are supporting the stated goals of the organization.

\textsuperscript{23}Aberdeen Group, \textit{The Transportation Management Benchmark Report} (Boston: Aberdeen Group Inc., 2006).


SUMMARY

This chapter focused on the connection between logistics strategy and an organization’s financial performance. Beginning with a discussion of the connection between corporate strategy and logistics strategy, the chapter provided an overview of key financial concepts as they relate to forming a better understanding of how logistics decisions can influence financial results.

The chapter also discussed key financial tools, such as the income statement, the balance sheet, the statement of cash flows, the strategic profit model, and the balanced scorecard. The connection between financial reporting requirements and logistics decisions was established. Various logistics performance measures were presented. We also looked at some key considerations when implementing a performance measurement system focused on logistics activities.

Key Terms

<table>
<thead>
<tr>
<th>Assets</th>
<th>Expenses (costs)</th>
<th>Return on assets (ROA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset turnover</td>
<td>Focus strategy</td>
<td>Revenues (sales)</td>
</tr>
<tr>
<td>Balanced Scorecard (BSC)</td>
<td>Income statement</td>
<td>Sarbanes-Oxley Act (SOX)</td>
</tr>
<tr>
<td>Balance sheet</td>
<td>Liabilities</td>
<td>Statement of cash flows</td>
</tr>
<tr>
<td>Cost leadership strategy</td>
<td>Net profit margin</td>
<td>Strategic Profit Model (SPM)</td>
</tr>
<tr>
<td>Current ratio</td>
<td>Omnichannel strategy</td>
<td></td>
</tr>
<tr>
<td>Differentiation strategy</td>
<td>Owners’ equity</td>
<td></td>
</tr>
</tbody>
</table>

Questions for Discussion and Review

3.1 Discuss the relationship between reverse logistics and financial performance.
3.2 In what ways is financial knowledge very important for logistics professionals?
3.3 Discuss the differences between corporate level, business unit level, and functional level strategies.
3.4 Discuss the cost leadership, differentiation advantage, and focus strategies.
3.5 Describe the three major orientations in formulating a logistics strategy.
3.6 What are the two key components of an income statement?
3.7 What are the three key components of a balance sheet?
3.8 Describe how logistics can affect the balance sheet of an organization.
3.9 What are the three key components of the statement of cash flows?
3.10 What are the key components of the strategic profit model? How can it be used to examine the effect of logistics decisions?
3.11 Discuss how logistics decisions affect net profit margin in an organization.
3.12 Discuss how logistics decisions affect asset turnover in an organization.
3.13 How does logistics strategy connect to overall corporate strategy? Is it a one-way or two-way connection?
3.14 What are some common logistics measures in transportation, warehousing, and inventory management?
3.15 How do you measure Return on Investment (ROI) of a logistics firm?
3.16 How do you measure gross margin return on inventory (GMROI)?
3.17 Describe the common types of information included in traditional logistics measurement systems.
3.18 How might the Balanced Scorecard (BSC) approach help a logistics manager in performing strategic analysis?
3.19 Do you think corporate cultures are relevant for designing a logistics measurement system? Why or why not?
3.20 Identify some of the key considerations for a logistics manager who is designing and implementing a logistics measurement system in his or her organization.
**Suggested Readings**


**CASE**

**CASE 3.1 BRANT FREEZER COMPANY**

Located in Fargo, North Dakota, the Brant Freezer Company manufactures industrial freezers. These freezers come in one size and are distributed through public warehouses in Atlanta, Boston, Chicago, Denver, Los Angeles, Portland, and St. Louis. In addition, some space is used in the company's Fargo warehouse. Young Joaquin (J. Q.) Brant, with a fresh MBA degree from the University of South Alabama, returned to the family firm, where he had once worked during summers. On his first day of work, J. Q. met with his father. His father complained that they were being “eaten alive” by warehousing costs. The firm’s controller drew up a budget each year, and each warehouse’s monthly activity (units shipped) and costs were tallied. Exhibit 3.A shows actual 2016 figures for all warehouses, plus actual figures for the first five months of 2017. Projected 12-month 2017 budgets and shipments are also included. Exhibit 3.B shows the Income Statement for 2016. Exhibit 3.C is the 2016 Balance Sheet.

When comparing the 2016 figures with the 2017 figures shown in the table, the amount budgeted for each

(continued)
warehouse in 2017 was greater than actual 2016 costs. How much of the increase is caused by increased volume of business (units shipped) and how much by inflation?

7. Use the 2016 Income Statement and Balance Sheet to complete a Strategic Profit Model for J. Q.

8. Holding all other information constant, what would be the affect on ROA for 2017 if warehousing costs declined 10% from 2016 levels?

<table>
<thead>
<tr>
<th>2016 Figures</th>
<th>2017 Figures</th>
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<tbody>
<tr>
<td><strong>Units Shipped</strong></td>
<td><strong>Warehouse Costs</strong></td>
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<tr>
<td>Boston</td>
<td>6,920</td>
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<td>Chicago</td>
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<td>Denver</td>
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<td>Fargo</td>
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<td>St. Louis</td>
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</table>

Exhibit 3.A Brant Freezer Warehouse Performance

* Denver warehouse closed by strike March 4–19, 2016.

<table>
<thead>
<tr>
<th>Income Statement 2016</th>
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</thead>
<tbody>
<tr>
<td>Sales</td>
</tr>
<tr>
<td>Cost of goods sold</td>
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<tr>
<td>Gross Margin</td>
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<tr>
<td>Transportation cost</td>
</tr>
<tr>
<td>Warehousing cost</td>
</tr>
<tr>
<td>Inventory carrying cost</td>
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<tr>
<td>Other operating costs</td>
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<tr>
<td>Total operating cost</td>
</tr>
<tr>
<td>Earnings before interest and taxes</td>
</tr>
<tr>
<td>Interest</td>
</tr>
<tr>
<td>Taxes</td>
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<tr>
<td>Net Income</td>
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Exhibit 3.B Brant Freezer Company Income Statement
### Balance Sheet 2016

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<tbody>
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<td>Cash</td>
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<table>
<thead>
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<tbody>
<tr>
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<td>Shareholders’ Equity</td>
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<td>Total Liabilities and Equity</td>
<td>$3,454,975</td>
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</table>

Exhibit 3.C Brant Freezer Company Balance Sheet
This chapter focuses on organizational and managerial issues in logistics, and, with respect to organizational issues, the degree to which logistics activities are fragmented or unified can play a key role in determining an organization’s logistical effectiveness and efficiency. Likewise, logistical effectiveness and efficiency can be enhanced by successfully addressing the wide variety of managerial issues faced by today’s logistician.

This chapter first looks at organizing logistics within the firm, with a specific focus on organizational structure for logistics as well as organizational design for logistics. The chapter also looks at select managerial issues in logistics, with a particular emphasis on productivity, quality, risk, sustainability, and complexity.

Learning Objectives

4.1 To explain organizational structure for logistics
4.2 To compare traditional and contemporary organizational design for logistics
4.3 To identify productivity issues and improvement efforts in logistics
4.4 To discuss quality issues in logistics
4.5 To report on programs designed to lessen the impact of terrorism on logistics systems
4.6 To describe ways to manage theft and pilferage
4.7 To review the concept of logistics social responsibility
4.8 To articulate logistics issues associated with complexity

This chapter focuses on organizational and managerial issues in logistics, and, with respect to organizational issues, the degree to which logistics activities are fragmented or unified can play a key role in determining an organization’s logistical effectiveness and efficiency. Likewise, logistical effectiveness and efficiency can be enhanced by successfully addressing the wide variety of managerial issues faced by today’s logistician.

This chapter first looks at organizing logistics within the firm, with a specific focus on organizational structure for logistics as well as organizational design for logistics. The chapter also looks at select managerial issues in logistics, with a particular emphasis on productivity, quality, risk, sustainability, and complexity.

ORGANIZING LOGISTICS WITHIN THE FIRM

The organization of logistics activities within a firm depends on a number of factors, including the number and location of customers, as well as an organization’s size, among others. For example, the number and location of customers might influence whether a firm adopts a centralized or decentralized logistics organization (to be more fully discussed in the “Organizational Structure for Logistics” section that follows). A company’s size might influence the organizing of logistics activities in the sense that there are limitations in the degree of specialization of managerial talent in small firms. In such situations, one consideration in organizing might be to even out the workloads of each manager. Thus, one manager might have transportation-related responsibilities, another manager might be responsible for ordering and inventory management, and a third manager might be assigned warehousing responsibilities.

It’s not possible to present a comprehensive description of the many organizational topics associated with logistics. As a result, we’ll focus on two key organizational topics, namely, organizational structure for logistics and organizational design for logistics.

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Organizational Structure for Logistics

Organizational structure focuses on how work roles and administrative mechanisms are allocated in an effort to integrate and control work. Two basic organizational structures are associated with logistics, namely, fragmented and unified. In a fragmented logistics structure, logistics activities are managed in multiple departments throughout an organization. For example, a company might assign outbound transportation, demand forecasting, warehousing management, and customer service to the marketing department, whereas procurement, inbound transportation, packaging, and materials handling might be the responsibility of the manufacturing department. A fragmented logistics structure might also see order management under the control of the accounting department, and inventory management might be under the auspices of the finance department.

Although the example in the previous paragraph suggests logistics activities that are spread across four distinct departments, a fragmented logistics structure can come in all shapes and sizes. In a fragmented structure, it’s possible for the various logistics activities to be managed in two, three, four, or more departments. Likewise, although our example assigns particular logistics activities to certain departments, there is no established template for which logistics activities are assigned to which departments. For example, an organization might divide inventory management into three categories—raw materials, work-in-process, and finished goods; raw materials and work-in-process inventories might be managed by the manufacturing department, whereas finished goods inventory might be the purview of the marketing department.

One problem with a fragmented logistics structure is that because logistics activities are scattered throughout the firm, they likely remain subservient to the objectives of the department (e.g., marketing, manufacturing) in which they are housed. Moreover, because effective and efficient logistics is predicated on a high degree of coordination among logistics activities, such coordination can become difficult when the logistics activities are spread throughout an organization.

In a unified logistics structure, multiple logistics activities are combined into, and managed as, a single department. The unified structure can be further classified based on the number and type of activities assigned to the department. A basic unified logistics structure might have responsibility for transportation, inventory management, and warehousing. A more progressive unified structure would include these basic activities plus several additional logistics activities such as order management and customer service. An advanced unified structure would include both the basic and progressive activities, along with several other logistics activities such as demand forecasting and procurement.

Regardless of how many, or what type, of logistics activities are managed, the unified logistics structure should be better positioned than the fragmented structure to achieve coordination across the various activities. For example, efficient and accurate communication among inbound and outbound transportation, warehousing, inventory management, procurement, and so on should be facilitated when they are combined into one department. Indeed, so-called leading-edge logistics companies—firms with demonstrably superior logistical capabilities—exhibit different logistics organizational structures than do other organizations. For example, leading-edge organizations are more likely to use a unified, as opposed to fragmented, logistics organizational structure. In addition, leading-edge companies tend to manage more types of logistics activities than do other companies, including less-traditional logistics activities such as demand forecasting and procurement.

An important issue in terms of organizational structure is whether the logistics department should be centralized or decentralized. A centralized logistics organization implies that the company maintains a single logistics department that administers the related activities for the entire company from the home office. A decentralized logistics organization, in contrast, means that

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logistics-related decisions are made separately at the divisional or product group level and often in different geographic regions.

There are advantages to both approaches, with a primary advantage of centralization being its relative efficiency, whereas a primary advantage of decentralization is its customer responsiveness. Centralization allows an organization to take advantage of the cost savings that can arise from volume-creating opportunities. Suppose, for example, that an organization has five distribution facilities that annually generate 100,000 pounds of outbound freight, for a total outbound volume of 500,000 pounds. A centralized logistics organization should be able to achieve lower transportation rates for 500,000 pounds of volume than the individual facilities could each achieve for 100,000 pounds of volume.

Advocates of decentralization question the ability of a centralized logistics unit to provide the required levels of customer responsiveness. Indeed, the contemporary marketplace is made up of heterogeneous customers who aren’t necessarily well served by centralized logistics practices. For instance, an organization with a mixture of consumer and business-to-business product lines might benefit from decentralization because of differing logistical requirements of consumer and business-to-business segments. Likewise, many global firms need to decentralize operations because of geographic and time distances from the home office. As an example, the time difference between the United States and China (at least 12 hours depending on one’s location in the United States) doesn’t readily lend itself to timely resolution of issues if managed under a centralized approach.

Another important issue in logistics organization structure is the job title or corporate rank (e.g., manager, director, vice president, chief) of the top logistics person; indeed, one attribute of leading-edge organizations is that logistics tends to be headed by senior-level (vice president, chief) personnel. Although in recent years logistics has assumed greater importance in many organizations in the sense that the top logistics person holds a vice president title, to date logistics has generally been excluded from holding a “C-level” position, which refers to corporate officers such as a chief executive officer (CEO), a chief operating officer (COO), or a chief financial officer (CFO). In other words, there are few companies in which a person holding the position of chief logistics officer (CLO) leads the logistics function. One exception is Green Mountain Coffee Roasters, a leader in specialty coffee and coffee makers. Driven by the complexity of its multichannel business, it has established a CLO for their organization. Similarly, retailer Target Corporation established an Executive Vice President, Chief Supply Chain and Logistics Officer to lead its planning, distribution, and transportation as part of its supply chain transformation.

Organizational Design for Logistics

Organizational design is much broader than the familiar series of boxes and lines that detail reporting relationships in an organization. Organizational design is also concerned with issues such as who makes work-related decisions and the appropriate communication channels between workers and managers, among other things. Broadly speaking, three primary types of organizational design are used: hierarchical (also called functional), matrix, and network.

Hierarchical, or functional, organizational design has its foundations in the command-and-control military organization, where decision making and communication often follow a top–down flow. One advantage to hierarchical design is flexibility in exercising command in the sense that no one manager leads more than a “limited” number (e.g., 10, 20, 25) of employees. In addition, each employee reports to one, and only one, supervisor. One disadvantage of hierarchical design is that societal changes, such as individuality and questioning authority, are not easily accommodated in a command and control philosophy.

In a matrix design, one employee might have cross-functional responsibilities. For example, the category manager of small appliances at a particular organization might report to logistics, marketing, and production executives, and this manager would have responsibility for the production,
marketing, and logistics of small appliances. One advantage of this design is that the category manager (such as the small appliance manager in our example) can be very responsive to customer requirements. One disadvantage is that a matrix organization tends to cost more to operate because increasing numbers of managerial-level employees are necessary in comparison to a hierarchical organization.

Both the hierarchical and matrix forms of organization are well suited for environments dominated by costly information and restricted communication—constraints that have been lessened by the Internet and availability of big data. Moreover, hierarchical and matrix organizations flourish when there are a limited number of decision alternatives as well as limited time constraints on making a decision. However, the contemporary business environment is increasingly characterized by a myriad of decision alternatives and shorter time windows for making decisions. To this end, a network organization design attempts to create an organization that is responsive to the parameters of the contemporary business environment.

A key attribute of a network organizational design is a shift from function to process. In a functional–hierarchical philosophy, products and processes were divided into easy-to-complete tasks. A process philosophy, by contrast, focuses on combining tasks into value-creating products and activities. For example, effective and efficient order management is a process designed to produce satisfied and loyal customers, and order management consists of a number of different tasks such as order receipt, order entry, credit check, order triage, order picking, and so on. It's only when these tasks work in concert that value is created.

The network organization's emphasis on process and value creation has important implications for organizational design. Because processes and value creation tend to be customer focused, organizational design should facilitate an organization's interaction with its customers. For example, one way to facilitate customer interaction is to move decisions as close as possible to the point at which action is required, which requires empowering lower-level employees and managers with the authority to make decisions. You should recognize that the concept of worker empowerment is directly opposed to the specifications of hierarchical organizational design.

Moreover, from a logistics perspective, a network organizational design is manifested in terms of relevancy, responsiveness, and flexibility. Relevancy, which refers to satisfying current and emerging customer needs, can be facilitated by developing mutually beneficial relationships with key customers; at a minimum, these relationships should provide an understanding of customer needs and wants. Responsiveness reflects the degree to which an organization can accommodate unique or unplanned customer requests; responsiveness can be achieved when the appropriate decision makers are provided with both relevant information and the authority to address unique or unplanned requests. Flexibility, which can be defined as an organization's ability to address unexpected operational situations, is predicated on avoiding early commitment to an irreversible course of action. One example of logistics flexibility would be the postponement of assembly, labeling, and so on until exact customer requirements are known.6

MANAGERIAL ISSUES IN LOGISTICS

The logistics discipline would be relatively easy if it entailed simply organizing a logistics system and then putting it into operation. However, well-run companies recognize that logistics systems must not only be organized, but they must also be managed. Although the remaining chapters will discuss managerial issues associated with particular logistics activities (e.g., procurement-specific managerial issues, warehousing-specific managerial issues, and so on), the following sections will focus on overarching managerial issues affecting logistics managers that are not activity specific.

Productivity

Productivity is an important managerial issue because it provides insight into the efficiency (or inefficiency) with which corporate resources are being utilized. At a basic level, productivity can be defined as the amount of output divided by the amount of input. An understanding of this relationship leads to the recognition that there are three ways to improve productivity—reduce the amount of input while holding output constant, increase the amount of output while holding input constant, or increase output while at the same time decreasing input or at least not allowing input to increase above the rate that output is going up.

Understanding the three ways to improve productivity is important to the logistics manager because several logistics activities, particularly warehousing and transportation, are heavily dependent on human labor. For productivity purposes, human labor is considered an input (i.e., workers receive wages or salaries), and most humans are resistant to productivity suggestions that focus on reducing their wages or salaries (i.e., input). As such, productivity improvement efforts in logistics are often directed toward increasing the amount of output while holding input constant.

Moreover, in some geographic locations logistics operating employees (e.g., warehouse workers, truck drivers) are unionized, and the union contracts can provide a challenge to improving productivity. This is because union work rules are often very specific in the sense that job descriptions spell out in exacting detail the responsibilities associated with a particular job. Thus, if an order picker's forklift were to malfunction, the order picker might be prohibited from remedying the situation because forklift repairs are the responsibility of another group of workers. Although detailed job specifications help create additional employment opportunities, the relative lack of worker flexibility can potentially hinder productivity by increasing inputs (e.g., additional workers, hence additional labor costs) while also decreasing output. For example, the order picker with the malfunctioning forklift may have to delay order picking until the forklift is repaired or another forklift becomes available for use.

Many warehousing facilities have clearly articulated work rules that serve a number of purposes, the most important of which is to keep the workforce in general, and individual employees in particular, from engaging in unproductive and potentially unsafe activities. It's simply not enough to have a set of clearly articulated work rules—to be effective, the work rules must be enforced.

Another challenge facing logistics managers is the rising labor costs of their logistics operating employees due to increasing upward pressure on wage levels. Whether as a result of federal minimum wage increases, difficulty in attracting talent, or by their own choice to raise employee salaries, companies are seeing an emerging upward trend on wage levels. In response, logistics managers are constantly looking for ways to increase productivity within their warehouses through innovation. While this innovation can take many forms, the introduction of technology is a common approach. For example, Walmart, the world's largest retailer, has begun testing drones within its warehouses as a potential solution to enhance warehouse productivity. While Walmart employees now manually scan pallets using hand-held technology, drones are being evaluated as a way to reduce the labor requirements in this setting. Drones are able to take up to 30 images per second to inspect inventory and labeling. Thus, this technology could perform the amount of work in a single day that currently takes a month using traditional employees. While these drones would still require an employee to operate them, the overall number of employees in the warehouse could be reduced.

A distinction needs to be made between warehousing and trucking when discussing the management of labor productivity in logistics. In warehousing, supervisors can be physically present and are expected to be on top of nearly any situation. When a worker in a warehouse falls behind schedule, it is usually noticed relatively quickly, and corrective action can be taken in a timely fashion.

However, once on the road, truck drivers are removed from immediate supervision, and their work becomes more difficult to evaluate. Truck drivers can fall behind schedule or be delayed for a variety of reasons such as traffic conditions, a bottleneck at a loading dock, or perhaps too much time socializing with fellow drivers at a particular truck stop. Typically, a manager has little choice but to accept the driver's explanation for the delay. As such, it is necessary to have control
mechanisms so that drivers who often encounter uncontrollable delays (e.g., traffic conditions) can be distinguished from those who encounter controllable delays (e.g., socializing with fellow drivers).

As was the case in warehousing, technological considerations play an increasingly important role in managing truck drivers and their productivity. For example, some firms photograph or videotape drivers making pickups at their loading docks. Moreover, activity can be recorded by a tachograph, a recording instrument that is installed inside a truck and produces a continuous, timed record of the truck, its speed, and its engine speed. From the information on a tachograph chart, one can tell how efficiently the truck and driver are being used. If the driver works on a regular route, it may be possible to rearrange the stops so that the driver can avoid areas of traffic congestion. Bad driving habits, such as high highway speeds and excessive engine idling, can also be detected. In case of an accident, a tachograph chart is invaluable in reporting and explaining what occurred just prior to the crash.

The interfaces involving wireless communications, global positioning systems (GPS), and graphical information systems (GIS) offer tremendous technology-related opportunities to improve driver productivity. Global positioning systems use satellites that allow companies to compute vehicle position, velocity, and time, whereas graphical information systems allow companies to produce digital maps that can drill down to site-specific aspects such as bridge heights and customer locations. GPS and GIS are evolving toward a situation in which instant updates can be provided to GIS databases—data that can be leveraged to provide real-time route planning that can direct drivers away from accidents and other traffic bottlenecks.

While the use of technology offers potential productivity enhancement, logistics managers should be aware that there is a complex relationship between formal technology-based controls and firm performance. For example, research has shown that electronically monitoring truck drivers can result in both positive and negative organizational outcomes. Technology by itself does not improve firm performance, it is more about how a particular technology is used to enhance productivity. The research indicates that the most efficient way to improve performance is to combine a high level of process control (e.g., drivers self-reporting their work) with a high level of activity control (e.g., formalized scheduling of driver’s work) or a high level of technology control (e.g., electronic driver monitoring). As such, logistics managers must be careful to use technology appropriately to achieve desired worker productivity enhancements in their specific contexts.

Thus far this section has focused only on worker productivity, but asset productivity is also an important consideration for logistics managers. One asset-related productivity concern involves space utilization, or the percent of available space that’s actually being used. Excess capacity, or unused available space, can be unproductive because it may result in the purchase of additional equipment or facilities—a situation that adds to costs (input) but not necessarily to output, thus resulting in lower productivity.

Consider the example of a company that built an approximately 700,000-square-foot warehouse as a replacement for a smaller storage facility. A review of the new warehouse one year after its opening revealed that only 55 percent of the available space was actually being utilized, and the company concluded (reluctantly) that it could have satisfied current and future demand with a 450,000-square-foot facility. The 700,000-square-foot facility caused the company to purchase additional real estate, incur higher construction costs, and incur higher materials handling costs (in the form of storage racks and forklifts) when compared to a 450,000-square-foot facility. From a managerial perspective, the 700,000-square-foot facility handled the same amount of product (output), at a higher cost (input), as could a 450,000-square-foot facility—thus resulting in decreased productivity.

In response to the issue of excess capacity, one emerging trend is the concept of a sharing economy, which entails an organization making their unused resources (e.g., excess warehouse

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Part I • Overview of Logistics

space, unused trailer space) available to other organizations. Companies are finding that strategic sharing can result in increased revenues, enhanced utilization of assets, and savings from a reduced need to make capital investments. Cargomatic is an Internet-based company that is supporting efforts to share logistics assets. The company was established in response to operational challenges associated with local truck capacity in large markets. Its web-based system and mobile apps enable truckers and shippers in the Los Angeles, New York, and San Francisco markets to more efficiently utilize capacity and enhance productivity of assets. Cargomatic strives to provide an Uber-like solution for drivers of freight and those nearby that need to move their products. On average, a Cargomatic shipment involves 1 ton of freight moving 20 miles for about $145. Cargomatic makes its money by charging a 20 percent commission.

A second asset-related productivity concern focuses on improving the output from existing assets. Southwest Airlines, for example, is able to fly more trip segments per day with its airplanes than many of its competitors because Southwest’s planes spend less time parked at airport gates. Another way of improving the output from existing assets involves extending their revenue-producing lifespan. For example, one of the authors worked for a trucking company that regularly utilized 25-year-old tractors to serve certain customers. From one perspective, the 25-year-old tractors were extremely productive in the sense that a fully depreciated asset was generating revenues. Having said this, the 25-year-old tractors lacked certain safety features found on newer-model tractors, incurred higher maintenance costs, and were less fuel-efficient than newer-model tractors.

Quality

Logistics service quality relates to a firm’s ability to deliver products, materials, and services without defects or errors to both internal and external customers. However, it is important that we operationalize “quality” before beginning our description of logistics service quality. Consider that the American Society of Quality, which bills itself as the world’s leading membership organization focused on quality, notes that quality is a subjective term. Each person will have his or her own definition. Although there are somewhat stringent definitions of quality, such as a product or service that is free from defects, deficiencies, or errors, we will take a more flexible approach and define quality as conformance to mutually agreed upon requirements.

The issue of quality in logistics often represents a delicate balancing act for the involved organizations. That is, if an organization provides logistics services of inferior quality when delivering its products, it runs the risk of lowering the customer’s perceived value of the seller’s product. If an organization provides higher levels of logistics service quality than its customer values or requires, it may be paying for something that is not needed. This increased cost without an associated perception of value can affect the competitiveness of a firm’s offering. In short, organizations designing their logistics service offerings must understand issues of quality and strive to match the quality levels of the logistics services they provide with the expectations of their customers and the competitive landscape in which they operate.

Today, vendors are expected to have quality programs, and many have worked for years to achieve a good reputation for quality. One way for vendors to convince potential buyers that they are committed to quality is through a program known as ISO (International Standards Organization) 9000 certification. ISO 9000 is a set of generic standards used to document, implement, and demonstrate quality management and assurance systems. Applicable to manufacturing and service industries, these standards are intended to help companies build quality into every core process in each

Learning Objective 4.4

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1 www.cargomatic.com
4 www.asq.org
department. Firms demonstrating a commitment to quality through training, reviews, and continuous improvement can receive ISO 9000 certification. After achieving ISO 9000 certification, organizations are audited each year and can be recertified every three years. Among logistics managers, ISO 9000 certification is credited with increasing customer service, improved order accuracy, and enabling enhanced costs analysis.12

Another quality-related concept or practice relevant for logistics managers, known as Six Sigma, emphasizes the virtual elimination of business errors. Those who remember the normal distribution (curve) from their statistics class will recall that sigmas are related to standard deviations from the mean. The higher the number of deviations included, the more area under the normal curve that is covered. In the case of Six Sigma, or six standard deviations, the area covered is 99.99966 percent, leaving a tiny area, .00034, uncovered. More specifically, the Six Sigma approach suggests that there will be 3.4 defects, deficiencies, or errors per one million opportunities—obviously a very high standard. These standards can be applied to various logistics activities such as order packing.

From a North American perspective, Six Sigma began to achieve widespread acceptance—and adoption—during the mid-1990s. A worldwide Six Sigma study indicated that only about 10 percent of the responding organizations had established a structured performance improvement program prior to 1995. This same study also found that the most significant benefits from Six Sigma have been reduced costs, reduced errors and waste, and reduced cycle time, whereas the key drawbacks have involved overcoming business cultural barriers, investing the required resources (both human and money), and gaining top management commitment.13

While traditionally seen as rival initiatives, the integration of Six Sigma with the Lean approach, so-called Lean Six Sigma, is an area of increased focus within many companies. Lean Six Sigma integrates the goals and methods of these two approaches in pursuit of quality. What sets Lean Six Sigma apart from its individual components is the recognition that organizations cannot focus only on quality or speed. There needs to be an organizational focus on improving quality as it relates to responsiveness. Halliburton, an oilfield services provider, has implemented Lean Six Sigma concepts both internally as well as pushing the concept out to its suppliers in an effort to better align its supply base with Halliburton’s increasing demand and supply expectations.14 LeanCor, a third-party logistics company, has used Lean Six Sigma tools with its clients as part of its efforts to develop a culture of continuous improvement.15 LeanCor not only uses these tools for enhancing the logistics services it provides, but it also conducts training in Lean Six Sigma tools for its client’s employees.

Another quality-related initiative is the Malcolm Baldrige National Quality Award, which was established in the late 1980s to recognize U.S. organizations for their achievements in quality and performance. Initially only manufacturers, services, and small businesses were eligible for this award, but eligibility was expanded to include health care and educational institutions in the late 1990s. Research has shown that several factors included in the Baldridge criteria are important to the improvement of logistics processes.16

The Baldrige Quality Awards, which are restricted to organizations headquartered in the United States, require interested parties to submit a formal application that is evaluated by a committee largely made up of private-sector experts in business and quality. Applications are evaluated for achievement and improvement across seven categories: business results; customer and market focus; human resource focus; leadership; measurement, analysis, and knowledge management; process

15www.leancor.com
importantly, organizations that choose not to apply for a Baldrige Award can use these seven categories as a template for evaluating the quality of current and prospective suppliers.

there are substantive differences between ISO 9000 and the Baldrige Award; ISO 9000 essentially allows an organization to determine if it complies with its specific quality system. in contrast, the Baldrige Award is more heavily focused on the actual results from a quality system as well as on continuous improvement. the Baldrige Award also tends to be more externally focused in the sense that organizations benchmark themselves against organizations from outside their particular industry.

Risk

logistics systems are complex networks of companies and activities that are constantly exposed to potential unpredictable disruptions. Risk can be viewed as susceptibility to disruptions that could lead to a loss for a firm, and this risk can take a variety of forms as it relates to the management of logistics activities. for example, regularly occurring risks involve things such as variability in demand or the potential for a damaged shipment, whereas catastrophic risks such as earthquakes or terrorist attacks can also unexpectedly affect a logistics system. the logistics uncertainty pyramid model has been established to identify sources of uncertainty that can affect the risk exposure for logistics activities. the model identifies several types of uncertainty including shipper, customer, carrier, control systems, and external. the model can help logistics managers structure their examination of potential risks that could influence their firms' logistics systems. while space limitations restrict us from discussing all potential risks that could arise in these areas of uncertainty, we will describe one operational risk and one catastrophic risk in greater detail. the remainder of this section will focus on two risks that can impact logistics activities in a firm, namely, terrorism and theft/pilferage.

Terrorism can be viewed as an illegal use of, or threat of, force or violence made by a group or an individual against a person, a company, or someone's property with a goal of menacing the target, often grounded in politics or ideology. although terrorism is often viewed by the media through a political or ideological lens, it can have important implications for commerce and for managing logistics systems.

It's no exaggeration to state that the terrorist attacks in the United States on September 11, 2001, were a defining moment that brought terrorism considerations to the forefront of logistics management. the September 11 terrorist attacks have profoundly impacted logistics practices on a worldwide basis, and processes, procedures, and activities that might have been given minimal attention prior to September 11 are now viewed from an entirely different perspective.

Consider the storage and transport of hazardous materials, which prior to September 11 were primarily managed from a safety perspective. although safety remains an important perspective, the storage and transport of hazardous materials in today's world are also managed with an eye to potential terrorist considerations. for example, there are continuing efforts to reroute rail shipments of hazardous materials—because of terror concerns—away from major u.s. population centers, and oceangoing petroleum tankers have the potential to be used as mobile bombs.

17www.quality.NIST.gov
18Ibid
One response to the September 11 attacks involved the creation of a new federal agency in the U.S., the Department of Homeland Security (DHS); two of its major aims are to prevent terrorist attacks in the United States as well as to reduce the vulnerability of the United States to terrorism. A total of 22 separate U.S. government entities were incorporated into the DHS, with the Transportation Security Administration (TSA) and Customs and Border Protection (CBP) being two of the most important from a logistics perspective.

The Transportation Security Administration is responsible for the security of the U.S. transportation system. You might be familiar with the TSA because it is the agency that conducts the passenger screening at U.S. commercial airports. The TSA also plays a number of roles with respect to freight security, such as using dogs to screen airfreight. In addition, the TSA was responsible for developing a Transportation Worker Identification Credential (TWIC), which is a common credential used to identify workers across all modes of transportation. One of the key attributes of TWIC is that the corresponding card contains both personal and biometric data, with the biometric data being used to exclude certain workers from secure areas at ports and terminals. The TWIC program became fully operational in early 2009, and while implementation has been relatively smooth, several problems, such as lengthy processing time for credentials, have surfaced.22 In 2014, the U.S. House of Representatives passed the Essential Transportation Worker Identification Credential Assessment Act that would require TWIC to undergo an independent assessment of how well the program is working as well as identifying potential alternative technologies.

Customs and Border Protection is responsible for securing U.S. borders to protect the American people and the U.S. economy. One key CBP function is inspecting cargo, and a number of high-profile CBP initiatives have affected the management of logistics systems. The Trade Act of 2002, which required submission of advanced electronic data on all shipments entering and leaving the United States, is aimed at identifying high-risk shipments that might threaten U.S. safety and security. Table 4.1 summarizes the manifest times for inbound and outbound shipments involving air, rail, water, and truck.

<table>
<thead>
<tr>
<th>TABLE 4.1</th>
<th>Timeline for Presenting Electronic Advance Manifest Information</th>
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<tbody>
<tr>
<td><strong>Inbound to the United States</strong></td>
<td></td>
</tr>
<tr>
<td>Mode</td>
<td>Timeline</td>
</tr>
<tr>
<td>Air and courier</td>
<td>Four hours prior to arrival in the United States, or “wheels up” from certain nearby airports</td>
</tr>
<tr>
<td>Rail</td>
<td>Two hours prior to arrival at a U.S. port of entry</td>
</tr>
<tr>
<td>Ocean vessel</td>
<td>24 hours prior to lading at foreign port</td>
</tr>
<tr>
<td>Truck</td>
<td>Free and Secure Trade (FAST): 30 minutes prior to arrival in the United States; non-FAST: one hour prior to arrival in the United States</td>
</tr>
</tbody>
</table>

**Outbound from the United States**

<table>
<thead>
<tr>
<th>Mode</th>
<th>Timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air and courier</td>
<td>Two hours prior to scheduled departure from the United States</td>
</tr>
<tr>
<td>Rail</td>
<td>Two hours prior to the arrival of the train at the border</td>
</tr>
<tr>
<td>Ocean vessel</td>
<td>24 hours prior to departure from U.S. port where cargo is laden</td>
</tr>
<tr>
<td>Truck</td>
<td>One hour prior to the arrival of the truck at the border</td>
</tr>
</tbody>
</table>


In particular, oceangoing containers destined for the United States are receiving much greater scrutiny today than prior to September 11. One of the things learned after the 2001 terrorist attacks was that a relatively small percentage of containers that arrived at U.S. ports was scanned to learn about their actual contents. This alarmed some U.S. legislators, and the result was a series of proposals that culminated in legislation requiring 100 percent scanning of U.S.-bound containers by 2012.

This scanning, which is to be done prior to a container being loaded onto ships at non-U.S. ports, has the potential to be quite disruptive to international trade because a number of nondomestic ports currently do not have the technology required to inspect containers. These ports would have to acquire and install the relevant scanning technology (which is quite expensive), discontinue sending containers to the United States, or route containers through other nondomestic ports that are equipped with the relevant technology. However, in early 2009, the DHS suggested that the 2012 scanning deadline probably would not be achieved, in part because of difficulties in achieving agreements with all nondomestic ports that ship containerized cargo to the United States. This prediction turned out to be true. As of mid-2016, the goal of achieving 100 percent scanning was still beyond reach of the DHS. One big issue was how to deal with transshipments, where containers scanned at a foreign origin port were then offloaded at a secondary foreign port prior to arriving in the United States. This intermediate step introduced a potential for tampering with the container. The DHS has begun to look outside of its agency for private solutions to the expensive and complex problem of meeting the 100 percent inspection mandate.

Another example of the CBP’s emphasis on containerized shipments is the Container Security Initiative (CSI), an agreement in which some of the world’s ports agree to allow U.S. customs agents to identify and inspect high-risk containers bound for the United States before they are loaded onto ships. Approximately 60 international ports, including such major ports as Hong Kong, Singapore, Shanghai, and Rotterdam, currently participate in the CSI.

One of the best-known CBP programs enacted since September 11 is the Customs Trade Partnership Against Terrorism (C-TPAT), in which public (CBP) and private (e.g., retailers and manufacturers) organizations work together to prevent terrorism against the United States through imports and transportation. Private organizations apply to Customs and Border Protection for C-TPAT certification, and the process involves demonstrating that organizations have improved the physical security of their containerized shipments as well as the ability to track people who have access to the containerized shipments. Although the government-provided benefits to C-TPAT certification include fewer security inspections of inbound containers along with faster processing time through Customs, many companies have discovered that the C-TPAT process has also led to a reduction in cargo theft, pilferage, and loss.

As if logistics managers aren’t potentially overwhelmed by TWIC, CSI, C-TPAT, and other terrorism-related acronyms, Customs and Border Protection is also responsible for implementing and enforcing the Importer Security Filing (ISF) rule, also known as “10 + 2,” which went into effect in early 2009. The “10 + 2” moniker refers to the fact that importers are required to file 10 pieces of information (e.g., country of origin; manufacturer’s name and address), and carriers two pieces of information (e.g., vessel storage plan), before cargo is loaded at non-U.S. water ports.

The initial feedback on “10 + 2” suggests that while erroneous filings have declined from 30 percent to less than 5 percent, some importers struggle to get timely, accurate, and complete information for their 10 required pieces of information. In addition, importers are concerned with the costs of “10 + 2” compliance, which can include the cost of upgrading their information systems.

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the actual cost of filing the 10 pieces of information, and potential monetary penalties for erroneous information or failure to file the information.25

Theft (stealing), which can be defined as the taking and removing of personal property with the intent to deprive the rightful owner of it,26 is another logistics risk issue that confronts many managers. Unfortunately, it is often difficult to accurately quantify the impact of theft, in part because some companies are hesitant to report these data because a reported theft serves as direct evidence of a logistics system shortcoming. Having said this, anecdotal evidence suggests that cargo theft increased as U.S. economic conditions began to deteriorate in late 2007.27

You might be wondering why logisticians would be concerned about theft, particularly because many organizations carry insurance to compensate themselves in cases of theft. However, even though insurance may reimburse an organization for the market value of the stolen items, the time and costs (e.g., documentation) associated with theft tend not to be covered by insurance. A second logistical concern is that theft results in the planned flow of goods being interrupted and can lead to stockouts.

In addition, theft can factor into the facility location decision in the sense that some organizations will avoid locating their facilities in areas characterized by high crime rates.28 It’s also possible for the stolen products to reappear in the market at a lower price to compete with products that have moved through traditional channels. Indeed, there are suggestions that approximately 2 percent of the products available on Internet auction sites are actually stolen goods.29

Schneider, a full truckload firm headquartered in Green Bay, Wisconsin, has been very successful in reducing the amount of cargo theft that occurs in the more than 3 million loads they move each year. Schneider utilizes a combination of multiple technologies, procedures, and driver training to achieve an almost perfect record of theft avoidance. According to trucking industry research, 890 loads were lost in 2015 by trucking firms at an average cost of $185,297 per incident. A major aspect of Schneider’s approach toward avoiding these types of incidents has been through training during the on-boarding process for new drivers, communication with drivers regarding locations and types of thefts based on data analysis, and systematic re-training of their drivers based on the emergence of new theft prevention techniques.30

Pilferage, which refers to employee theft, cannot be eliminated, and both warehousing and transportation operations are especially vulnerable to pilferage. Managing pilferage can be challenging for the logistics manager, and the managing begins with the hiring process. In fact, one of the best ways to manage pilferage is to avoid hiring people who are predisposed to steal, such as people with credit, alcohol, or drug problems. Some organizations utilize psychological tests as part of the hiring process in an effort to identify prospective employees who might pilfer.

Organizations can better manage pilferage if they have clearly articulated and enforced pilferage-related policies. To this end, experts recommend that the best pilferage policy should be based on zero tolerance because problems inevitably arise for those companies that tolerate a “small amount” of pilferage. For example, there may be disagreement in terms of how to operationalize “amount”—are we concerned with the number of units or the dollar value of items? Once this has been established, then what is meant by “small”—does, say, five units or $75 qualify as “small”? Quite simply, a zero-tolerance policy means that pilferage exceeding zero units or zero dollars is unacceptable.

26www.m-w.com/dictionary
One of the most effective methods of protecting goods from theft or pilferage is to keep them moving through the system. Goods waiting in warehouses, in terminals, or to clear customs are more vulnerable to theft than goods that are moving. No list of methods for protecting goods is complete; determined thieves are likely to overcome almost any safeguard placed in their way. However, a few suggestions are offered here, mainly to reflect the breadth of measures that might be taken:

- Decals are required for autos in employee parking lots, and nonemployees may be required to park in designated areas as well as to register with a company receptionist. This makes it more difficult for outsiders to access an organization’s facilities.
- Forklifts in warehouses are locked at night, making it difficult to reach high items or to move heavy items.
- Seals (small wirelike devices that once closed cannot be reopened without breaking) are used more and more, with dispatchers, drivers, and receiving personnel all responsible for recording the seal number and inspecting its condition. Figure 4.1 shows a seal used for container doors.
- Electronic tags or strips are embedded in products at the time of their manufacture, and they can activate alarms at warehouse or retail store doors.
- Organizations should take a proactive approach to theft; waiting until theft reaches “unacceptable” levels might mean that certain dysfunctional behavior has been permitted for so long that it has come to be viewed as typical or acceptable.
- Experts suggest that companies should facilitate an employee’s ability to report theft and other aberrant behavior, such as through a hotline that guarantees anonymity as well as protection from potential retaliation or retribution.
- Pick, pack, and shipping processes for exceptionally expensive items should be tailored to reduce opportunities for pilferage. For example, one company requires multiple warehouse employees to jointly pick the luxury writing instruments ordered by customers.

Figure 4.1  Shipping Container Locking Handle with a Uniquely Numbered Customs Seal.

Source: Philip Cridland/Alamy Stock Photo
Note that many of the preceding suggestions are common sense in nature (e.g., decals, locked forklifts); indeed, common sense is viewed as a basic foundation for controlling theft. Importantly, commonsense approaches to system security are often no cost, or low cost, in nature.31

The discussion to this point has been primarily focused on domestic theft and pilferage. When goods move in international commerce, particularly by ship, they are much more vulnerable to theft and pilferage. Piracy attacks on ships have become a major concern in the twenty-first century, and unlike the somewhat romanticized pirates of movies and literature who wore eye patches and carried swords, contemporary pirates use speedboats, smart phones, global positioning systems, and automatic weapons. In addition, approximately 20 percent of all pirate attacks in recent years have involved petroleum tankers, which is of concern because of the potential for an environmental accident as well as the fact that tankers could be used as bombs in a terrorist attack.

To underscore the seriousness of pirate attacks for today’s logistics manager, the International Maritime Bureau, an arm of the International Chamber of Commerce, reported 240 pirate attacks worldwide in the first six months of 2009 compared to 114 pirate attacks during the same time period in 2008.32 Much of the 2009 increase was due to a surge in pirate attacks off the Somalian coast, and managerial responses to these attacks included outrunning the pirates, rerouting vessels away from Somalia, vehicle escort services, and armed professionals. The cost of these responses to pirate attacks—just for Somalia—has been estimated at approximately $500 million annually.33 While the number of attacks has decreased from this 2009 peak, piracy continues to be a concern for logistics managers. In response, the International Chamber of Commerce provides a wide range of services to help companies address this issue (e.g., training, on-line maps of pirate activity).34

Sustainability

Logistics has an inherent connection to sustainability. A common definition of sustainability centers on the concept of the “triple bottom line,” which was introduced in the mid-1990s and refers to the interaction of social, environmental, and economic dimensions. While most attention to date has focused on the environmental dimension, the social and economic dimensions are also critical to consider.35 As such, this section will discuss logistics social responsibility as well as environmental issues associated with reverse logistics. The environmental dimension, while not specifically examined, underlies managerial decisions in both of these areas. In order to be truly sustainable, logistics managers must consider the economic impact of their sustainability-related decisions on their firm’s bottom line.

The social responsibility concept suggests that an organization’s obligations transcend purely economic considerations such as profit maximization. While the corporate social responsibility concept has existed since the early 1970s, the concept of logistics social responsibility, or corporate social responsibility issues that relate directly to logistics,36 did not emerge until the mid-1990s.

Potential logistics social responsibility dimensions include the environment, ethics, diversity, safety, philanthropy, and human rights, among others, and myriad activities or practices can be used to assess each of these dimensions. In terms of the environment, for example, organizations might

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32www.ics-ccs.org
34www.icc-ccs.org
focus on reusing and recycling products, reducing the amount of packaging, improving energy efficiency, and reducing various types of pollution. Ethical considerations include improperly sharing information, as well as bribes and gift giving, whereas diversity might evaluate the use of minority and female suppliers. Safety-related activities or practices include the safe movement and storage of products, particularly those of a hazardous nature, preventive vehicle maintenance, and proper workplace equipment (e.g., hardhats, goggles). Philanthropic logistics activities might include the donation of excess or obsolete inventory to charitable organizations, and sweatshop labor continues to be a preeminent human rights consideration.

Energy efficiency is a prominent logistics social responsibility issue for many organizations, and we’ll take a closer look at energy efficiency in the following paragraphs. Warehousing and transportation represent two logistics activities where most energy costs occur and where energy-saving measures should be focused. For instance, design, lighting, and roofing represent three possible energy control areas in warehousing. With respect to design, facilities might be positioned so that dock doors aren’t placed on the north side of a building (data indicate that cold winds tend to blow from the north). Lighting provides a variety of opportunities for managing energy consumption; skylights, large windows that incorporate solar energy, and high-efficiency lighting can reduce electricity usage between 20 and 60 percent. In addition, high-efficiency lighting generally provides better lighting quality, and thus potentially improves workplace safety (another logistics social responsibility issue).

Roofing, which tends to be the largest exposed surface of a warehouse facility, is often overlooked as an area for energy control. White roof material, for example, tends to reflect sun-generated heat, while darker roof colors such as black and gray tend to absorb sun-generated heat, which causes increased electricity consumption to cool the interior areas of a warehouse. Moreover, some warehousing facilities are being designed with grass roofs, which lower energy consumption during the summer months.

Transportation is a second logistics activity in which considerable energy savings can take place, particularly because transportation is a primary consumer of energy. Indeed, transportation accounts for approximately two-thirds of all petroleum consumption in the United States. As a result, many transportation providers are actively searching for ways to reduce their fuel consumption, which in turn will reduce their fuel costs. The U.S. Environmental Protection Agency’s Smart Way Transport Partnership, established in 2004, helps companies address environmental challenges such as fuel consumption. Results have been promising, as illustrated by Kohl’s Department Stores, which has reduced empty truck movements by nearly 4 million miles since joining the partnership.37

You might be surprised to learn that the annual cost of reverse logistics, which refers to the process of managing return goods, exceeds $100 billion in just the United States. In addition, reverse logistics can be four to five times more expensive than forward logistics and the reverse logistics process can take 12 times as many steps (e.g., assessing the returned product and repairing the returned product) as the forward logistics process.38

The reverse logistics process focuses on three critical factors: (1) why products are returned, (2) how to optimize reverse logistics, and (3) whether reverse logistics should be managed internally or outsourced to a third party.39 With respect to the first factor, products are returned for a variety of reasons, such as the customer making an error in ordering or the shipper making an error when filling an order. Goods may also be returned because of a product recall, which occurs when a hazard or defect is discovered in a manufactured or processed item, and its return is mandated by a government agency.

The second factor in managing returned goods, optimizing reverse logistics, involves a number of strategic and tactical considerations. One basic decision concerns the design of the reverse logistics system, such as whether return operations should be incorporated into existing warehousing and production facilities. If so, how will returned products be segregated from other products in an effort to reduce loss of returned product, to prevent mixing returned and nonreturned goods, and to prevent returned products from mistakenly being shipped out of the particular facility?40

Optimizing reverse logistics is incumbent on goods being carefully counted and the appropriate records (e.g., accounting, inventory) being adjusted. After a returned item has been received, it is important to evaluate the item in terms of a series of questions:

- Is the product damaged and unsalable, or can it be refurbished and resold?
- Was it returned as part of an overstock arrangement with a retailer?
- Is it a product that is being recalled?
- Is the item in an unopened package that can go into inventory for immediate resale?
- Does the item need to undergo special testing?
- What is the item’s worth?
- How do the company’s returned goods policies apply to this item?41

The scope of the preceding questions indicates that returned goods should not be managed as an afterthought. This leads directly to the third critical factor in managing reverse logistics—whether reverse logistics should be managed internally or outsourced to a third party. If a company decides to internally manage returned goods, there must be recognition that one or more employees will have returned goods as their primary, if not only, job responsibility. Because reverse logistics can be so different (e.g., irregular flow of product, small shipments) from forward logistics, the outsourcing of reverse logistics continues to grow in popularity.42

### Complexity

The degree of complexity in a logistics system is largely a function of the dynamic, global, diverse, and highly uncertain nature of relationships and activities that are involved in today’s business environment. Logistics managers are increasingly faced with the challenge of managing this complexity both within their firms and across the network of relationships that exist in their supply chain. The increased data challenges, decision-making variability, and relationship intricacy pose difficult situations for logistics managers. While space limitations will limit us from examining all of the various manifestations of complexity in logistics systems, we will take a look at some of the most relevant types affecting logistics decision making. Specifically, we will explore the role of network complexity, process complexity, and range complexity on logistics activities.

**Network complexity** refers to the growing number of nodes and the associated changes to the links in logistics systems. For example, a decision to outsource manufacturing activities to a country like China will necessarily increase the complexity of logistics activities associated with managing the flow and storage of materials and information from this facility. New modes, new carriers, customs issues, and exchange rate considerations are only a few examples of how logistics activities are affected by this change. In addition, with the increased use of outsourcing over the past decade, an associated increase in network complexity has occurred. Often, managers have been overly influenced by the promise of potential labor cost savings without fully considering the increased logistics costs that result from this more dispersed network. As labor rates have increased, this appreciation has begun to emerge.

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40Ibid.
41Ibid.
“Process complexity” centers on the haphazard development of processes, additions and modifications to processes over time, and/or changing process requirements. For example, take a logistics process associated with pick and pack operations in a warehouse environment. Logistics implications of increased process complexity could emerge due to an increased amount of time required to pick an order resulting from changes in the number of steps or changes in the handling requirements that the warehouse worker needs to complete. These changes could be caused by safety, regulatory, or even customer considerations.

“Range complexity” centers on the implications associated with the increasing number of products that most companies continue to face in an effort to differentiate themselves with their customers. This so-called issue of stock-keeping unit (SKU) proliferation will typically result in increased levels of inventory and warehousing costs. In addition, the ability to realize scale economies in areas of transportation and procurement could also be affected by this type of complexity. Logistics managers must work not only to reduce the complexity they face but also to communicate the costs of increased complexity to the firm.

Summary

A diverse set of organizational and managerial issues affect today’s logisticians. The chapter began by examining how logistics is organized within a firm, with a specific focus on organizational structure and design approaches. The chapter concluded by looking at general managerial issues facing logistics managers. These issues included productivity concerns, quality management, risk considerations, sustainability concerns, and complexity management.

KEY TERMS

- “C-level” position
- Centralized logistics organization
- Container security initiative (CSI)
- Customs Trade Partnership Against Terrorism (C-TPAT)
- Decentralized logistics organization
- Excess capacity
- Fragmented logistics structure
- Importer security filing (ISF) rule
- ISO 9000
- Lean Six Sigma
- Logistics service quality
- Logistics social responsibility
- Logistics uncertainty pyramid model
- Malcolm Baldrige National Quality Award
- Pilferage
- Productivity
- Reverse logistics
- Sharing economy
- Six Sigma
- Tachograph
- Theft
- Transportation worker identification credential (TWIC)
- Unified logistics structure

Questions for Discussion and Review

4.1 Discuss several issues that influence the organization of logistics activities within a firm.
4.2 Compare and contrast the fragmented and unified logistics organizational structures.
4.3 What are the differences between a centralized and a decentralized logistics department?
4.4 Describe the hierarchical and matrix organizational design.
4.5 From a logistics perspective, how is network organizational design manifested in terms of relevancy, responsiveness, and flexibility?
4.6 Define what is meant by productivity and discuss the ways in which productivity can be improved.
4.7 In what ways can a unionized workforce be a challenge to improving worker productivity?
4.8 How might GPS, GIS, and Tachograph be used to improve truck driver productivity?
4.9 What are some potential challenges to improving productivity by getting more output from existing assets?
4.10 How might ISO and six-sigma concepts help to improve service quality in logistics operations?
4.11 How might a firm use the logistics uncertainty pyramid model for better logistics performance?
4.12 What are some of the programs in your country to prevent terrorism through imports and transportation channels?
4.13 Discuss the reasons why logisticians might be concerned with theft.
4.14 How can logistics managers attempt to control pilferage?
4.15 Explain why piracy attacks on ships are a potentially serious issue for today’s logistics manager.

4.16 What questions should be asked after a returned item has been counted and recorded?
4.17 Discuss how reverse logistics might be considered as an appropriate implementation of logistics social responsibility.
4.18 How can warehouses control their energy usage in terms of design, lighting, and roofing considerations?
4.19 What safety aspects should be considered under logistics social responsibility?
4.20 What are the major causes of complexities in a logistics system?

Suggested Readings


McKinnon, Alan, Sharon Cullinane, Michael Browne, and Anthony Whiting. Green Logistics: Improving the Environmental Sustainability of Logistics (London: Kogan Page, 2010).


CASE

CASE 4.1 Red Spot Markets Company

The Red Spot Markets Company operates a chain of grocery stores in New England. It has a grocery distribution center in Providence, Rhode Island, from which deliveries are made to stores as far north as Lowell, Massachusetts, as far west as Waterbury, Connecticut, and as far northwest as Springfield, Massachusetts. No stores are located beyond the two northernmost points in Massachusetts. Stores to the west are supplied by a grocery warehouse located in Newburgh, New York. The Providence grocery distribution center supplies 42 Red Spot retail stores.

Robert Easter, Red Spot’s distribution manager, is responsible for operations at the Newburgh and Providence distribution centers. By industry standards, both centers were fairly efficient. However, of the two, the Providence center lagged in two important areas of control: worker productivity and shrinkage. Warehouse equipment and work rules were the same for both the Newburgh and Providence centers, yet the throughput per worker hour was 4 percent higher for the Newburgh facility. Shrinkage, expressed as a percentage of the wholesale value of goods
handled annually, was 3.6 percent for the Newburgh center and 5.9 percent for the Providence center. Jarvis Jason had been manager of the Providence distribution center for the past three years and, at great effort, managed to narrow the gap between the performance rankings of the two Red Spot facilities. Last week he requested an immediate reassignment, and Easter arranged for him to become the marketing manager for the Boston area, which would involve supervising the operations of 11 Red Spot markets. The transfer involved no increase in pay.

Easter needed a new manager for the Providence distribution center, and he picked Fred Fosdick for the task. Fosdick graduated from a lesser Ivy League college, where he majored in business with a concentration in logistics. He had been with Red Spot for two years and had rearranged the entire delivery route structure so that two fewer trucks were needed. As part of this assignment, he also converted the entire system to one of unit loads, which meant everything loaded on, or unloaded from, a Red Spot truck was on a pallet. Fosdick was familiar with the operations of both the Providence and Newburgh centers. He has been in each facility at least 50 different times. In addition, he spent two weeks at the Providence center when the loading docks were redesigned to accommodate pallet loading. Fosdick was surprised that Jason had requested his reassignment to a slot that did not involve an upward promotion. That was his first question to Easter after Easter asked whether he was interested in the Providence assignment.

“I’m sorry you started with that question,” said Easter to Fosdick. “Now we’ll have to talk about the troublesome aspects of the assignment first, rather than the positive ones. To be frank, Fred, one of the union employees there made so much trouble for Jason, he couldn’t stand it.”

“Who’s the troublemaker?” asked Fosdick.

“Tom Bigelow,” was Easter’s answer.

Fosdick remembered Bigelow from the times he had been at the Providence center. Thomas D. Bigelow was nicknamed T. D. since his days as a local Providence high school football star. Fosdick recalled that during work breaks on the loading dock, Bigelow and some of the other workers would toss around melons as though they were footballs. Only once did they drop a melon. Fosdick recalled hearing the story that Bigelow had received several offers of athletic scholarships when he graduated from high school. His best offer was from a southern school, and he accepted it. Despite the fact that the college provided a special tutor for each class, Bigelow flunked out at the end of his first semester and came back to Providence, where he got a job in the Red Spot warehouse.

In the warehouse, Bigelow was a natural leader. He would have been a supervisor except for his inability to count and his spotty attendance record on Monday mornings. On Mondays, the day that the warehouse was the busiest because it had to replenish the stores’ weekend sales, Bigelow was groggy, tired, and irritable. On Mondays, he would sometimes hide by loading a forklift with three pallets, backing into any empty bay, and lowering the pallets in position (which hid the lift truck from view), and he would fall asleep. The rest of the week Bigelow was happy, enthusiastic, and hardworking. Indeed, it was he who set the pace of work in the warehouse. When he felt good, things hummed; when he was not feeling well or was absent, work dragged.

“What did Bigelow do to Jason?” Fosdick asked Easter.

“Well, as I understand it,” responded Easter, “about two weeks ago Jason decided that he had had it with Bigelow and so he suspended him on a Monday morning after Bigelow showed up late, still badly hung over. It was nearly noon, and he told Bigelow to stay off the premises and to file a grievance with his union shop steward. He also told Bigelow that he had been documenting Bigelow’s Monday performance—or nonperformance—for the past six months and that Red Spot had grounds enough to fire Bigelow if it so chose. He told Bigelow to go home, sober up, and come back on Tuesday when they would discuss the length of his suspension. Bigelow walked through the distribution center on his way out, and I’m sure Jason felt he had control of the matter.”

“However,” continued Easter, “by about one o’clock, Jason realized he had a work slowdown on his hands. Pallet loads of bottled goods were being dropped, two forklifts collided, and one lift truck pulled over the corner of a tubular steel rack. At 4:00 p.m. quitting time, there were still three trucks to be loaded; usually they would have departed by 3:30. Rather than pay overtime, Jason let the workforce go home, sober up, and he and the supervisor loaded the last three trucks.”

“On Tuesday, Bigelow did not show up, and the slowdown got worse. In addition, retail stores were phoning with complaints about all the errors in their orders. To top it off, at the Roxbury store, when the trailer door was opened, the trailer contained nothing but empty pallets. Tuesday night somebody turned off the switches on the battery chargers for all the lift trucks, so on Wednesday, the lift-truck batteries were dying all day. I got involved because of all the complaints from the stores. On Wednesday, Jason got my permission to pay overtime, and the last outgoing truck did not leave until 7:00 p.m. In addition we had to pay overtime at some of our retail stores because the
workers there were waiting for the trucks to arrive. While I was talking to Jason that afternoon, he indicated that he had fired Bigelow.”

Easter lit his cigar and continued, “On Wednesday, I decided to go to Providence myself, mainly to talk to Jason and to determine whether we should close down the Providence center and try to serve all our stores out of Newburgh. This would have been expensive, but Providence was becoming too unreliable. In addition, we had a big weekend coming up. When I showed up in Providence, Jason and I had breakfast together in my hotel room Thursday morning, and he told me pretty much the same thing I’ve been telling you. He said he knew Bigelow was behind all the disruption and that today, Thursday, would be crucial. I’ve never seen Jason looking so nervous. Then we drove to the distribution center. Even from a distance, I could tell things were moving slowly. The first echelon of outgoing trucks, which should have been on the road, was still there. Another 20 of our trucks were waiting to be loaded. On the other end of the building, you could see a long line of arriving trucks waiting to be unloaded; usually there was no line at all. I knew that our suppliers would start complaining because we had established scheduled unloading times. However, I decided not to ask Jason whether he had begun receiving phone calls from them.”

“Inside the center, the slowdown was in effect. Lift-truck operators who usually zipped by each other would now stop, turn off their engines, dismount, and carefully walk around each other’s trucks to ensure there was proper clearance. Satisfied of this, they would then mount, start their engines, and spend an inordinate amount of time motioning to each other to pass. This was only one example. When we got to Jason’s office, he had a message to phone Ed Meyers, our local attorney in Providence, who handles much of our labor relations work there. He called Meyers and was upset by the discussion. After he hung up, he told me that Meyers had been served papers by the union’s attorney, charging that Wednesday’s firing of Bigelow was unjustified, mainly because no provable grounds existed that Bigelow was behind the slowdown. Meyers was angry because, in firing Bigelow on Wednesday, Jason may have also blown the suspension of Bigelow on Monday. Jason and I started talking, even arguing. I talked so much that my cigar went out,” said Easter, “so I asked Jason, who was sitting behind his desk, for a match. He didn’t carry matches but looked inside his center desk drawer for one. He gasped, and I didn’t know what was the matter. He got up, looking sick, and walked away from his desk. He said that a dead rat had been left in his desk drawer, and he wanted a transfer. He was in bad shape and the distribution center was in bad shape, so I had the opening in the Boston area and I let him have it. Actually, right now he and his family are vacationing somewhere in Eastern Canada. He needs the rest.”

Fosdick was beginning to feel sorry that he knew all the details, but he persisted. “Then what?” he asked Easter.

“Well, I took over running the distribution center. I phoned Meyers again, and he and I had lunch. He thought that Jason had blown the case against Bigelow and that we should take him back. So on Friday, Meyers, Bigelow, the union attorney, the shop steward, Bigelow’s supervisor, and I met. Jason, of course, was not there. It was a pleasant meeting. Everything got blamed on poor Jason. I did tell Bigelow that we would be documenting his performance and wanted him to know that Jason’s successor, meaning you, was under my instructions to tolerate no nonsense. Bigelow was so pleasant that day that I could not imagine him in the role of a troublemaker. The amazing thing was that, when he went out into the center to resume work, a loud cheer went up and all the drivers started blowing their lift-truck horns. For a moment, I was afraid all the batteries would run down again. But I was wrong. They were plain happy to see Bigelow back. You know, the slowdown was still in effect when Bigelow walked onto the floor. I’d say it was 10:00 a.m. and they were an hour behind. Well, let me tell you what happened. They went to work! By noon we were back on schedule, and by the end of the shift we were a half-hour ahead of schedule. In fact, the last half-hour was spent straightening up many of the bins that had been deliberately disarranged during the slowdown. I tell you, Tom Bigelow does set the work pace in that warehouse!”

“So what do you suggest I do at the center?” asked Fosdick.

“Well, the key is getting along with Bigelow. Talk to Meyers about the kind of records you should keep in case you decide to move against Bigelow. Be sure to consult with Meyers before you do anything irreversible. Frankly, I don’t know whether Bigelow will be a problem. We never had trouble with him that I knew about before Jason was there. According to Bigelow and the union attorney, Jason had it in for Bigelow. If I were you, I’d take it easy with Bigelow and other labor problems. See what you can do instead about the inventory shrinkage.”

On the next Monday morning, Fosdick showed up at the Providence distribution center. After gingerly looking in all his desk drawers, he had a brief meeting with his supervisors and then walked out to meet the entire workforce on a one-to-one basis. Many remembered Fosdick from his earlier visits to the facility. Because it was a Monday morning,
he had not expected to encounter Bigelow, who was present, clear-eyed, alert, and enthusiastic. Bigelow was happy to see Fosdick and shook his hand warmly. Bigelow then excused himself, saying he had to return to work. The truck dispatcher said that the workforce was ahead of schedule again: It was 11:00 A.M., and they were about 15 minutes ahead. Fosdick returned to his office, and there was a phone message from Ed Meyers. Meyers asked to postpone their luncheon for that day until Tuesday noon. Then Robert Easter called to ask how things were going on Fosdick’s first day. Easter was pleased that things were going smoothly.

It was lunchtime. Fosdick decided to walk to a small café where he had eaten at other times. It was two blocks from the distribution center and on the side away from the office. So he walked through the center, which was quiet since it was closed down for lunch. He walked by the employees’ lunchroom and heard the normal sounds of 50 people eating and talking. Just outside the lunchroom was one lift truck with an empty wooden pallet on it. As Fosdick watched, one of the stock clerks came out of the lunchroom with an opened case of sweet pickles from which three jars had been taken. Next came another stock clerk with an opened carton of mustard from which two bottles had been removed. One of the clerks suddenly saw Fosdick and said weakly, “We take these opened cases to the damaged merchandise room.” Fosdick went into the lunchroom. There, on the center table were cases of cold meat, cheese, soft drinks, mayonnaise, and bread. All had been opened and partially emptied to provide the workers’ lunches.

Bigelow was making himself a large sandwich when he saw Fosdick approach. “Don’t get uptight,” he said to Fosdick. “You’ve just come across one of the noncontract fringe benefits of working at the Red Spot Providence distribution center. May I make you a sandwich?”

**QUESTIONS**

1. How should Fosdick respond to the immediate situation?
2. What controls, of the types discussed in this chapter, might have been used by Red Spot Markets to reduce or eliminate the problems discussed in the case?
3. What longer-range steps should Fosdick take to control the operations of the Providence distribution center?
4. What longer-range steps should Fosdick take to improve the Providence distribution center’s productivity?
5. What longer-range steps can Fosdick take to reduce the distribution center’s high rate of shrinkage?
6. Assume that Fosdick decides that the practice of free lunches from the opened cases of goods must be stopped. Develop and present the arguments he should give in a meeting with the union shop steward.
7. (This is a continuation of Question 6.) Assume, instead, that you are the union shop steward. Develop and present your argument that the free lunches represent a long-standing employee benefit enjoyed by the distribution center’s employees and that management’s attempt to stop them is a breach of an unwritten contract and will be resisted.
8. Much of the situation described in the case seems to evolve around the personality of T. D. Bigelow. How should he be treated? Why?
Because supply chain management and procurement are inextricably linked with logistics management, Part II of *Contemporary Logistics* takes a closer look at these two topics. Chapter 5 examines supply chain management, which is a distinct concept from logistics management. Supply chain management focuses on business process integration that requires contributions from logistics as well as the other functional areas. In addition, supply chain management provides the structure for the network of interorganizational relationships that form one's supply chain. Also covered are enablers and barriers that affect one's ability to integrate their network of relationships.

Chapter 6 examines procurement, a business function responsible for ensuring an efficient and effective supply of materials in support of manufacturing and marketing strategies. It will examine key aspects of this essential linkage between suppliers and buyers and the mechanism that initiates the movement of materials into one's logistics system. In addition, logistics considerations that can potentially affect procurement decisions are detailed.
As pointed out in Chapter 1, the contemporary view is that logistics is a key part of supply chain management (SCM), and there are many examples of the importance of the logistics function to SCM. Research on underperforming supply chains, defined as those exhibiting poor service, unproductive assets, or high variable operating costs, suggests that logistical considerations can be crucial to achieving desired levels of supply chain performance. For example, damaged goods resulting from shoddy materials handling practices might result in poor service. Poor inventory turnover, an indicator of unproductive asset utilization that can negatively affect firm performance, can be addressed by consolidating stocking points and eliminating slow-moving items. Finally, high transportation costs, one example of margin-reducing operating costs, call for an examination of modal or carrier selection policies as well as of transportation routing decisions.1

This chapter provides an overview of the SCM concept, begins with a description of its evolution, and establishes its definition. Next, descriptions of two prominent SCM process frameworks are provided. An examination of key enablers that can influence a firm’s ability to implement SCM, such as the leveraging of technology for enhanced visibility and communication, will follow this. Next comes an overview of select barriers to SCM implementation, and the chapter concludes with a look at supply chain integration approaches.

EVOLUTION OF SUPPLY CHAIN MANAGEMENT

SCM is a relatively young concept in the sense that it was rarely mentioned in either the academic or practitioner communities prior to 1990. According to Professor Mentzer and colleagues, “the supply chain concept originated in the logistics literature, and logistics has continued to have a significant impact on the SCM concept.”2 More specifically, a dominant logistical philosophy throughout the 1980s and into the early 1990s involved the integration of logistics with other functional areas of an organization in an effort to achieve the enterprise’s overall success.3 The early to mid-1990s witnessed

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a growing recognition that there could be value in coordinating the various business functions not only within organizations but across organizations as well—in what can be referred to as an SCM philosophy.

Since the early to mid-1990s academics, practitioners, and industry associations have suggested a number of definitions for both a supply chain and SCM. As was the case when defining logistics, it is important to have a common understanding of what is meant by supply chain and SCM in order to support management efforts in this area.

A supply chain can be liberally viewed as a combination of processes, functions, activities, relationships, and pathways along which products, services, information, and financial transactions move in and between enterprises from original producer to ultimate end-user or consumer. Figure 5.1 presents illustrations of several generic types of supply chains, and it is important to note several key points. First, supply chains are not a new concept in that most organizations traditionally have been dependent on suppliers, and organizations traditionally have served customers. For example, Procter & Gamble (P&G), a prominent multinational company that produces consumer packaged goods, needed raw materials to make soap, as well as customers for the soap, when it was founded in 1837; today, P&G still needs raw materials to make soap—as well as customers for the soap.

Figure 5.1 also points out that some supply chains can be much more complex (in terms of the number of participating parties) than others, and coordinating complex supply chains is likely to be more difficult than doing so for less-complex supply chains. Moreover, complex supply chains may include “specialist” companies, such as third-party logistics (3PL) providers, to facilitate coordination among various supply chain parties. Note also that customers are an integral component in supply chains, regardless of their complexity. Contemporary thought has also extended the role of consumers in SCM. Consumers have gone from being viewed as merely recipients of supply chain activities to a potential value co-creator. Pfizer, a global pharmaceutical company, employs consumers to report on product merchandising and availability during their shopping trips. Hoover, a manufacturer of vacuum cleaners, has allowed consumers to 3D print accessories for their vacuums.

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With respect to the relationship between logistics and supply chain management, the Council of
Supply Chain Management Professionals (CSCMP) views logistics activities as being part of manage-
ing one’s supply chain. In addition, activities involved in sourcing, procuring, and manufacturing are also involved. Consistent with Figure 5.1, CSCMP also asserts the need to work with multiple parties, including suppliers, third-party service providers, and end customers as an organization integrates supply and demand management internally and with other companies in the supply chain.

The CSCMP view goes on to establish that SCM has a leading role for connecting business functions and business processes internally and across companies so as to ensure coordination and high performance across the supply chain. As such, SCM is inclusive of logistics management activities, and logistics managers can contribute to the success and benefit from involvement in SCM. Moreover, although nearly any organization can be part of a supply chain, SCM must be specifically managed by the organizations operating within the supply chain.

Successful SCM requires companies to adopt an enterprise-to-enterprise point of view, which can cause organizations to accept practices and adopt behaviors that haven’t traditionally been associated with buyer–seller interactions (as will be seen later in this chapter). Moreover, successful SCM requires companies to apply the systems approach (previously mentioned in Chapter 1) across all organizations in the supply chain. When applied to supply chains, the systems approach suggests that companies must recognize the interdependencies of the decisions made in major functional areas and business processes within, across, and between firms. In turn, the goals and objectives of individual supply chain participants should be compatible with the goals and objectives of other participants in the supply chain. For example, a company that is committed to providing a high level of customer service might be out of place in a supply chain comprising companies whose primary goal is cost containment.

SUPPLY CHAIN MANAGEMENT PROCESS FRAMEWORKS

The APICS Supply Chain Council (Supply Chain Operations Reference [SCOR] Model—www.apics.org) and the Supply Chain Management Institute (Global Supply Chain Forum [GSCF] Model—www.scm-institute.org) have established the two prominent SCM process frameworks. The prominence of these models is attributable to the fact that they identify business processes in such a way that the processes can actually be implemented, and thus evaluated, by organizations; each of the models is also supported by major corporations. A primary distinction between the models is the degree of cross-functional involvement prescribed by each, with the GSCF model involving all business functions. In contrast, the SCOR model is focused on the logistics, operations, and procurement functions. The proposed models are briefly described next.

The SCOR model identifies six processes—Plan, Source, Make, Deliver, Return, and Enable—associated with SCM (see Table 5.1). Moreover, closer analysis of the six processes, and their definitions, indicates the important role of logistics in SCM. It can be argued that logistics has some involvement in both sourcing and making; for example, with respect to making, recall the narrative in Chapter 1 about the concept of postponement resulting in value-added activities being performed in warehousing facilities. Alternatively, logistics can be involved in delivering and returning; the definition of the deliver process specifically mentions the logistics components of order management, transportation management, and distribution management. Logistics is also a key area of consideration within SCOR’s planning and enabling processes. In terms of planning, logistics is a

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6Ibid.
8Mentzer et al, “Defining Supply Chain Management.”
key contributor to understanding capacity constraints that could inhibit the ability to meet delivery requirements. With respect to the enable process, logistics assets such as trucks and warehouses are scheduled and maintained in order to enable the ultimate deliver process.

The **GSCF model** comprises eight processes (see Table 5.2)—customer relationship management, supplier relationship management, customer service management, demand management, order fulfillment, manufacturing flow management, product development and commercialization, and returns management. Unlike the SCOR model, the GSCF model includes the involvement of all business functions. However, as was the case with the SCOR model, logistics plays an important role in the processes associated with the GSCF model. For example, logistics considerations such as on-time pickup and delivery could arise within the order fulfillment process as well as being monitored by the customer service management process. The logistics function can contribute to customer relationship management and supplier relationship management processes in terms of outbound or inbound material flow being part of a product and service agreement with a key customer or supplier. Logistics decisions in support of a new product might surface in the manufacturing flow (inbound flows of new raw materials), demand management (forecasted transportation requirements for a product rollout), or product development and commercialization (packaging considerations) processes. Moreover, reverse logistics is a key consideration for the returns management process.

**ENABLERS OF SCM IMPLEMENTATION**

A variety of enablers can influence a firm’s ability to implement SCM, including managerial understanding of the implications of increased customer power, establishing appropriate relationship structures, leveraging technology for enhanced visibility and communication, and the use of supply chain facilitators. Although each of these is discussed in the following paragraphs as discrete entities, interdependencies exist among them. For example, advances in technology could facilitate enhanced communication across organizations in support of a collaboration initiative between a company and one of its third-party logistics providers.

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Understanding the Implications of Increased Customer Power

You are probably familiar with the adage that “information is power.” In recent years, the customer has gained tremendous power over buying decisions, in large part because of greater access to information. This access, largely enabled by the Internet, allows the consumer to become highly knowledgeable about an individual organization and its products—as well as also becoming aware of competing organizations and their products.

This increased power of customers has important implications for the design and management of supply chains. For example, because customer needs and wants can change relatively quickly, supply chains are increasingly required to be fast and agile, rather than slow and inflexible. A fast supply chain emphasizes a speed and time component, whereas an agile supply chain focuses on an organization’s ability to respond to changes in demand with respect to volume and variety.

Failure to be fast and agile can result in decreased market share, reduced profitability, lower stock price, or dissatisfied customers for supply chain members. The drive to be fast and agile has even resulted in some e-commerce firms such as Amazon beginning to offer same-day delivery services in select markets. In fact, Amazon offers Prime Now service in some markets promising delivery of more than 18,000 items within one hour for those subscribing to the service.

Furthermore, the customer power concept suggests that traditional factory-driven, push supply chains should be replaced by customer-centric, pull-oriented ones. And where traditional supply chains focused on internal cost metrics (measures) such as labor costs and freight costs, customer-centric supply chains are increasingly concerned with metrics that take a more holistic perspective.

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15www.amazon.com
Take for example, the **perfect order** (i.e., *simultaneous* achievement of relevant customer metrics such as on-time delivery, damage free, and correct order quantity) metric that examines the total impact of an incorrect order in a single metric via a multiplier effect. This metric has been shown to help diagnose problems within a supply chain and improve satisfaction by looking at orders from the customer's perspective.\(^{16}\)

However, firms must focus on both effectively and efficiently designing their supply chains according to market needs/characteristics. While an agile supply chain may be most appropriate in contexts where customer demand is volatile, and their requirements for variety are high,\(^ {17}\) in cases where customer demand is relatively stable and the need for variety is low, establishing a **lean supply chain** may be a more appropriate goal. Lean supply chains are focused on eliminating all waste, including time, and ensuring a level schedule. A hybrid approach used in practice, sometimes referred to as **leagility**, combines aspects of both lean and agile as a way to focus part of one’s supply chain on a timely response to fluctuating customer orders and/or product variety and another part of the supply chain on leveling out the planning requirements to smooth production output.\(^ {18}\)

Logistics decisions such as mode selection, warehouse design, facility location, and inventory levels can directly influence the ability to achieve the goals of any of these approaches. For example, attempts to “lean out” the supply chain through a better-controlled flow of inventory with lower levels of expensive inventory “lumps” along the way can be a daunting task. In this situation, managerial focus is on reducing the so-called **bullwhip effect**, which is characterized by variability in demand orders among supply chain members—the end result of which is inventory lumps.\(^ {19}\) In short, one aspect of inventory control that could be influenced by a lean approach is to move from a pattern of stops and starts to a continuous flow.

Another goal of a lean approach could center on reducing the amount of inventory in the supply chain. Inventory can be reduced in a number of ways, such as smaller, more frequent orders; the use of premium transportation; demand-pull, as opposed to supply-push, replenishment; and the elimination or consolidation of slower-moving product, among others. However, prominent supply chain disruptions in the early part of the twenty-first century—terrorist attacks (such as September 11, 2001), natural disasters (such as the earthquake in Haiti or the hurricanes that hit New Orleans and the Northeast part of the United States), and health pandemics (such as sudden acute respiratory syndrome [SARS] and swine flu [H1N1]) have caused some supply chains to reassess the risk implications of this approach.

### Establishing Appropriate Relationship Structures

Well-run supply chains improve the long-term performance of the individual companies and the supply chain as a whole. This perspective suggests that companies should consider employing a long-term as opposed to a short-term orientation with key members—suppliers, customers, intermediaries, and facilitators—of their supply chain. Importantly, a long-term orientation tends to be predicated on **relational exchanges**, whereas a short-term orientation tends to focus on **transactional exchanges**. For relational exchanges to be effective, a transactional “What’s in it for me?” philosophy needs to be replaced by a relational “What’s in it for us?” philosophy. Relational exchanges tend to be characterized by a far different set of attributes than are transactional exchanges, including—but not limited to—trust, commitment, dependence, joint investment, and shared benefits.\(^ {20}\)

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At a minimum, relational exchanges may result in individual supply chain members having to rethink (and rework) their approaches to other supply chain members. Commitment, for example, suggests that supply chain members recognize the importance of maintaining the relationship that has been established, as opposed to regularly changing sources to take advantage of short-term bargains. Moreover, relational exchanges—and by extension, SCM—cannot be successful without information sharing among key members. However, this is much more easily said than accomplished, in part because the previously mentioned business adage, “Information is power,” can make supply parties somewhat hesitant to share information, lest they jeopardize their competitive advantages or expose organizational shortcomings.

Given a primary objective of SCM is to optimize the performance of the supply chain as a whole, rather than optimizing the performance of individual organizations, collaboration among supply chain members across both transactional and relational exchanges is essential. While collaboration between functions within an organization (internal collaboration) can sometimes be problematic, the benefits from organizations successfully collaborating with other supply chain members (external collaboration) drop directly to the bottom line and can increase the competitiveness of one’s supply chain.21

A great deal has been written about supply chain collaboration in recent years, and a review of what’s been written might leave the reader confused in the sense that some writings indicate that supply chain collaboration is currently more wishful thinking than practical reality, that few organizations engage in collaboration, and those that do haven’t experienced much improvement in performance. Alternatively, other writings indicate that supply chain collaboration is widely applied, and participating organizations experience noticeable performance-related improvements. One reason for the widely divergent views of supply chain collaboration is that there are myriad definitions of it. For our purposes, supply chain collaboration will be defined as cooperative relationships between members of a supply chain—formal or informal—between companies and their suppliers or customers, established to enhance the overall business performance of all parties.22

In addition, some writers believe that supply chain collaboration is strategic in nature (a “narrower” view), whereas others view collaboration as ranging from transactional to strategic behaviors (a “broader” view). We’ll take the broader view, which suggests that supply chain collaboration can be classified as transactional, tactical information sharing, or strategic in nature (summarized in Figure 5.2). According to this rubric, although transactional and tactical information sharing are currently the most prevalent types of collaboration, strategic collaborations are increasing and offer the best opportunity for improving supply chain performance.23

An example of a strategic collaboration could be the formation of a formal supply chain partnership, defined as a tailored business relationship between two supply chain members. Key characteristics of supply chain partnerships include, but are not limited to, high interdependence among the partners, an increased willingness to share information, compatible goals, mutual trust, and buying decisions based on value as opposed to cost or price. Recent research has empirically demonstrated favorable relationships between the formation of supply chain partnerships and performance-related outcomes such as cost reduction, improved profits, and revenue growth.24 Organizations should establish systematic processes for identifying, developing, implementing, and continuously improving the key relationships in their supply chain.25

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23Ibid.
Leveraging Technology for Enhanced Visibility and Communication

It is argued that technology has been at the center of changes taking place that affect the supply chain, and that two key factors—computing power and the Internet—have sparked much of this change.\(^{26}\) With respect to the former, supply chains can be complex entities consisting of multiple organizations, processes, and requirements. As such, attempts at applying mathematical modeling techniques to supply chains in an effort to maximize shareholder wealth or minimize costs (1) were not very practical prior to the advent of computers and (2) took a great deal of time, even after computers were introduced. However, the introduction and continued advancement of computing power now allows for fast, low-cost mathematical solutions to complex supply chain issues.

Business futurists Joseph Pine and James Gilmore have referred to the Internet as “the greatest force of commodization known to man, for both goods and services.”\(^{27}\) With respect to supply chains, the Internet can facilitate efficiency and effectiveness by providing opportunities for supply chains to simultaneously improve customer service and reduce their logistics costs.\(^{28}\)

It is important to recognize that the Internet has important implications for both business-to-consumer links and business-to-business links within supply chains. (These implications are more fully discussed in Chapter 2.) In today’s business environment, the Internet can allow one supply chain party to have virtually instantaneous visibility to the same data as other parties in the supply chain. Such instantaneous visibility offers the opportunity for supply chains to become more proactive and less reactive, which can translate into lower inventories and improved profitability throughout the supply chain.\(^{29}\)

Because supply chains depend on huge quantities of real-time information, it is essential that this information can be seamlessly transmitted across organizations. For example, retail point-of-sale information can be transmitted directly to suppliers and translated into orders for replenishment of product. Alternately, vendors may allow customers to query vendor inventory records to determine what products are in stock and where the stocks are located. The enhanced communication across organizations is dependent on both technological capabilities and a willingness to share information (part of a long-term orientation). Figure 5.3 shows a handheld computer with a radio-frequency connection used to communicate real-time inventory information regarding a truck and its contents. Customers could use this information for tracking anticipated delivery of their orders and suppliers


\(^{29}\) Rosenbaum, “The Technology-Enabled Supply Chain Network.”
may use the same information to trigger replenishments. Companies are investing more aggressively in technology to achieve supply chain visibility in pursuit of this “single version of truth” about what is going on inside of their supply chain.30

**Use of Supply Chain Facilitators**

In Figure 5.1, we saw that the ultimate supply chain contains several types of organizations (e.g., third-party logistics supplier), which exist to facilitate coordination among various supply chain members. Because this is a logistics textbook, the most relevant facilitator for our purposes is the third-party logistics provider, so it is especially relevant to examine its impact on logistics and supply chains.

Third-party logistics, also called logistics outsourcing or contract logistics, continues to be one of the most misunderstood terms in logistics and SCM. As we have seen with other supply chain concepts (e.g., collaboration, SCM), there is no commonly accepted definition of third-party logistics. Some definitions, for instance, take a “broad” perspective by suggesting that any logistics activity not performed in-house is representative of third-party logistics. Other definitions, in contrast, emphasize that 3PL arrangements involve a long-term perspective between buyer and seller and that the parties have a relationship, as opposed to transactional, perspective.

Regardless of whether one takes a broad or narrow perspective, the general idea behind third-party logistics is that one company (say, a manufacturer) allows a specialist company to provide it with one or more logistics functions (e.g., warehousing, outbound transportation). Some well-known 3PL providers include DHL Supply Chain, Kuehne and Nagel, DB Schenker, and UPS Supply Chain Solutions. A great deal of consolidation has occurred among 3PL providers in recent years (e.g., Deutsche Post acquired Exel, UPS Supply Chain Solutions acquired Menlo Logistics, among others),

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and this consolidation is expected to continue into the future. Although these consolidations could provide customers a broader range of supply chain services, consolidation could also lead to fewer competitive options.31

3PL customers can demand a number of different activities, with some of the most common involving inbound and outbound transportation, carrier negotiation and contracting, and freight consolidation.32 Moreover, some 3PL providers have begun to offer so-called supplemental services—such as final product assembly, product installation, and product repair, among others—that are beyond their traditional offerings. As noted in Chapter 1, these supplemental 3PL services can blur traditional distinctions among supply chain members (e.g., product assembly has generally been performed by the manufacturing group). Importantly, however, this blurring of distinctions may actually facilitate supply chain integration, in that there is less emphasis on functional issues and more emphasis on cross-functional processes.33

The decision to use 3PL services can be driven by strategic considerations, in the sense that an organization believes that one or more aspects of its supply chain(s) need to be transformed. Alternatively, the decision to use 3PL services could be more tactical in nature; an organization might have an inefficient distribution network, an inability to control internal costs, a costly or inflexible workforce, outdated warehousing facilities, or outdated information systems. Whether strategic or tactical in nature, the use of 3PL services is driven by recognition that an organization does not have sufficient internal capabilities to address the issue, or issues, in question.34

Although logistics outsourcing has the potential to improve both the effectiveness and efficiency of supply chains, 3PL arrangements can easily result in failure (i.e., an inability for one party to provide what is expected by the other party). One common cause of 3PL failure is unreasonable and unrealistic expectations, generally from the user’s perspective; for example, it might be unreasonable (and unreasonable) for a customer to expect a 3PL provider to cut the user’s annual transportation expenditures by 50 percent. Another cause of failure in 3PL arrangements involves a lack of flexibility. Regardless of how thoroughly the provider and customer have prepared for a 3PL arrangement, unexpected issues and challenges are bound to arise. Has the arrangement been structured so that unexpected occurrences can be dealt with in a timely and satisfactory manner?35

One measure of the pervasiveness of outsourcing in SCM can be seen in the evolution of fourth-party logistics (4PL), or the lead logistics provider (LLP), concept, which emerged in the mid-1990s. Because 4PL/LLP is still relatively young, there is disagreement as to what it should be called as well as how it should be defined. With respect to the former, lead logistics provider appears to be emerging as the moniker of choice, but some providers, such as UPS Supply Chain Services, don’t use either term to describe their services. And although an exact definition is elusive, for our purposes 4PL/LLP will refer to a company whose primary purpose is to ensure that various 3PLs are working toward the relevant supply chain goals and objectives. In order to be successful at managing other 3PLs, a 4PL/LLP needs to have the expertise to consider supply chain solutions and potential trade-offs, make constant objective decisions across a broad set of value-adding activities, and be viewed as neutral.36 Whatever one calls it, by one estimate, 4PL/LLP currently accounts for approximately 20 percent of total logistics outsourcing expenditures, and revenues are projected to continue growing in the future.37

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BARRIERS TO SCM IMPLEMENTATION

Although implementation of SCM may sound attractive from a conceptual perspective, a number of barriers can block its effectiveness, and these are discussed in the following paragraphs.

Regulatory and Political Considerations

Several decades ago, many of the supply chain arrangements in use today would have been considered illegal under certain regulatory statutes. In the United States, for example, cross-business coordination was fostered by the passage of the National Cooperative Research and Development Act of 1984. Long-term commitments, which are one of the bedrocks of SCM, may stifle competition to the extent that they make it more difficult for others to enter particular markets. Although the overall global climate for business has shifted toward allowing more cooperation among firms, it still would be wise to seek sound legal advice before entering into future supply chain arrangements.

Political considerations such as war and governmental stability can also act as a barrier to SCM. With respect to war, the twenty-first century has witnessed ongoing tensions in the Middle East, increasing tensions between Pakistan and India (both with nuclear weapon capabilities), industry nationalization by the Venezuelan government, and wars in Iraq and Afghanistan, as well as civil and political unrest in various parts of Africa. These political uncertainties might cause some organizations to shy away from joining or developing supply chains that rely on companies located in these areas of the world. Governmental stability is also a key consideration, because SCM is so dependent on interorganizational coordination. Governmental policies that either discourage such coordination or discourage doing business with certain countries would obviously have a negative impact on supply chain efficiency. Developed countries are not immune to the challenges of political uncertainty. For example, the 2016 decision by the United Kingdom to exit the European Union will have significant effects on European supply chains. Companies in Europe will ultimately need to reconfigured their distribution channels to match the new complexities of managing logistics in the region.

Lack of Top Management Commitment

Top management commitment is regularly cited as an important component when individual companies attempt to initiate and implement new initiatives, programs, and product introductions. Because of SCM’s interorganizational focus, top management commitment is absolutely essential if supply chain efforts are to have any chance of success. Top management has the ability to allocate the necessary resources for supply chain endeavors and the power to structure, or restructure, corporate incentive policies to focus on achieving organizational and interorganizational (as opposed to primarily functional) objectives.

Unfortunately, research presents a “mixed bag” of sorts with respect to top management commitment to SCM. More specifically, although senior management tends to be aware of SCM, actual senior management commitment to SCM occurs in only one of every three organizations. Top management may be hesitant to fully commit to SCM because it is uncomfortable with (or does not understand) one or more of its underpinnings. For example, some companies may be uncomfortable with the concept of customer power in supply chains. Alternatively, other companies may be hesitant to enter into long-term relationships because such relationships might be perceived as limiting their operational flexibility or potentially increasing costs.

Reluctance to Share, or Use, Relevant Information

One tenet of SCM is that well-run supply chains are characterized by information sharing among their members. Nevertheless, some organizations are reluctant to share information, particularly

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information that might be considered proprietary in nature. However, this reluctance can contribute to supply chain problems because members may be making decisions based on erroneous data or assumptions. For example, one cause of the bullwhip effect is asymmetrical information among supply chain members.

Furthermore, advances in computer hardware and software now permit significant amounts of information to be processed and analyzed relatively quickly. To this end, supply chain analytics combines technology with manual employee effort to identify trends, perform comparisons, and highlight opportunities in supply chain processes, even when large amounts of data are involved. Supported by technology, supply chain analytics help decision makers in areas such as sourcing, inventory management, manufacturing, quality, sales, and logistics. Supply chain analytics leverage enterprise applications, the Internet, data warehouses, and information obtained from external sources to locate data patterns. For example, frequent shopper cards, such as those offered by grocery chains, offer the opportunity to develop highly detailed profiles of individual customers. Some companies, however, are reluctant to fully utilize the information that comes from these data; they believe that the highly detailed data that can be provided by the cards—what was purchased, when it was purchased, where it was purchased, how it was purchased—potentially violate the customer’s right to privacy. A recent survey of 1,000 senior executives conducted by consulting firm Accenture found 97 percent had an understanding of how big data analytics could benefit their supply chain, but only 17 percent indicated they had implemented analytics focused on supply chain activities.39

### Incompatible Information Systems

Twenty years ago, a major barrier to interorganizational collaboration was incompatible computer hardware; today, by contrast, software compatibility is likely the more pressing issue. A key software question involves the decision between a single integrator approach and a best-of-breed approach. Organizations pursuing a single integrator approach rely on a single vendor to provide all relevant software applications (e.g., inventory management, transportation management, warehouse management). One advantage to the single integrator approach is that there should be coordination across the various applications.40

Alternatively, a best-of-breed approach chooses the best application for a particular function, so that an organization could have transportation management software from one company and warehouse management software from another company.41 However, best-of-breed solutions often require additional software packages to coordinate these different applications—and these integrations don’t always proceed smoothly. One well-known example of a not-so-smooth integration involved Hershey Foods’ effort to integrate several specialized supply chain software packages. The growing pains of this integration included unfilled candy orders for Halloween and Christmas, longer delivery times, increased inventory levels, and upset customers.42

### Incompatible Corporate Cultures

Because SCM can involve a long-term orientation and partnerships between various members, it is important that the parties be comfortable with the companies they will be working with. In a broad sense, corporate culture refers to “how we do things around here” and reflects an organization’s vision, values, and strategic plans. It is important to recognize that compatible corporate cultures don’t require all organizations to be the same. Rather, organizations should identify potential differences that could negatively affect supply chain effectiveness and efficiency. For example, an organization

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41Ibid.

with a participative management style might not mesh very well with an organization that has an autocratic management style.\textsuperscript{43}

All manifestations of corporate culture may provide important clues about the ability of companies to work together. For instance, one of the more notable supply chain failures in past years involved the dissolution of the relationship between Office Max and Ryder Integrated Logistics. Although a number of reasons explain why this relationship didn’t succeed, the two companies had quite different dress codes. Indeed, a Ryder manager told one of the authors that it was clear from the first face-to-face meeting that the companies were going to have difficulty working together—in large part because of their vastly different dress codes!

**Globalization Challenges**

Although much of the discussion so far has focused on domestic supply chains, one should recognize that supply chains are becoming increasingly global in nature. Reasons for the increased globalization of supply chains include lower-priced materials and labor, the global perspective of companies in a supply chain, and the development of global competition, among others.\textsuperscript{44} Supply chain integration can be challenging in a domestic setting, but integration challenges are even greater in global supply chains due to cultural, economic, technological, political, spatial, and logistical differences.

Global supply chains translate into both longer and more unpredictable lead times (time from when an order is placed until it is received) for shipments, which increases the chance that customer demand might not be fulfilled due to a potential out-of-stock situation. In addition, recent research indicates that glitches are routine occurrences in global supply chains; causes include, but are not limited to, documentation errors, packaging errors, routing errors, incomplete shipments, and failure to follow order guidelines. These and other global supply chain glitches drive up supply chain costs and potentially jeopardize customer satisfaction.\textsuperscript{45}

**SUPPLY CHAIN INTEGRATION**

An individual firm can be involved in multiple supply chains at the same time, and it is important to recognize that expectations and required knowledge can vary across supply chains. For example, food manufacturers may sell to grocery chains, institutional buyers, specialty firms (which might position the food items as gifts), and industrial users (which might use the product as an ingredient in another product that they manufacture). It seems reasonable to assume that the packaging expectations of specialty firms might be more demanding than those of industrial users.

Supply chains are integrated by having various parties enter into and carry out long-term mutually beneficial agreements. These agreements are known by several names, including partnerships, strategic alliances, third-party arrangements, and contract logistics. Whatever they are called, these agreements should be designed to reward all participants when collaborative ventures are successful, and they should also provide incentives for all parties to work toward success. In a similar fashion, the participants should share the consequences when cooperative ventures are less successful than desired.

When an organization enters into a long-term agreement with a supplier or customer, the organization must keep in mind how this arrangement could affect the rest of the supply chain. Ideally, all participants in the supply chain will establish whatever agreements are necessary to ensure that the entire supply chain functions in the most desirable manner.

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To integrate a particular supply chain, the various organizations must recognize the shortcomings of the present system and examine channel arrangements as they currently exist and as they might be. All this is done within the framework of the organization’s overall strategy, as well as any logistics strategies necessary to support the goals and objectives of the firm’s top management.

Broadly speaking, organizations can pursue three primary methods when attempting to integrate their supply chains. One method is through vertical integration, where one organization owns multiple participants in the supply chain; indeed, the Ford Motor Company of the 1920s owned forests and steel mills and exercised tight control over its dealers. The most common examples of vertical integration today are some lines of paint and automotive tires. It's important to recognize that regulations (often in the form of state laws) may limit the degree of vertical integration that will be permitted in particular industries.

A second possible method of supply chain coordination involves the use of formal contracts among various members. One of the more popular uses of contracts is franchising, which attempts to combine the benefits of tight integration of some functions along with the ability to be very flexible while performing other functions. From a supply chain perspective, a franchiser may exert contractual influence over what products are purchased by a franchisee, acceptable vendors (suppliers) of these products, and the distribution of the product to the franchisee. For example, the Martin-Brower Company handles distribution for some McDonald's franchisees in the United States (e.g., food, beverage, and store supplies).

A third method of supply chain coordination involves informal agreements among the various organizations to pursue common goals and objectives, with control being exerted by the largest organization in the supply chain. Although this method offers supply chain participants flexibility in the sense that organizations can exit unprofitable or unproductive arrangements quickly and with relative ease, organizations should be aware of potential shortcomings. For one, the controlling organization may be so powerful that the supply chain becomes more like a dictatorship than a partnership. Moreover, the same flexibility that allows for exiting unprofitable or unproductive arrangements also allows parties the ability to switch supply chains when presented with what appears to be a better deal.

**Summary**

This chapter focused on the supply chain concept and began by defining supply chain and SCM. Supply chains consist of a number of different parties and can include the end consumer; SCM requires companies to adopt an enterprise-to-enterprise point of view.

The chapter also discussed two of the most prominent SCM process frameworks. Key enablers of SCM, such as an understanding of the implications of increased customer power and leveraging technology for enhanced visibility and communication, were identified and described. Various barriers to SCM, such as lack of top management commitment and reluctance to share, or use, relevant data, were also presented. The chapter concluded with a look at issues around and approaches for supply chain integration.

**Key Terms**

- Agile supply chain
- Bullwhip effect
- Contract logistics
- Fast supply chain
- Fourth-party logistics
- GSCF model
- Lead logistics provider
- Leagility
- Lean supply chain
- Perfect order
- Relational exchanges
- SCOR model
- Supply chain
- Supply chain analytics
- Supply chain collaboration
- Supply chain management
- Supply chain partnership
- Third-party logistics (logistics outsourcing)
- Transactional exchanges
Questions for Discussion and Review

5.1 Discuss the differences between a supply chain and supply chain management.

5.2 Discuss the SCOR and GSCF models of supply chain management.

5.3 Discuss how the logistics function contributes to the supply chain management processes established in the SCOR and GSCF models.

5.4 What are four key enablers of supply chain management implementation?

5.5 What is the difference between a lean and an agile supply chain? Under what circumstances is each an appropriate supply chain approach to pursue?

5.6 Discuss some of the ways that inventory can be reduced in the supply chain.

5.7 What is the difference between relational and transactional exchanges? Which is more relevant for supply chain management? Why?

5.8 Do you agree or disagree that supply chain collaboration can be classified as transactional, tactical information sharing, or strategic in nature? Why?

5.9 This chapter suggests that technology has been at the center of changes taking place that affect the supply chain. Do you agree or disagree? Why?

5.10 Discuss the impact of the Internet on supply chain management.

5.11 How might regulatory and political conditions act as barriers to supply chain management?

5.12 Why is top management commitment necessary for successful supply chain management?

5.13 Some companies are hesitant to use frequent shopper cards because the data provided could violate the customer’s privacy. Do you agree or disagree? Why?

5.14 Discuss the best-of-breed and single integrator approaches.

5.15 Do you think corporate cultures are relevant for supply chain management? Why or why not?

5.16 Why is supply chain integration so difficult in global supply chains?

5.17 Discuss the strategic and tactical considerations that can drive a company to use the services of a 3PL.

5.18 What are some reasons that third-party logistics arrangements aren’t always successful?

5.19 What is the difference between a 3PL and a 4PL/LLP?

5.20 Discuss the three primary methods that organizations can use to integrate their supply chains.

Suggested Readings


CASE

CASE 5.1 JOHNSON TOY COMPANY

Located in Biloxi, Mississippi, the Johnson Toy Company is celebrating its seventy-fifth year of business. Amy Johnson, who is president, and Lori Johnson, who is vice president, are sisters and are the third generation of their family to be involved in the toy business. The firm manufactures and sells toys throughout the United States. The toy business is very seasonal, with the majority of sales occurring before Christmas. A smaller peak occurs in the late spring–early summer period, when sales of outdoor items are good.

The firm relies on several basic designs of toys—which have low profit margins but are steady sellers—and on new designs of unconventional toys, whose introduction is always risky but promises high profits if the item becomes popular. The firm advertises regularly on Saturday morning television shows for children.

Late last year, just before Christmas, the Johnson Toy Company introduced Jungle Jim the Jogger doll, modeled after a popular television show. Sales skyrocketed, and every retailer’s stock of Jungle Jim the Jogger dolls was sold out in mid-December; the Johnson Company could have sold several million more units if they had been available before Christmas. Based on the sales success of this doll, Amy and Lori made commitments to manufacture 10 million Jungle Jim the Jogger dolls this year and to introduce a wide line of accessory items, which they hoped every doll owner would also want to have. Production was well under way, and many retailers were happy to accept dolls in January and February because they were still a fast-selling item, even though the toy business itself was sluggish during these months.

Unfortunately, in the aftermath of a Valentine’s Day party in Hollywood, the television actor who portrayed Jungle Jim the Jogger became involved in a widely publicized sexual misadventure, the details of which shocked and disgusted many readers and TV viewers, and we would be embarrassed to describe them. Ratings of the television series plummeted, and within a month it had been dropped from the air. On March 1, the Johnson Company had canceled further production of the Jungle Jim the Jogger dolls, although it had to pay penalties to some of its suppliers because of the cancellation. The company had little choice because it was obvious that sales had stopped.

On April 1, a gloomy group assembled in the Johnson Company conference room. Besides Amy and Lori, those present included Carolyn Coggins, the firm’s sales manager; Cheryl Guridi, the logistics manager; Greg Sullivan, the controller; and Kevin Vidal, the plant engineer. Coggins had just reported that she believed there were between 1.5 million and 2 million Jungle Jim the Jogger dolls in retail stores, and Sullivan had indicated there were 2,567,112 complete units in various public warehouses in Biloxi. Vidal said that he was still trying to count all the unassembled component parts, adding that one problem was that they were still being received from suppliers, despite the cancellation.

Amy said, “Let’s wait a few weeks to get a complete count of all the dolls and all the unassembled component parts. Lori, I’m naming you to work with Carolyn and Kevin to develop recommendations as to how we can recycle the Jungle Jim item into something we can sell. Given the numbers involved, I’m willing to turn out some innocuous doll and sell it for a little more than the cost of recycling because we can’t take a complete loss on all these damned Jungle Jim dolls! Greg says we have nearly 2.6 million of them to play with, so let’s think of something.”

“Your 2.6-million figure may be low,” said Coggins. “Don’t forget that there may be nearly 2 million in the hands of the dealers and that they will return them.”

“Return them?” questioned Amy. “They’re not defective. That’s the only reason we accept returns. The retailers made a poor choice. It’s the same as if they ordered sleds and then had a winter with no snow. We are no more responsible for Jungle Jim’s sex life than they are!”

Cheryl Guridi spoke up: “You may be underestimating the problem, Amy. One of our policies is to accept returns. The retailers made a poor choice. It’s the same as if they ordered sleds and then had a winter with no snow. We are no more responsible for Jungle Jim’s sex life than they are!”

Sullivan added, “We’ve received several bills in which the retailer has deducted the costs of the Jungle Jim dolls and of the freight for shipping them back from what he owes us.”
“We can’t allow that!” exclaimed Amy.
“Don’t be so sure,” responded Sullivan. “The account in question has paid every bill he’s owed us on time for 40 years. Do you want me to tell him we won’t reimburse him?”
“This is worse than I imagined,” said Amy. “Just what are our return policies, Lori?”
“Well, until today, I thought we had only two,” said Lori. “One for our small accounts involves having our salespeople inspect the merchandise when they make a sales call. They can pick it up and give the retailer credit off the next order.”
“Sometimes they pick up more than defective merchandise,” added Coggins. “Often, they’ll take the slow movers out of the retailer’s hands. We have to do that as a sales tool.”
“That’s not quite right,” interjected Vidal. “Sometimes, the returned items are just plain shopworn—scratched, dented, and damaged. That makes it hard for us because we have to inspect every item and decide whether it can be put back into stock. When we think a particular salesperson is accepting too many shopworn items, we tell Carolyn, although it’s not clear to me that the message reaches the salespeople in the field.”
“I wish I had an easy solution,” said Coggins. “We used to let our salespeople give credit for defects and then destroy everything out in the field. Unfortunately, some abused the system and resold the toys to discount stores. At least now we can see everything we’re buying back. I agree we are stuck with some shopworn items, but our salespeople are out there to sell, and nothing would ruin a big sale quicker than for our salespeople to start arguing with the retailer, on an item-by-item basis, as to whether something being returned happens to be shopworn.”
“Is there a limit to what a salesperson is permitted to allow a retailer to return?” asked Amy.
“Well, not until now,” responded Coggins. “But with this Jungle Jim snafu we can expect the issue to occur. In fact, I have several phone queries on my desk concerning this. I thought I’d wait until after this meeting to return them.”
“Well, I think we’d better establish limits—right now,” said Amy.
“Be careful,” said Lori. “When I was out with the salespeople last year, I gathered the impression that some were able to write bigger orders by implying that we’d take the unsold merchandise back, if need be. If we assume that risk, the retailer is willing to take more of our merchandise.”
“Are there no limits to this policy?” asked Amy.
“Informal ones,” was Coggins’s response. “It depends on the salesperson and the account. I don’t think there is much abuse, although there is some.”
“How do the goods get back to us under these circumstances?” asked Amy.
“The salespeople either keep them and shuffle them about to other customers or—if it’s a real loser—they ask us what to do,” replied Coggins.
“Greg,” said Amy, “do our records reflect these returns and transfers?”
“Oh, fairly well,” was his response. “We lose track of individual items and quantities, but if the salesperson is honest—and I think ours are—we can follow the dollar amount of the return to the salesperson’s inventory, to another retailer, or back here to us. We do not have good controls on the actual items that are allowed for returns. Kevin and I have difficulty in reconciling the value of returned items that wind up back here. Carolyn’s records say they’re okay for resale, and Kevin says they’re too badly damaged.”
“I insist on the reconciliation before we allow the goods back into our working inventory,” said Guridi. “That way I know exactly what I have here, ready to ship.”
“You know, I’m finding out more information about inventories and returns than I thought existed,” said Amy.
“Too many trips to Paris, dearest,” said Lori, and the others all suppressed smiles.
Amy decided to ignore Lori’s remark, and she looked at Guridi and asked, “Are you satisfied with your control over inventories, Cheryl?”
“I have no problem with the ones here in Biloxi,” was Guridi’s response, “but I have an awful time with the inventories of return items that salespeople carry about with them, waiting to place them with another retailer. I’m not always certain they’re getting us top dollar, and each salesperson knows only his or her own territory. When Carolyn and I are trying to monitor the sales of some new item, we never know whether it’s bombing in some areas and riding around in salespeople’s cars as they try to sell it again.”
“Have you now described our returns policy, such as it is?” asked Amy, looking at everybody in the room.
“No,” was the response murmured by all. Sullivan spoke: “For large accounts we deduct a straight 2 percent off wholesale selling price to cover defectives, and then we never want to hear about the defectives from these accounts at all.”
“That sounds like a better policy,” said Amy. “How well is it working?”
“Up until Jungle Jim jogged where he shouldn’t, it worked fine. Now a number of large accounts are pleading
‘special circumstances’ or threatening to sue if we don’t take back the dolls.”

“They have no grounds for suit,” declared Amy. “You’re right,” said Coggins, “but several of their buyers are refusing to see our sales staff until the matter is resolved. I just heard about this yesterday and meant to bring it up in today’s meeting. I consider this very serious.”

“Damn it!” shouted Amy, pounding the table with her fist. “I hope that damned jogger dies of jungle rot! We’re going to lose money this year, and now you’re all telling me how the return policy works, or doesn’t work, as the case may be! Why can’t we just have a policy of all sales being final and telling retailers that if there is an honest defect they should send the goods back here to us in good old Biloxi?”

“Most of the small accounts know nothing about shipping,” responded Vidal. “They don’t know how to pack, they don’t know how to prepare shipping documents, and they can’t choose the right carriers. You ought to see the hodgepodge of shipments we receive from them. In more cases than not, they pay more in shipping charges than the products are worth to us. I’d rather see them destroyed in the field.”

Sullivan spoke up. “I’d object to that. We would need some pretty tight controls to make certain the goods were actually destroyed. What if they are truly defective, but improperly disposed of, then fall into the hands of children who play with them and the defect causes an injury? Our name may still be on the product, and the child’s parents will no doubt claim the item was purchased from one of our retailers. Will we be liable? Why can’t we have everything come back here? We have enough volume of some returned items that we could think in terms of recycling parts.”

Vidal responded, “Recycling is a theoretical solution to such a problem, but only in rare instances will it pay. In most instances the volume is too small and the cost of taking toys apart is usually very high. However, the Jungle Jim product involves such a large volume that it is prudent and reasonable to think up another product that utilizes many of the parts. It would even pay to modify some machines for disassembling the Jungle Jim doll.”

“As I listen to this discussion,” said Lori, “one fact becomes obvious: We will never have very good knowledge about volume or patterns of returns until it’s too late. That’s their very nature.”

Guridi asked, “Could we have field representatives who do nothing but deal with this problem? The retailers would be told to hang onto the defectives until our claims reps arrive.”

Coggins replied, “That would be expensive, because most retailers have little storage space for anything and would expect our claims rep to be there immediately. Besides, it might undermine our selling efforts if retailers could no longer use returns to negotiate with as they talked about new orders.”

“That may be,” interjected Amy, “but we cannot continue having each salesperson tailoring a return policy for each retailer. That’s why we’re in such a mess with the jogger doll. We have to get our return policy established, made more uniform, and enforced. We cannot go through another fiasco like Jungle Jim the Jogger for a long time. We’re going to lose money this year, no matter what, and I have already told Kevin that there will be virtually no money available for retooling for next year’s new products.”

QUESTIONS

1. From the standpoint of an individual concerned with accounting controls, discuss and evaluate Johnson Toy Company’s present policies for handling returned items.
2. Answer Question 1, but from the standpoint of an individual interested in marketing.
3. Propose a policy for handling returns that should be adopted by the Johnson Toy Company. Be certain to list circumstances under which exceptions would be allowed. Should it apply to the Jungle Jim dolls?
4. Should this policy, if adopted, be printed and distributed to all of the retailers who handle Johnson Toy Company products? Why or why not? If it should not be distributed to them, who should receive copies?
5. Assume that it is decided to prepare a statement on returns to be distributed to all retailers and that it should be less than a single double-spaced page. Prepare such a statement.
6. On the basis of the policy in your answer to Question 3, develop instructions for the Johnson Toy Company distribution and accounting departments with respect to their roles and procedures in the handling of returns.
7. Assume that you are Cheryl Guridi, the firm’s logistics manager. Do you think that the returns policy favored by the logistics manager would differ from what would be best for the firm? Why or why not?
8. Until the policy you recommend in your answer to Question 3 takes effect, how would you handle the immediate problem of retailers wanting to return unsold Jungle Jim the Jogger dolls?
Procurement, which refers to the raw materials, component parts, and supplies bought from outside organizations to support a company’s operations, is an important activity and closely related to logistics because acquired goods and services must be entered into the supply chain in the exact quantities and at the precise time they are needed. While procurement has been traditionally viewed as transactional in nature, studies indicate that the function’s profile is rising due to the increased globalization and complexity of today’s supply chains.\(^1\) Procurement is also important because its costs often range between 60 and 80 percent of an organization’s revenues.

The magnitude of procurement expenditures meant that procurement’s historical focus in many organizations was to achieve the lowest possible cost from potential suppliers; oftentimes these suppliers were pitted against each other in “cutthroat” competition involving three- or six-month arm’s-length contracts awarded to the lowest bidder. Once this lowest bidder was selected, the bidding cycle would almost immediately start again, and another low bidder would get the contract for the next several months. Today, by contrast, procurement has a much more strategic orientation in many organizations, and a contemporary procurement manager might have responsibility for reducing cycle times, playing an integral role in product development, or generating additional revenues by collaborating with the marketing department.\(^2\)

Historically, procurement, purchasing, and supply management were terms that could be used almost interchangeably, but this is no longer the case. Although “procurement” and “purchasing” are sometimes viewed as synonymous terms, supply management is now viewed as a relational exchange approach involving a limited number of suppliers. You might recall from Chapter 5 that relational exchanges adopt a long-term orientation that can be characterized by attributes such as trust, commitment, dependence, and shared benefits. In addition, taking a supply chain perspective toward purchasing has led some companies to use the term strategic sourcing. This approach involves an increased focus on identifying and using data internally and across the supply chain so that a company can consolidate its purchasing power for enhanced value. For example, one company was spending

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over $5 million on corrugated boxes each year with five suppliers at five different locations. The company used a strategic sourcing approach to collect data to benchmark a standard price for corrugated boxes in the industry along with using external data to qualify potential alternative suppliers interested in their business at this price level. Another example of how data are affecting procurement comes from global shipping company Maersk. In an approach it terms “moneyball sourcing,” Maersk has been able to analyze data from auction events to influence its procurement strategy. After analyzing over 8,000 e-auctions it found that every time it added an additional supplier to the auction, it was able to save an additional 1 percent. This relationship held true for up to eight suppliers.3

Electronic commerce continues to bring many changes to the procurement discipline, such as electronic procurement and reverse auctions, which were discussed in Chapter 2. Moreover, utilization of procurement cards (also referred to as p-cards) has also grown dramatically with the evolution of electronic commerce. P-cards are similar to charge cards such as Visa and MasterCard that are typically focused on personal use, with p-cards being used for an organization’s buying needs. Organizations generally restrict the number of employees authorized to use procurement cards, and each month, an organization receives a detailed statement listing employees, details of their purchases, and purchase prices. P-cards may require control processes that measure usage and identify procurement trends, limit spending during the appropriate procurement cycle, and block unauthorized expenditures at gaming casinos or massage parlors.4 However, the incidence of fraud has been found to be low primarily due to investments that the card issuers have made in programs to seek out and eliminate it.5

P-cards can benefit organizations in several ways, one of which is a reduction in the number of invoices. Unlike personal credit cards, with p-cards an organization will make one payment for the total amount of purchases during one month, as opposed to making individual payments for each p-card holder. In addition, these cards allow employees to make purchases in a matter of minutes, as opposed to days, and procurement cards generally allow suppliers to be paid in a more timely fashion.

While the benefits of using p-cards increase exponentially as more people within an organization use them, expanding use beyond the domestic market can be a challenge. Issues associated with an expansion of p-cards overseas include currency differences, availability of technology, differences in card acceptance across countries, and cultural issues with the program. For example, in some Asian markets, employee turnover is so high that card security is a major concern.6

Because entire textbooks are devoted to procurement, it’s really not possible for us to cover all aspects of this topic in just one chapter. We’ll begin our examination with a brief overview of possible objectives for procurement, and this will be followed by a description of supplier selection and evaluation. We’ll also look at global procurement, sustainable procurement, and supply chain finance.

**PROCUREMENT OBJECTIVES**

Because procurement has become more strategic in nature, its primary objective is no longer to only achieve the lowest possible cost of supply. Potential procurement objectives include, but are not limited to, (1) supporting organizational goals and objectives, (2) managing the purchasing process effectively and efficiently, (3) managing the supply base, (4) developing strong relationships with other functional groups, and (5) supporting operational requirements. Each objective will be briefly highlighted in the following paragraphs.

First and foremost, procurement’s objectives must support organizational goals and objectives. If, for example, minimal inventory is an organizational objective, then procurement probably should...
not be attempting to minimize total procurement costs. With respect to managing the purchase process effectively and efficiently, effectively is concerned with how well procurement keeps its promises, whereas efficiently refers to how well (or poorly) procurement uses company resources in keeping its promises. A third procurement objective, managing the supply base, refers to the selection, development, and maintenance of supply sources.

Developing strong relationships with other functional groups recognizes that the interfunctional consequences of procurement decisions require more cooperation and coordination than has traditionally existed between procurement and areas such as logistics, manufacturing, and marketing. The lack of cooperation and coordination between procurement and other functions can result in supply shortages, excess inventory, frequent write-downs, and increased lead times. Supporting operational requirements means that procurement’s focus is on satisfying internal customers and can be summarized by buying the right products, at the right price, from the right source, at the right specifications, in the right quantity, for delivery at the right time to the right internal customer.

### SUPPLIER SELECTION AND EVALUATION

One of procurement’s most important responsibilities involves supplier (vendor) selection and evaluation. The selection and evaluation of suppliers is a process that involves stating an organization’s needs and then determining how well various potential suppliers can fulfill these needs (see Figure 6.1). The first step in this process, identify need for supply, can arise from a number of considerations, such as the end of an existing supply agreement or the development of a new product.

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Situation analysis, the second step, looks at both the internal and external environments within which the supply decision is to be made. Internal considerations include identification of the relevant stakeholders, where the supply is needed, and the appropriate quantity and quality of the supply, as well as applicable supply policies (e.g., minority supplier initiatives). The external environment includes economic considerations, the legal and regulatory frameworks controlling the purchase, and the marketplace within which potential suppliers operate.

Identify and evaluate possible suppliers is the third step. A myriad of sources can be used to identify possible suppliers, such as salespeople, trade shows, trade publications, and the Internet. It’s important to recognize and understand the potential advantages and disadvantages of each source. For example, although trade shows might highlight offerings from several different supply sources (which could facilitate supplier comparisons), the costs to attend or exhibit at trade shows have skyrocketed in recent years; moreover, trade shows are often held only once a year.

Evaluating suppliers can be facilitated if an organization (1) delineates relevant selection criteria and (2) assigns weights to these criteria. With respect to the latter, if an organization uses four relevant selection criteria, should all four be assigned equal weight (i.e., 25 percent per criteria), or should certain criteria be weighted more heavily than others (e.g., two criteria weighted at 30 percent apiece and two others weighted at 20 percent each)? This weighting technique serves as a foundation for generating a rating (score) for each possible supplier, and these ratings are instrumental in the fourth step of the supplier selection process, select supplier(s), which occurs when an organization chooses one or more companies to supply the relevant product.

Selecting the most appropriate number of suppliers a firm should use has been the subject of continuing debate. Internal considerations, which were mentioned in Step 2, could influence the decision to use a single-source or a multiple-source approach. While the goal of both approaches is to provide the buying organization with the best value of a supplied part, each offers distinct advantages. Multiple sourcing proponents argue that by having more than one supplier increased amounts of competition, greater supply risk mitigation, and improved market intelligence can arise. Single sourcing, on the other hand, consolidates purchase volume with a single supplier with the hopes of enjoying lower costs per unit and increased cooperation and communication in the supply relationship. However, the achievement of these potential savings is connected to the buyer’s relative size in the market. For some smaller buyers, single sourcing might actually reduce their alternatives and ultimately raise the price they pay.9

The final step of the supplier selection process, evaluate decision, involves a comparison of expected supplier outcomes to actual supplier outcomes. There are two primary approaches for evaluating suppliers: process based and performance based. A process-based evaluation is an assessment of the supplier’s service and/or production process (typically involving a supplier audit). A supplier audit usually involves an onsite visit to a supplier’s facility. The goal of this visit is to gain a deeper knowledge of the supplier. Supplier audits can involve assessments of the supplier’s structure (management, people, quality, innovation), resources (technology, processes), health (financials, risk), and responsibility (social, environmental).10

A performance-based evaluation is focused on the supplier’s actual performance on a variety of criteria, such as cost and quality. This evaluation can be facilitated if an organization has explicitly defined selection criteria, as mentioned in Step 4. Many companies use supplier scorecards to report performance information to their suppliers. Scorecards can be categorical (simple check-off items that reflect supplier performance), weighted point (weights assigned to multiple categories with defined performance scales), or cost based (attempts to quantify total cost of doing business with a supplier over time).11 PolyOne Corp., a producer of latex, compounds, and plastics, has used a scorecard program with its top suppliers to improve on-time delivery and grow sales.12

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The preceding paragraphs have presented supplier selection and evaluation as a seemingly straightforward and easy-to-follow process, but supplier selection and evaluation can actually be quite complex. First off, supplier selection and evaluation generally involve multiple criteria, and these criteria can vary both in number and importance, depending on the particular situation. As an example, a study involving the procurement of electronic components\(^\text{13}\) looked at 10 possible selection criteria, whereas 16 selection criteria were investigated in a study of overseas vendors by Canadian apparel buyers.\(^\text{14}\)

Second, because some vendor selection criteria may be contradictory, it is important to understand potential trade-offs between them. For instance, it may be difficult for a supplier to achieve both competitive pricing and high-quality supply. Third, the evolution of business practices and philosophies, such as just-in-time, green purchasing, and supply chain management, may require new selection criteria or the reprioritization of existing criteria. As an example, whereas EDI capabilities might have been an important supplier selection criterion in the early 1990s, in the contemporary environment Internet-related capabilities (e.g., tracking, pricing) have assumed increased relevance and importance.\(^\text{15}\)

**Procurement Portfolio Approach**

As part of the situation analysis mentioned previously, procurement managers must continually be aware of the supply and demand characteristics of the raw materials, component parts, and supplies they purchase. **Kraljic’s Portfolio Matrix** (see Figure 6.2) is used by many managers to classify corporate purchases in terms of their importance and supply complexity with a goal of minimizing supply vulnerability and getting the most out of the firm’s purchasing power.\(^\text{16}\) The matrix delineates four categories: *noncritical* (low importance, low complexity), *leverage* (high importance, low complexity), *strategic* (high importance, high complexity), and *bottleneck* (low importance, high complexity). Each category requires distinct procurement strategies for managing supply. For example, p-cards might be

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used for noncritical items, leverage items might rely upon reverse auctions, and strategic items would tend to use long-term, cost-based contracts with key suppliers, whereas firms may turn to buying consortiums to address the complexity of bottleneck items. Many researchers and companies have built upon Kraljic’s approach by proposing new portfolio dimensions for classifying both products and suppliers. The key will be for procurement to work with other functional areas to identify the most appropriate segmentation dimensions for their firm. This segmentation should also be reviewed and updated on a regular basis.

**Supplier Development (Reverse Marketing)**

Our description of supplier selection and evaluation has taken a “traditional” approach in the sense that there has been underlying assumptions that (1) suppliers initiate marketing efforts toward purchasers and (2) potential suppliers are available and willing to serve prospective purchasers. However, because it has become increasingly common for potential suppliers not to be available and willing to serve prospective purchasers, some purchasers are taking a more proactive role in the procurement process. To this end, supplier development (reverse marketing) refers to aggressive procurement involvement not typically part of supplier selection and can include a purchaser initiating contact with a supplier or a purchaser establishing prices, terms, and conditions, among other behaviors.

There are several key reasons for why purchasers are adopting a more proactive and aggressive role in the procurement process. One is the myriad of inefficiencies associated with suppliers initiating marketing efforts toward purchasers, such as suppliers possessing inadequate, insufficient, or untimely information. A second reason for more proactive and aggressive procurement is that the purchaser may be aware of important benefits, such as reduced inventory and improved forecasting accuracy, which are unknown to the supplier. Yet another reason is that achieving competitive advantage in the supply chain is predicated on purchasers adopting a more aggressive approach so as to compel suppliers to meet the necessary requirements.

**GLOBAL PROCUREMENT (SOURCING)**

While world trade continues to grow, the pace of this growth has slowed significantly since the 2008/2009 world economic downturn. The continuing growth of globalization means that many organizations, rather than relying on local and domestic suppliers, will continue to cast a wider net in search of supply sources. Indeed, a recent procurement study projected that half of all firms would have a global spend of over 40 percent.

Global procurement (sourcing), which refers to buying components and inputs anywhere in the world, is driven by two primary reasons, namely, the factor-input strategy and the market-access strategy. With the factor-input strategy, an organization is seeking low-cost or high-quality sources of supply, whereas the market-access strategy involves sourcing in markets where an organization plans to do significant business.

A global sourcing development model would include the following components: planning, specification, evaluation, relationship management, transportation and holding costs, implementation, and monitoring and improving. Each of these will be briefly detailed next. Planning is the first step in global procurement and involves an honest assessment of global sourcing opportunities and challenges. The outcome of this stage should be a set of global procurement policies and procedures.

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that are consistent with an organization’s overall objectives. Specification involves quantifying and qualifying current sources across a variety of dimensions such as quality, costs, reliability, and standardization, among others.

An earlier section in this chapter discussed supplier selection and evaluation, and although the evaluation process associated with global procurement has similarities, there are potential differences as well. For example, should an organization use the same standards to evaluate international sources as are used to evaluate domestic sources? Another component in a global sourcing development framework, relationship management, has been discussed in previous chapters. Relationship management in global procurement is exacerbated by potential difficulties in cross-cultural communication such as language and time considerations.

Because global sourcing increases the distance that components and inputs must be moved, managers must consider trade-offs between transportation and holding costs. The choice of a faster transportation alternative (e.g., air) will likely create higher transportation costs and lower inventory holding costs; alternatively, a slower transportation alternative (e.g., water) will create lower transportation costs and higher inventory holding costs. Implementation, or carrying out, is often a major shortcoming to many global procurement plans; indeed, some organizations fail to specify an implementation plan. Moreover, the greater uncertainty associated with global sourcing means that implementation plans must be flexible and provide guidance for decision making when confronted with the unexpected.

Finally, monitoring and improving means that performance measures must be established for global procurement systems and that these measures should be reviewed on a regular basis. Comparisons can be made between actual and expected performance, and the results of these comparisons can be used to improve the global sourcing process. Commonly used performance measures for monitoring global sourcing systems include the percentage of shipments that arrive early or late, completeness of orders, and percentage of orders accepted or rejected on delivery.

Establishing a successful global sourcing strategy can be one of the most difficult assignments for the procurement function. As organizations continue to expand their supply bases, many are realizing hidden cost factors are affecting the level of benefits that were projected to be achieved through this approach. Some of these hidden costs include increased costs of dealing with suppliers outside the domestic market, duty and tariff changes that occur over the life of a supply agreement, increased inventory-related costs associated with global supply chains, and rising levels of logistics cost volatility (e.g., ocean freight rates) that can occur unexpectedly. Thus, when assessing the costs of global sourcing, it is important to examine all cost implications of this strategy. The need to fully evaluate the implications of global sourcing has motivated an increased examination of the total cost of ownership (TCO) when procuring items from outside countries. When taking a TCO approach, firms consider all the costs that can be assigned to the acquisition, use, and maintenance of a purchase. While these additional costs can take many forms, logistics costs related to the typically longer delivery lead times associated with global shipments are a key consideration. Ideally, firms should create their own TCO models that provide a more realistic view of the costs of global sourcing.

Phillips, a Dutch electronics company, has recently transformed its global procurement process. As the company implemented a new product design process, the need to change its approach toward procurement arose. Driven by a need to build stronger relationships with its suppliers, Phillips redesigned its procurement away from the traditional approach of focusing on driving costs down by negotiating more favorable supplier pricing. Phillips’ procurement organization now engages early on in the product design process, closely coordinating with suppliers and focusing on value to

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customers. A key aspect for this transformation was making sure its procurement professionals had a more holistic approach for its decision making.²⁴

Recently, rising transportation and energy costs, growing desires to be able to quickly adapt to changing market trends, along with risk and sustainability concerns have all influenced an examination of near-sourcing (procuring products from suppliers closer to one’s own facilities) by many firms.²⁵ Given that procurement strategies and logistics strategies are intertwined, managers considering when to source globally and when to source close to their home markets must carefully consider the inbound and outbound logistics implications of these decisions. Decisions that made sense a few years ago in terms of labor cost savings may not be as clear-cut in today’s environment.

**SUSTAINABLE PROCUREMENT**

As previously mentioned in Chapter 4, the sustainability concept suggests that an organization’s responsibilities transcend economic considerations, such as the maximization of shareholder’s wealth, and should incorporate societal and environmental objectives and values. There are sustainability concerns at the corporate level (e.g., what are the behaviors of a socially and environmentally responsible organization?), as well as sustainability issues associated with organizational functions such as procurement. For the purposes of this discussion, sustainable procurement refers to the integration of social and environmental considerations into all stages of the purchasing process with the goal of minimizing the impact of procurement activities on human health and the environment.

**Social Responsibility**

Research suggests that socially responsible procurement consists of five dimensions, namely, diversity, the environment, human rights, philanthropy, and safety. Diversity is concerned with procurement activities associated with minority or women-owned organizations, whereas the environment includes considerations such as waste reduction and the design of products for reuse or recycling. Human rights issues include child labor laws as well as sweatshop labor. Philanthropy focuses on employee volunteer efforts and philanthropic contributions, and safety is concerned with the safe transportation of purchased products, as well as the safe operation of relevant facilities.²⁶

Many believe that ethical considerations (i.e., standards of conduct and moral principles) are also a part of socially responsible procurement. Indeed, research on procurement ethics dates back to the mid-1960s, and the competitiveness of the contemporary business environment creates—for some companies—a “win at all costs” philosophy that can exacerbate unethical behavior. Areas of ethical concern in procurement include gift giving and gift receiving; bribes (money paid before an exchange) and kickbacks (money paid after an exchange); misuse of information; improper methods of knowledge acquisition; lying or misrepresentation of the truth; product quality (lack thereof); misuse of company assets, to include abuse of expense accounts; and conflicts of interest, or activity that creates a potential conflict between one’s personal interests and the employer’s interests.

The topic of socially responsible procurement is much broader than the space devoted to it in this chapter indicates. Moreover, it’s important to understand that the relevance, importance, and challenges associated with socially responsible procurement are likely to increase in the coming years. As an example, BMW is now requiring potential vendors to answer 29 questions on their social and environmental standards, and the results are an integral part of BMW’s vendor selection process.²⁷

²⁶Ibid.
Investment Recovery

Investment recovery, which identifies opportunities to recover revenues or reduce costs associated with scrap, surplus, obsolete, and waste materials, is often the responsibility of the procurement manager. Investment recovery can provide an organization with the opportunity to simultaneously do well and do good in the sense that investment recovery increases a seller’s revenues (reduces a seller’s costs) while addressing selected environmental considerations. For example, although aluminum recycling can provide revenues to an organization, the recycling conserves raw materials, uses less energy, and reduces various types of pollution. Figure 6.3 shows an example of how aluminum cans might be recycled.

Because even the best managed organizations will generate excess, obsolete, scrap, and waste materials, it’s important to distinguish among these different categories of material. Excess (surplus) materials refer to stock that exceeds the reasonable requirements of an organization, perhaps because of an overly optimistic demand forecast. If an organization has several production facilities, excess materials might be transferred to the other facilities. Unlike excess materials, obsolete materials are not likely to ever be used by the organization that purchased them. Having said this, materials that are obsolete to one organization might not be obsolete to other users; as such, it might be possible to sell obsolete materials to other organizations.

Scrap materials refer to materials that are no longer serviceable, have been discarded, or are a by-product of the production process (e.g., scrap steel when producing an automobile or washing machine). Certain scrap materials, such as copper and nickel, have such economic value that procurement contracts sometimes include a price at which the scrap will be repurchased by the supplier. Waste materials refer to those that have been spoiled, broken, or otherwise rendered unfit for further use or reclamation. Unlike scrap materials, waste materials have no economic value.

The ways that organizations manage the investment recovery of excess, obsolete, scrap, and waste materials should be influenced by the materials’ classification. Waste materials have limited investment recovery options because they are unfit for further use and have no economic value.

Figure 6.3  The Recycling of Aluminum Cans  
Source: VanderWolf Images/Fotolia.

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28Much of the material in this section is drawn from Leenders et al., Purchasing & Supply Management.
value. As a result, it wouldn’t be realistic to search for ways to reuse waste materials elsewhere in an organization or to find prospective buyers for the waste products. On the other hand, there are more expansive investment recovery options for excess materials, to include using them elsewhere within an organization, selling to another organization, returning to the supplier, and selling through a surplus dealer.

**SUPPLY CHAIN FINANCE**

An emerging focus within the supply chain that is directly affecting procurement relationships is the concept of **supply chain finance**. Supply chain finance is a set of technology and finance-based processes that strive to optimize cash flow by allowing businesses to extend their payment terms to their suppliers while simultaneously allowing suppliers to get paid early. As was described in Chapter 3, cash flows are a critical aspect of running and maintain a successful business. To support the implementation of supply chain finance, financial technology firms are stepping in to facilitate transactions between buyers and sellers. These so-called **FinTech** companies use cloud-based software to optimize the connection between procurement and accounts payable. Procurement would negotiate extended payment terms with its suppliers by using technology to enable the supplier to choose to receive its money early (minus a service fee for this convenience). The advantage for the selling firm is an ability to decide when it receives payment, while the buying firm receives the benefit of longer payables. Companies such as P&G are using this approach to improve their working capital to help fund growth.\(^{29}\) While supply chain finance is an emerging approach, the procurement function should be aware of potential implications of using these processes on other aspects of its supplier relationships.

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**Summary**

Procurement is closely related to logistics because nearly anything purchased must be moved to wherever it is needed—in the right quantity and at the precise time. Logistics services may also be an important focus of procurement activities within an organization. Procurement, an important activity because its costs often range between 60 and 80 percent of an organization’s revenues, has assumed greater strategic orientation in many contemporary firms.

The chapter began with a discussion of procurement objectives and the importance for these objectives to be aligned with, and supportive of, those of the organization. One of procurement’s most important responsibilities is supplier selection and evaluation, and this can be quite challenging, in part because of the multiple, and sometime conflicting, selection and evaluation criteria. Kraljic’s Portfolio Matrix was introduced as a way to segment procured items in order to more effectively align sourcing strategies. Supplier development (reverse marketing) was also introduced as being a more important part of the procurement process.

Global sourcing, which refers to buying components and inputs anywhere in the world, continues to grow in scope. Because of the tremendous distances that can be involved in global sourcing, managers must understand the trade-offs between transportation and holding costs. An appreciation for the total cost of ownership is critical.

Sustainable procurement, with an emphasis on socially responsible procurement was described. We learned that a number of ethical issues are associated with procurement. In addition, the environmental implications of investment recovery (managing excess, obsolete, scrap, and waste materials) were detailed.

The chapter concluded with an examination of the use of supply chain financing in procurement relationships. An explanation of how FinTech companies are changing the way payment terms are managed was provided.

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Key Terms

Bribes
Excess (surplus) materials
FinTech
Global procurement (sourcing)
Investment recovery
Kickbacks
Kraljic’s Portfolio Matrix
Multiple sourcing
Near-sourcing
Obsolete materials
Procurement
Procurement cards (p-cards)
Purchasing
Scrap materials
Single sourcing
Strategic sourcing
Sustainable procurement
Supplier audit
Supplier development (reverse marketing)
Supplier scorecards
Supply chain finance
Supply management
Total cost of ownership (TCO)
Waste materials

Questions for Discussion and Review

6.1 What is procurement? What is its relevance to logistics?
6.2 Contrast procurement’s historical focus to its more strategic orientation today.
6.3 Discuss the benefits and potential challenges of using electronic procurement cards.
6.4 Discuss three potential procurement objectives.
6.5 Name and describe the steps in the supplier selection and evaluation process.
6.6 Distinguish between a single sourcing approach and a multiple sourcing approach.
6.7 What are the two primary approaches for evaluating suppliers? How do they differ?
6.8 Discuss the factors that make supplier selection and evaluation difficult.
6.9 Distinguish between supplier audits and supplier scorecards. When should each be used?
6.10 Describe Kraljic’s Portfolio Matrix. What are the four categories of this segmentation approach?
6.11 Define supplier development, and explain why it is becoming more prominent in some organizations.
6.12 What are the components of the global sourcing development model presented in this chapter?
6.13 What are some of the challenges of implementing a global sourcing strategy?
6.14 Pick, and discuss, two components of the global sourcing development model presented in this chapter.
6.15 What is total cost of ownership and why is it important to consider?
6.16 Why are some firms considering near-sourcing?
6.17 Name, and give an example of, the five dimensions of socially responsible purchasing.
6.18 Discuss some of the ethical issues that are associated with procurement.
6.19 Distinguish between excess, obsolete, scrap, and waste materials.
6.20 How can supply chain finance help procurement drive value for its firm?

Suggested Readings

Fatih Terim was in his small office in Antalya, a Mediterranean port in southwestern Turkey. He looked at the clock on the wall and realized he had spent the entire afternoon thinking about one thing and one thing only—the most recent meeting with his Romanian business “connection.” Terim had just completed a trip to the Balkans and was in his office evaluating his firm’s progress in the region. This was necessary because he was thinking of going to Syria for the same reasons that had taken him to the Balkans: finding goods at cheap prices and selling them with handsome markups at home in Turkey or in other neighboring countries.

Terim had established Tempo Ltd. in 1989 in Antalya. Terim, then fresh out of Akdeniz University, quickly became an entrepreneur. The focus of his business was to buy goods from nearby foreign sources and then find buyers for those products in the domestic Turkish market. The first couple of years were easy for Terim because he was working very hard, and the Turkish economy was soaring. With the fall of communism, Terim saw even more opportunities. He started marketing Turkish-made goods to former communist countries around Turkey and in central Asia.

However, the Turkish economy took a major hit in April 1994. The sudden death of the country’s president added to the nation’s political instability. The value of Turkish lira (TL) plummeted against the U.S. dollar ($US). In the following years, the Turkish economy took many more hits, including the financial crisis in the Asian markets, the Russian market crash, and most recently, the Argentinean crisis. In 1999, two major earthquakes hit the northwestern part of Turkey, where one-third of the nation’s 67 million persons reside and which is the heartland of Turkish industry. Although Turkey recovered quickly from the earthquakes, political instability continued and pushed the entire economy into a slowdown. In 1993, one U.S. dollar could buy 7,000 Turkish liras. In 2003, that same one U.S. dollar could buy 1,567,000 TL. Despite these discouraging events, the Turkish economy still has opportunities for growth. One reason such a major potential still exists is the simple fact that hard-working, sharp-trading people like Fatih Terim never stood still and kept putting together the best deals they could.

Today Terim’s company has some connections in almost every European country and is working very hard to maintain these connections by generating steady flows of commerce. Terim’s latest trip was to the Balkan nations of Bulgaria, Romania, and Greece. Terim held meetings with key businesspeople in all three nations. In both Bulgaria and Greece, Terim had entered into modest sales agreements that extend into the middle of next year.

In Romania, matters did not move as quickly. Terim’s Romanian connection, George Hagi, was not interested in any of the small transactions that Terim was suggesting. Hagi, in an almost mysterious manner, did tell Terim that he looking for a Turkish partner willing to participate in a substantial, although not exactly legitimate, deal. The first aspect was that the customer wanted to buy Turkish chemicals to be used for fertilizers...
in agriculture. However, the terms of payment from the prospective customers would be in the form of barter rather than cash, and the goods bartered for the chemicals would be kereste (lumber). Although “barter” was a term and practice with which Terim was familiar, he had no idea what to do with kereste. Over the years, Tempo Ltd. had concentrated its business on small consumer products. However, he wasn’t going to let a detail like this get in the way of new markets. He knew he could find a market in Turkey for lumber because little was produced domestically, and both new construction and earthquake reconstruction were underway.

What worried Terim were his new customers. He learned from Hagi that these new customers were either a large state-owned company in North Korea or the North Korean government itself, which is why Terim spent that entire afternoon thinking about just one thing. All day he tried to justify his possible decisions to himself. The problem was that North Korea was a communist regime, and beyond that, North Korea, according to NATO and the United Nations, was a country that provided support to certain terrorist activities all over the world. In early 2002, U.S. President George W. Bush had described Iran, Iraq, and North Korea as an “axis of evil.” North Korea and those with whom it traded were under tight scrutiny from both the United Nations and the United States (which still stationed troops in South Korea).

Terim came up with the excuse that if he didn’t sell to the North Koreans, someone else would eventually, so why should he give up this money? However, the solution was not that easy. Hagi said in his e-mail to Terim that if the negotiations went well, a party of North Korean bureaucrats would wish to visit Antalya for “inspection” purposes and that Terim would have to cover the costs of entertainment and accommodations. Those accommodations would range from luxurious hotel rooms to young attractive companions, of both sexes, for business-related dinners and receptions. Terim knew exactly what those inspection purposes were. They were pleasure trips for certain bureaucrats in North Korea. Unfortunately, he was also aware that this was the way things worked in Third World governments. Over the years, he had learned the tricks of the trade, and one thing he knew well was that without the rusvet (bribe: the grease money or large amounts of payments specifically for one-time transactions), such risky situations would end up as a “no sale.” He wondered whether he should ask the Turkish agricultural chemical manufacturers to help with the entertainment costs. Also, should he and the chemical manufacturers touch base with each other with respect to the rusvet that would undoubt-

dedly be expected by the North Koreans? Terim’s position regarding rusvet was unclear. Indeed, the chemical manufacturers should be expected to give him, or Hagi, a kickback for facilitating the sale of chemicals.

“Talk about core competency,” Terim mumbled to himself. To get his mind off these sticky issues, he looked into the logistics costs to move the bartered lumber from North Korea. He would need to know those costs before proceeding. He had a couple of options.

The first option would be to ship the lumber by sea from Wonsan, North Korea, through the Sea of Japan, across the Indian Ocean, through the Suez Canal, and into the Liman (port) of Antalya, Turkey. (See Exhibits 6.A and 6.B.) This would be the perfect solution, except, he suddenly realized, he would not be able to bring the lumber into Turkey legally because of trade sanctions against North Korea. Hence, this option was dropped.

His second option would be to send the lumber to a country where its entry would be legal. The country to which the kereste could be shipped legally was none other than Romania, one of Turkey’s neighbors on the Black Sea. The reason was hidden in history. Since their communist years, Romania and North Korea had had strong ties that remained nearly intact after the fall of communism in Romania. So lumber could be loaded on to a gemi (ship) and could be shipped to Romania via the Dardanelles and the Bosphorus (the two straits that make up the gateway to the Black Sea) and finally to the port of Constantza, Romania, in the Black Sea. Once there, the lumber could be covered by new documents, and eventually the origin of the goods could be stated as “Romania,” not “North Korea.” The lumber could then move by tir (truck) to Turkey. This sounded like a feasible solution, but how much would such an operation cost? Terim recalled that Hagi had said that redoing documents in situations like this cost about 16,000,000,000 TL, including rusvets.

Terim’s mind then shifted to a third option. From Wonsan, the lumber could be shipped to a port in Syria, in this case Latakia. From there, tirs could haul the lumber to Iskenderun at the southeastern border of Turkey. Because the border at Iskenderun is the most ladly guarded border in Turkey, small rusvets to low-ranking officers at the gates would allow the kereste to enter Turkey without any problems. The rusvets would be about 10 percent of the kereste shipment’s value.

The same could be done at the Liman of Antalya. However, the chances of getting caught were much higher. If Tempo Ltd. were caught red-handed, it would be fined a sum of double the total value of goods entering the country. Thus, this was a fourth, but discarded, option.
Only two options were feasible, and each came with certain risks. One was to ship the *kereste* to Romania, have new documents drawn, falsify the shipment’s origin, and then send it to Turkey by *tir*. The other was to send the *kereste* by ship to Syria, truck it to Turkey, and bribe customs inspectors at the Turkish border. Terim was initially concerned with the logistics costs of getting the *kereste* inside the Turkish border. The *kereste* would be of various dimensions, bound together by metal straps into bundles measuring 1 meter by 1 meter by 5 meters, and the North Koreans would deliver and load the *kereste* aboard a breakbulk vessel in a North Korean port.

If Terim could get the *kereste* inside Turkey, it should sell for 783,500,000,000 TL. The Turkish chemical manufacturers expect to be paid 60 days after the chemicals leave the Turkish port, which will be same date as the *kereste* leaves North Korea.

Terim gazed at his notes, which were full of numbers and currency exchange rates.

(continued)
Ocean transportation costs for Gemi (Shipping lines require payment in U.S. dollars):

<table>
<thead>
<tr>
<th>Destination</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wonsan to Constantza</td>
<td>$42,000</td>
</tr>
<tr>
<td>Wonsan to Latakia</td>
<td>$33,000</td>
</tr>
<tr>
<td>Suez Canal charges</td>
<td>$3,100</td>
</tr>
</tbody>
</table>

**Tir:**

<table>
<thead>
<tr>
<th>Service</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constantza into Turkey</td>
<td>$15,000</td>
</tr>
<tr>
<td>Latakia into Turkey</td>
<td>$12,000</td>
</tr>
<tr>
<td>Handling fees at the Liman (Syria or Romania)</td>
<td>1.25 percent of the total value of goods</td>
</tr>
<tr>
<td>Generating false Romania origin documents</td>
<td>16,000,000,000 TL</td>
</tr>
<tr>
<td>Projected amount of rusvet at Syrian–Turkish border</td>
<td>10 percent of shipment’s value</td>
</tr>
<tr>
<td>Currency exchange rates</td>
<td>$1 = 1,567,000 TL</td>
</tr>
</tbody>
</table>

**Option 1:** Wonsan/Constantza/Turkey would take 43 days

**Option 2:** Wonsan/Latakia/Turkey would take 22 days

**QUESTIONS**

1. Should Terim let somebody else complete the transaction because he knows that if he doesn’t sell to the North Koreans, someone else will?
2. What are the total costs given in the case for the option of moving via Romania?
3. What are the total costs given in the case for the option of moving via Syria?
4. Which option should Terim recommend? Why?
5. What other costs and risks are involved in these proposed transactions, including some not mentioned in the case?
6. Regarding the supply chain, how—if at all—should bribes be included? What functions do they serve?
7. If Terim puts together this transaction, is he acting ethically? Discuss.
8. What do you suggest should be done to bring moral values into the situation so that the developing countries are somewhat in accordance with Western standards? Keep in mind that the risks involved in such environments are much higher than the risks of conducting business in Western markets. Also note that some cultures see bribery as a way to better distribute the wealth among their citizens.
Part III presents a detailed examination of some of the more prominent elements of logistics systems. Chapter 7 looks at demand management, order management, and customer service. Demand management involves managing customer demand through the supply chain, whereas order management deals with incoming orders, and customer service deals with keeping existing customers happy. Chapter 8 discusses inventory management, and you will learn about inventory classifications as well as inventory-related costs. This chapter also examines how much inventory to order, when to order inventory, and special concerns with inventory.

The topic of Chapter 9 is facility location, which has moved from a tactical to a strategic consideration in many companies in part because of globalization. You will learn about general and specific factors in facility location in this chapter. Chapter 10 focuses on warehousing management and you will be introduced to the various types of warehousing, warehousing’s role in a logistics system, and design considerations in warehousing. The effectiveness and efficiency of warehousing operations can be greatly influenced by packaging and materials handling considerations; Chapter 11 looks at these two topics.

Two chapters are devoted to transportation because it often represents the highest cost logistics activity in a company. Chapter 12, “Transportation,” discusses the five modes of transportation, intermodal transportation, and select transportation specialists. Chapter 13, “Transportation Management,” focuses on some of the primary responsibilities of a transportation manager, which include rate considerations, modal and carrier selection, and domestic documentation. Chapter 14, the last chapter in this section, deals with international logistics, which tends to be more challenging and more costly than domestic logistics. Among the topics covered in Chapter 14 are macroenvironmental influences on international logistics, international documentation, terms of sale, and international trade specialists.
This chapter discusses two key issues: (1) how an organization determines what the customer wants and (2) how an organization facilitates the customer getting what is wanted. We will analyze these issues in terms of demand management (how an organization determines what the customer wants) along with order management and customer service (how an organization facilitates the customer getting what is wanted). Demand management is important because effective and efficient supply chains have learned to match both supply and demand; failure to do so can result in oversupply (more supply than demand) or undersupply (less supply than demand) of products. Oversupply likely means higher than desired inventory costs, whereas undersupply can mean a dissatisfied—or even lost—customer.

Order management and customer service begin where demand management ends. The ability to determine that the customer wants, say, a black shovel, is nice, but is the customer able to communicate this desire to an organization? Once the customer’s desire for a black shovel is communicated to an organization, is the organization able to fulfill this desire? Although these might seem like basic, commonsense questions, reality may be quite different. Indeed, one lesson learned in the early years of online retailing was that many companies were quite good at understanding and stimulating customer demand as well as receiving orders associated with the demand. Unfortunately, some of these companies were far less adept at processing these orders; orders arrived late (if they arrived at all), arrived incomplete, and arrived with incorrect product(s). Not surprisingly, these fulfillment shortcomings caused a great deal of customer dissatisfaction, which explains why some early online retailers (e.g., etoys.com) are no longer in business.

DEMAND MANAGEMENT

Demand management can be defined as “the creation across the supply chain and its markets of a coordinated flow of demand.”\(^1\) A key component in demand management is demand (sales) forecasting, which refers to an effort to project future demand. Without question, demand forecasting is helpful in make-to-stock situations (when finished goods are produced prior to receiving a customer order). However, demand forecasting can also be helpful in make-to-order situations (when finished goods are produced after receiving a customer order). Make-to-order situations generally involve some combination of standard and custom components, and forecasting could be quite

helpful in projecting the standard components needed. For example, although a computer manufacturer might not be able to forecast the exact configuration of each order for computers that it receives, the manufacturer might be able to forecast the percentage of orders for laptop and tablet computers (i.e., standard components).

Entire books are devoted to demand forecasting, and space limitations preclude a comprehensive discussion of the topic in this text. Rather, we will offer an overview of demand forecasting so the reader can understand forecasting’s role in determining what the customer wants.

**Demand Forecasting Models**

The three basic types of forecasting models are (1) **judgmental**, (2) **time series**, and (3) **cause and effect**. Judgmental forecasting involves using judgment or intuition and is preferred in situations where there is limited or no historical data, such as with a new product introduction. Judgment forecasting techniques include surveys and the analog technique, among others. With survey forecasting, questionnaires (surveys) are used to learn about customer preferences and intentions. A strong understanding of survey design and population sampling methodologies is necessary in survey forecasting, and you should recognize that customer intentions don't always translate into actual behavior. Analog forecasting involves determining an analog (similar item) to the item being forecast and then using the analog’s demand history as a basis for the relevant forecast. A key challenge is selecting the appropriate analog to use.

An underlying assumption of time series forecasting is that future demand is solely dependent on past demand. For example, if this year’s sales were 7 percent higher than last year’s sales, a time series forecast for next year’s sales would be this year’s sales plus 7 percent. Time series forecasting techniques include, but are not limited to, simple moving averages and weighted moving averages. The simple moving average is calculated by summing the demand across different time periods and then dividing by the number of time periods. Because each time period is assigned the same importance (weight), the simple moving average may not adequately reflect recent upturns or downturns in demand. To address this shortcoming, the weighted moving average technique assigns greater importance (weight) to the more recent data. The differences in forecasted demand between the simple and weighted moving averages can be seen in the example in Table 7.1.

Cause-and-effect forecasting (also referred to as associative forecasting) assumes that one or more factors are related to demand and that the relationship between cause and effect can be used to estimate future demand. In many western countries, for example, there tends to be an inverse relationship between the level of interest rates and the consumers’ ability to buy a house (e.g., as interest rates increase, housing sales tend to decrease). Examples of cause-and-effect forecasting include simple and multiple regression; in simple regression, demand is dependent on only one variable, whereas in multiple regression, demand is dependent on two or more variables.

<table>
<thead>
<tr>
<th>Time period (1)</th>
<th>Demand (2)</th>
<th>Simple Moving Average Weighting Factor (3)</th>
<th>Projected Demand (4; = 2 × 3)</th>
<th>Weighted Moving Average Weighting Factor (5)</th>
<th>Projected Demand (6; = 2 × 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last month</td>
<td>250</td>
<td>.25</td>
<td>62.5</td>
<td>.40</td>
<td>100</td>
</tr>
<tr>
<td>Two months ago</td>
<td>230</td>
<td>.25</td>
<td>57.5</td>
<td>.30</td>
<td>69</td>
</tr>
<tr>
<td>Three months ago</td>
<td>200</td>
<td>.25</td>
<td>50</td>
<td>.20</td>
<td>40</td>
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<tr>
<td>Four months ago</td>
<td>180</td>
<td>.25</td>
<td>45</td>
<td>.10</td>
<td>18</td>
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<tr>
<td><strong>Forecast</strong></td>
<td><strong>215</strong></td>
<td><strong>227</strong></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Demand Forecasting Issues

It’s important to recognize that the selection of a forecasting technique (or techniques) depends on a variety of factors, such as the situation at hand, forecasting costs in terms of time and money, and the accuracy of various forecasting techniques. With respect to the situation at hand, as pointed out earlier, judgmental forecasting is appropriate where there is little or no historical data available. Managers should also understand the time and monetary costs associated with each particular forecasting technique. Survey research, for example, can require quite a bit of both money and time, depending on the media (i.e., mail, telephone, electronic, in-person) used to collect and analyze the data. For example, in-person surveys can take a great deal of time to complete and can be quite expensive (e.g., compensation costs of the researcher who conducts in-person surveys).

Forecasting accuracy refers to the relationship between actual and forecasted demand, and accuracy can be affected by various considerations. One of the challenges with the analog technique is selecting the appropriate analog, because an inappropriate selection will reduce forecast accuracy. For instance, when a movie studio releases a sequel to a previously successful motion picture, a forecasting analog based on the initial release will likely generate a different revenue estimate than a forecasting analog based on the performance patterns of sequels to other movies—and one analog will be more accurate than the other.

Forecast accuracy can have important logistical implications, as illustrated at Lighthouse Foods, where improved forecasting resulted in substantial reductions in the amount of finished goods inventory. More specifically, Lighthouse used to carry nearly twice as much inventory as actually needed for certain stockkeeping units (SKUs) because of inaccurate demand forecasts for those items.3

Up to this point, we have treated demand forecasting as a discrete entity in the sense that each supply chain member generates its own demand forecasts. You may recall that Chapter 1 briefly mentioned the collaborative planning, forecasting, and replenishment (CPFR) concept, in which supply chain partners share planning and forecasting data to better match up supply and demand. Conceptually, CPFR suggests that supply chain partners will be working from a collectively agreed-to single demand forecast number as opposed to each member working off its own demand forecast projection. CPFR also suggests that supply chain partners will be working from a collectively agreed-to order forecast, which considers both forecasted demand and current inventory levels.4

A great deal of demand forecasting currently involves the use of computer software packages. Although this software can provide fast and detailed data, software packages should not be viewed as a panacea to an organization’s demand forecasting. For example, enterprise resource planning (ERP) systems conceptually should lead to much lower forecasting errors. However, the Grocery Manufacturers Association found forecasting errors that averaged more than 20% among companies that had implemented ERP-based forecasts.5 It is important to keep in mind that no software package—regardless of its sophistication and cost—is capable of totally eliminating forecast errors.

ORDER MANAGEMENT

Order management refers to management of the various activities associated with the order cycle; the order cycle (which can also be referred to as the replenishment cycle or lead time) refers to the time from when a customer places an order to when the goods are received. In recent years, some organizations have expanded the order management concept to include the length of time it takes an organization to receive payment for an order, or what is called the order to cash cycle.

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Before proceeding to a detailed discussion of the order cycle, several points should be made. First, the order cycle should be analyzed not only in terms of total cycle time but in cycle time variability (reliability) as well. Just as longer order cycles necessitate increased levels of inventory, so, too, does greater cycle time variability require additional levels of inventory (regardless of cycle time length). Consider the U.S. railroad, which analyzed transit times on one of its origin-destination pairs located approximately 400 miles apart. The railroad discovered an average transit time of 8 days, with a minimum of 3 days and a maximum of 28 days, and the railroad’s customers coped with the erratic transit times by holding additional inventory to avoid out-of-stock situations.6

A second point is that order management has been profoundly affected by advances in information systems. For example, one of this book’s authors worked in the U.S. trucking industry in the early 1980s. Back then if a customer telephoned to learn about a shipment’s status, a very manual—and, unfortunately, a time-consuming (at a minimum, the phone call had to be answered) and not always successful—shipment tracking process was initiated. Today, by contrast, that same customer doesn’t have to place a telephone call; rather, the customer can use a shipment tracking application (app) on her/his smartphone to learn about a shipment’s status.

We view the order cycle as consisting of four components or stages: order transmittal, order processing, order picking and assembly, and order delivery. Each of the four components will be discussed below.

Order Transmittal

Order transmittal refers to the time from when the customer places an order until the seller receives the order. In general, there are five possible ways to transmit orders: in person, by mail, by telephone, by facsimile (fax) machine, and electronically. Each method of order transmittal has advantages and disadvantages, and each performs differently with respect to the cost of ordering, the time to order, the potential for order errors, and ordering convenience. For example, in-person orders greatly reduce the potential for order errors, if for no other reason than that the order can be physically inspected prior to being accepted. However, in-person ordering isn’t always convenient (or practical) in situations where the supplier is geographically distant.

Although ordering by mail might be more convenient than in-person ordering, mail is considered to be a relatively slow form of order transmittal, and there are occasions when the order never reaches the intended destination (lost in the mail). Ordering by telephone can be relatively fast and convenient, but order errors may not be detected until the order is delivered. You may have placed a telephone order for home delivery of a large pepperoni pizza, only to be delivered a small mushroom pizza!

Both facsimile and electronic ordering are techniques that have emerged over the past 30 years, and both have had immense impacts on the order transmittal process. The fax can be fast, convenient, and unlike the telephone, provides hard copy documentation of an order. However, the seller’s fax machine can be cluttered with junk (unwanted) faxes, and the quality of the fax transmission can result in hard-to-read orders—which increases the chances of order errors in the form of incorrect product or incorrect quantity. Electronic ordering, which includes EDI, the Internet and mobile technology, can be fast, convenient, and accurate, particularly those orders involving scanners and bar codes. Concerns with ordering via the Internet and mobile technology include the security of the information being transmitted (particularly with respect to payment information) and the potential loss of privacy (due to cookies and tracking software).

Order Processing

Order processing refers to the time from when the seller receives an order until an appropriate location (such as a warehouse) is authorized to fill the order. Advances in technology have allowed most firms to computerize many aspects of their order processing systems. For instance, order forms,

whether printed or in computer format, are designed so that the use of computers by both the customer and the vendor is facilitated. Similarly, the billing of customers is increasingly done through computerized and electronic networks.

Figure 7.1, which presents an order processing flowchart, highlights the many distinct order processing activities. Typical order processing activities include checking an order for completeness and accuracy, checking the buyer’s ability to purchase, entering the order into the system, crediting a salesperson with a sale, recording the transaction, determining inventory location, and arranging for outbound transportation. Although some of the activities must be performed sequentially (e.g., an order can’t be transported until a company knows from which location(s) it will be filled), some might be performed simultaneously (e.g., crediting a salesperson with a sale and recording the transaction). Note that one way to reduce order cycle time is to identify activities that can be performed simultaneously and then perform the relevant activities simultaneously, rather than sequentially.

An understanding of the various order processing activities is only a first step, however. Companies differ in their approaches to managing order processing and its activities, and these different approaches can have important implications for order cycle effectiveness and efficiency as well as for customer satisfaction. We’ll highlight different managerial approaches by discussing three order processing activities—order receipt, order triage, and the location(s) used to fill an order—in the following paragraphs.

With respect to order receipt, Figure 7.1 indicates that incoming orders can be divided into categories, one category for EDI orders that are allowed to bypass checking for completeness and accuracy and one category for all other orders. It could be argued that all orders, regardless of transmission method, should be checked for completeness and accuracy; incomplete or inaccurate orders can negatively affect customer satisfaction and increase costs associated with addressing order irregularities. However, checking all orders for completeness and accuracy adds costs and time to the order cycle. Alternatively, companies might structure the order receipt function to reflect historical trends on order completeness and accuracy. Under this scenario, order transmission methods that consistently exhibit superior completeness and accuracy would bypass the order check activity.

Figure 7.1 also contains an order triage activity. The triage concept is often associated with the medical field and refers to classifying patients in terms of the severity of their illness or malady; the classification allows doctors to prioritize which patients should be attended to before others. Similarly, order triage refers to classifying orders according to pre-established guidelines so that a company can prioritize how orders should be filled. However, not all companies prioritize orders, and those that do must decide the attribute(s) used to prioritize (e.g., first in, first served; customer longevity; customer sales). Although there is no one right attribute to use for order prioritization, you should recognize that the chosen attribute(s) are likely to delight some customers (those that exhibit the chosen attribute) and disappoint other customers.

Another key order processing decision (see Figure 7.1) involves determining the location(s) from which an order is to be filled. As was the case with order triage, companies should have clear, consistently applied rules to help in making this decision, but there are companies that decide which facility to use on an order-by-order basis—which can lead to inconsistent order cycle time and cost. A commonsense approach would be to fill an order from the facility location that is closest to the customer, with the idea that this should generate lower transportation costs as well as a shorter order cycle time. Alternatively, an order could be filled from the facility location that currently has the largest amount of requested product; this likely would increase both order cycle time and transportation cost, but it could help the seller by reducing excess inventory at a particular location.

**Order Picking and Assembly**

Order picking and assembly is the next stage of the order management process, and it includes all activities from when an appropriate location (such as a warehouse) is authorized to fill the order until goods are loaded aboard an outbound carrier. Although order picking and assembly is sometimes
Figure 7.1 Flowchart of Order Handling (Order Processing) System
overlooked because neither activity is very glamorous, order picking and assembly often represents the best opportunity to improve the effectiveness and efficiency of an order cycle; order picking and assembly can account for up to two-thirds of a facility’s operating cost and time.

Importantly, the effectiveness and efficiency of order picking and assembly can often be improved without large expenditures. For example, one low-cost method to improve effectiveness and efficiency is to analyze order pickers’ travel time, in part because travel time often accounts for more than 50% of order picking hours. One way to reduce travel time involves combining several small orders into one larger order so that the order picker can make one pick trip rather than several pick trips.7 Another low-cost suggestion for improving the effectiveness and efficiency of the pick process is to match the picker to the order being picked. For example, an order consisting of fragile items might be assigned to a picker who exhibits a low percentage of damaged picks.8

Order picking and assembly has been greatly affected by advances in technology such as handheld scanners, radio-frequency identification (RFID), and voice-based order picking. Voice-based order picking refers to the use of speech to guide order-picking activities. Early voice-based picking systems were characterized by high adoption costs, poor voice quality, and systems that were easily disrupted by other noises. Contemporary voice-based systems, by contrast, are less costly, are more powerful, have better voice quality, and are less cumbersome for workers to use. Benefits of voice-based systems include improved productivity, fewer pick errors, and minimal training time for workers to learn how to utilize the technology.9

Another order picking technique that has grown in popularity in recent years is pick-to-light technology, in which orders to be picked are identified by lights placed on shelves or racks. Pick-to-light systems simplify the pick process because the worker simply follows the lights from pick to pick, as opposed to the worker having to figure out an optimal picking path. The combination of pick-to-light and voice-based picking can yield impressive operational improvements; for example, a cosmetics company that utilizes both technologies reported that workers could pick seven times as many orders per hour as prior to the technology adoption—while order accuracy improved by 50%.10

Order Delivery

The final phase of the order cycle is order delivery, which refers to the time from when a transportation carrier picks up the shipment until it is received by the customer. You will learn more about transportation in Chapters 12 and 13, so our discussion here will look at several key issues that can impact the effectiveness or efficiency of order delivery.

When the first edition of this book was published in the 1970s, transportation carriers provided a limited number of options in terms of transit times, and shippers thus had to incorporate the rather inflexible transit times into calculations of the length of an order cycle. For example, in the late 1970s, “next-day delivery” meant that a shipment would arrive sometime during the next business day—the customer could not request a specific delivery time. Today, by contrast, a customer can choose several next-day delivery options, such as delivery by 12 noon and delivery by 4:30 p.m.

Another key order delivery issue is that a number of shippers are emphasizing both elapsed transit time as well as transit time reliability (variability), which is important because increases in order cycle variability translate into higher inventory levels. To this end, more buyers are utilizing delivery appointments that contain delivery windows, or the time span within which an order must arrive. Although some delivery windows are one hour in length, other windows are as narrow as

7http://www.supplychain247.com/article/5_ways_to_improve_order_picking_productivity/MWPVL_International
15 minutes. So, if a carrier has a 9:00 a.m. appointment with a 15-minute delivery window, it must arrive no later than 9:15 a.m. Oftentimes, failure to meet the relevant delivery window means that the carrier must wait for the next open delivery time—which might not be until the end of the day.

A third key order delivery issue involves transportation carriers revamping their operations to provide faster transit times to customers. For example, 500 miles traditionally served as the maximum range for overnight service in the trucking industry. In recent years, by contrast, the maximum range for overnight service by truck has been pushed to between 600 and 700 miles. This expanded coverage allows customers to shift shipments from air to truck—an important consideration because truck transportation is less costly than air transportation.

**CUSTOMER SERVICE**

Customers are important to organizations, and organizations that view customers as a “nuisance” may not last very long in today’s highly competitive business environment. Consider several metrics associated with unhappy customers. A frequently cited metric is that it costs approximately five times as much to develop a new customer as it does to retain an existing one. In addition, approximately 95% of unhappy customers do not communicate their unhappiness to the responsible organization and they won’t return as customers—but they will tell nine people about their unhappiness. Quite simply, it’s easier for an organization to keep an existing customer than to acquire new customers. To this end, customer service strives to keep customers happy and creates in the customer’s mind the perception of an organization with which it is easy to do business.

Customer service can be an excellent competitive weapon. It is more difficult for competitors to imitate than other marketing mix variables such as price and promotion. Nordstrom’s (a high-end retailer) has a long-standing reputation for excellent customer service, and this customer focus often leads Nordstrom’s to do things that competitors cannot or will not match. For example, one of the authors was shopping at a Nordstrom’s and found a belt that he liked, but the store didn’t have the correct size in stock. Several days later, the author received a telephone call from a Nordstrom’s salesperson indicating that the desired belt was available for purchase at the local store. The salesperson had located the belt at another Nordstrom’s and had the belt expedited—via air freight—to the local store. With a retail value of approximately $45, it’s likely that this particular Nordstrom’s lost money on this purchase. It’s a reasonable assumption, however, that few other retailers would copy Nordstrom’s behavior in servicing the customer.

Macroevironmental changes, such as globalization and advances in technology, are causing organizations and individuals to demand higher levels of customer service. As was pointed out in Chapter 1, customer expectations continue to increase over time; if the associated performance (service) levels fail to keep up, then customer dissatisfaction is a likely outcome. In addition, as emphasized in this chapter, reliable service enables a firm to maintain a lower level of inventory, especially of safety stocks, which produces lower inventory holding costs. Third, in an increasingly automated and computerized world, the relationships between customers and vendors can become dehumanized. This situation is both frustrating and inefficient from the customer’s viewpoint. The firm that can offer a high level of customer service, especially on a personal basis, will find that it has a powerful sales advantage in the marketplace.

Furthermore, the increased use of vendor quality-control programs necessitates higher levels of customer service. In recent years, many firms, especially retailers and wholesalers, have become more inventory conscious. This emphasis has resulted in computer-assisted analysis to identify vendors that consistently give either good or bad levels of service. In the past, with manual systems, repeated and serious customer service errors occurred before a vendor’s activities were singled out for corrective action. Today, these factors are automatically programmed into computers, and companies are able to closely monitor the quality of service they receive from each vendor.

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We’ve talked at some length about customer service, but we’ve yet to offer a formal definition of it. Keeping in mind that there are myriad customer service definitions, for our purposes customer service will be defined as “the ability of logistics management to satisfy users in terms of time, dependability, communication, and convenience.” Let’s take a closer look at each of these four dimensions of customer service.

**Time**

Time refers to the period between successive events, and clearly the order cycle is an excellent example of the time dimension of customer service. At the risk of sounding redundant, many businesses today are looking to reduce order cycle times—longer cycle times translate into higher inventory requirements. Moreover, some customers now expect nearly instantaneous gratification—which explains why Amazon continues to add to the number of locations where it offers one-hour delivery for online orders.

**Dependability**

Dependability refers to the reliability of the service encounter. It consists of three elements, namely, consistent order cycles, safe delivery, and complete delivery. Our earlier discussion of the order cycle highlighted the importance of consistency (reliability/dependability)—inconsistent order cycles necessitate higher inventory requirements. And although order cycle time is important, an increasing number of companies are trading off order cycle speed for order cycle consistency. More specifically, these companies are willing to accept a slower order cycle so long as it exhibits a high level of consistency.

Safe delivery brings loss and damage considerations into play. Product can be lost or damaged for a multitude of reasons, but the reasons are rather immaterial to a customer—a lost or damaged product can cause a variety of negative ramifications for a customer, such as out-of-stock situations. Order fill rate, or the percentage of orders that can be completely and immediately filled from existing stock, is one way of measuring the completeness of delivery. As is the case with loss and damage, incomplete deliveries result in negative customer ramifications, such as out-of-stock situations.

It is unlikely that loss and damage can ever be totally eliminated; because orders are picked and assembled, they are handled—and every time product is handled it provides opportunities for loss or damage. However, the seller may be able to minimize the number of times an order is handled, perhaps by redesigning the order pick process. And, even if an organization has highly accurate demand forecasting, it’s unlikely that it will be able to achieve a 100 percent fill rate (i.e., all incoming orders are filled completely). Consider the situation of the McDonald’s restaurant where two people walked in and placed a take-out order for 142 Egg McMuffins! Although the restaurant was successfully able to fill this order (but not before ensuring that the two customers could pay for it), the inventory needed to fill it meant that a lot of other orders for Egg McMuffins went unfilled, at least until the next scheduled delivery of foodstuffs.

**Communication**

Effective communication should be a two-way exchange between seller and customer, with the goal of keeping both parties informed. Moreover, effective communication requires that the correct parties be involved in the process; if a customer has a logistics-related question, then the customer should be communicating with someone with logistics expertise. Moreover, customer service can be enhanced if complete information is exchanged between the participants; a delivery address can be helpful, but detailed characteristics of the delivery address would be even more helpful, as illustrated by the case of the transportation company that was responsible for delivering a $750,000 shipment of com-

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13Ibid.
Computer racks. What the transportation company didn’t find out—until it actually made the delivery—was that the customer was located on the seventeenth floor of an office building in the central business district of a major city. Because neither the transportation company nor the office building had the appropriate equipment to facilitate the shipment’s handling, the delivery had to be delayed until the proper equipment could be located and brought to the building.14

Two-way communication between seller and customer has certainly benefited from technological advances such as cell phones, smart phones, and the Internet. These technological advances allow for less costly and more frequent contacts between the two parties. However, technology such as text messaging and the Internet can depersonalize the communication process, which is why periodic telephone interaction and even face-to-face contact between seller and customer are recommended.15 You should recognize that face-to-face personal communication is an essential part of conducting business in some cultures.

Convenience

The convenience component of customer service focuses on the ease of doing business with a seller. Having said this, different customers may have different perceptions of the “ease of doing business” concept. For example, for a college student the “ease of doing business” with a bank might mean access to automatic teller machines, whereas for a small business owner it might mean bank tellers who specifically focus on commercial deposits and withdrawals. As such, sellers should have an understanding of their customer segments and how each segment views the “ease of doing business.”

Moreover, from the seller’s perspective, certain costs may be associated with convenience; for example, there may be a charge for pizza that’s delivered to your residence or workplace (or “free delivery areas” might be very limited in geographic coverage). As a result, sellers must assess the extent to which their customers are willing to pay for convenience. For example, allowing customers to electronically arrange their own travel (e.g., computer, tablet, smart phone) is quite cost-effective for airlines in that the costs of processing an electronic ticket are extremely low relative to involving an airline sales agent in the process. As a result, customers who arrange their travel by telephoning an airline’s customer service agent can be charged a fee for talking to the service agent (a service that for many years was “free” to the customer).

The convenience dimension also plays a key role in a consumer’s purchasing decision. Today’s consumer likes to have multiple purchasing options at her/his disposal and organizations have responded by developing multichannel marketing systems, i.e., separate marketing channels to serve customers. A retailer, for example, can facilitate customer purchasing with bricks-and-mortar stores (one channel) as well as with a website (another channel). The convenience dimension in multichannel marketing systems can be seen with omnichannel retailing—where a customer might place an order online and then pick up the order at a bricks-and-mortar store.

MANAGING CUSTOMER SERVICE

In addition to understanding what customer service is, the logistician faces multiple managerial considerations with customer service. The remainder of this chapter will discuss four specific considerations—establishing customer service objectives; measuring customer service; customer profitability analysis; and service failure and recovery.

Establishing Customer Service Objectives

Because customer service standards can significantly affect a firm’s overall sales success, establishing goals and objectives is an important management decision. Goals tend to be broad, generalized

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15Ibid.
statements regarding the overall results that the firm is attempting to achieve. Unfortunately, some firms’ statements of customer service goals are couched in platitudes lacking specific objectives specifying how the goals are to be achieved. This is a serious problem because if the customer service objectives or standards are not stated in specific terms, they may be ignored or be too vague to provide any real guidance to operating personnel.

Objectives, the means by which goals are to be achieved, state certain minimum requirements and are more specific than goals. One suggestion is that objectives should be “SMART,” that is, specific, measurable, achievable, realistic, and timely. Consider, for example, an objective to reduce order picking errors from 5 to 2 percent within a 12-month time period. This objective is specific in the sense that the degree of improvement (5 percent to 2 percent reduction) is clearly stated and the objective can be measured by comparing order pick errors across time. It's not clear, however, if this objective is achievable, realistic, and timely. For example, how will the reduction in pick errors be achieved? Will the company be forced to hire additional personnel to check the picked orders? Will the current order picking process need to be restructured, perhaps through the addition of new technology? Can new personnel be hired and trained and can new technology be purchased, installed, and be operational within 12 months? Is the improvement in customer service (i.e., from 5 percent order picking errors to 2 percent order picking errors) worth the additional costs necessary to achieve the improvement?

A central element in establishing customer service goals and objectives is determining the customer's viewpoint. This means asking customers for their insights about customer service. For example, what services would the customer like to receive that presently are not available from the seller? What services do customers view as the most important? How well does the seller currently provide what the customer wants? What could be improved?

Because customer service is a competitive tool, it is also important to learn how the customer evaluates the service levels of competing sellers. Many companies evaluate their service performance through benchmarking, which refers to a process that continuously identifies, understands, and adapts outstanding processes found inside and outside an organization. Well-run organizations benchmark not only against competitors (where possible) but against best-in-class organizations as well.

For maximum results, organizations should engage in performance benchmarking, which compares quantitative performance (e.g., fill rate performance), as well as process benchmarking, which is qualitative in nature and compares specific processes (e.g., how organizations achieve their fill rates). From a managerial perspective, performance benchmarking identifies gaps in a desired result while process benchmarking provides information as to why the gaps exist.

The nature of the product also affects the level of customer service that should be offered. Substitutability, which refers to the number of products from which a firm’s customers can choose to meet their needs, is one aspect. If a firm has a near monopoly on an important product (i.e., few substitutes are available), a high level of customer service is not required because a customer who needs the product will buy it under any reasonable customer service standard. However, if many products can perform the same task, then customer service standards become important from a competitive marketing point of view.

Another product-related consideration when establishing customer service goals and objectives is where the product is in its product life cycle. A product just being introduced needs a different kind of service support than one that is in a mature or declining market stage. When introducing a new product, companies want to make sure that there is sufficient supply of it to meet potential customer demand, and so companies might use expedited transportation to protect against out-of-stock situations. It is far less likely that the same company would use expedited transportation to guard against an out-of-stock situation with a product in the decline phase of the product life cycle.

Establishing minimum acceptable order sizes is an ever-present customer service problem because many customers want to order smaller quantities at more frequent intervals. Orders of decreasing size make diminishing (and eventually negative) contributions to profits. In any particular marketing situation, detailed analysis is needed regarding both why small orders are placed and the
possible reactions of existing customers to a new policy that requires either a larger minimum order size or a surcharge on small orders to offset losses. Online and catalog retailers sometimes require a minimum monetary order (e.g., $75) in order for customers to qualify for “free” shipping.

**Measuring Customer Service**

Grandiose statements and platitudes regarding a firm’s level of customer service represent little more than rhetoric unless the customer service standards to support them are actually implemented. To accomplish this, a systematic program of measurement and control is required, because *you can’t manage what you can’t measure*. Control is the process of taking corrective action when measurements indicate that the goals and objectives of customer service are not being achieved. Measurement by itself is merely wasted time and effort if no action is taken based on the feedback received. The actions taken after deficiencies have been identified can lead to an effective and efficient customer service program.

Several key issues are associated with measuring customer service, one of which involves determining the data sources to be used. Ideally, an organization might want to collect measurement data from both internal and external sources. With respect to internal sources, an organization might audit credit memos, which are the documents that must be issued to correct errors in shipping and billing. Comparing them with the volume of error-free activity gives a measure of relative activity accuracy in performance. External measurement data can be collected from customers, and a key managerial issue involves the amount of data to be collected from customer surveys. While customers tend to be more likely to respond to shorter surveys, shorter surveys, by definition, provide lesser amounts of useable data.

A second key issue associated with customer service measurement is determining what factors to measure. Some firms choose those aspects of customer service that are the easiest to measure, which isn’t necessarily a good idea because aspects that are difficult to measure may provide better insights into customer likes and dislikes. Some firms choose those aspects of customer service that they believe are most important, which isn’t necessarily a good idea either because these aspects might be relatively unimportant from the customer’s perspective.

Because so many potential customer service measurements exist, it is not possible to provide a simple list that would be applicable across the board. At a minimum, the measures should be consistent with the four dimensions of customer service—time, dependability, communication, and convenience—discussed earlier in this chapter. Table 7.2 provides representative customer service measures for each of these four dimensions.

In addition, the metrics that are chosen should be relevant and important from the customer’s perspective. While the following example might seem like the proverbial “no brainer,” consider the call center that measured customer service in terms of the length of customer calls, with shorter call lengths preferred to longer call lengths. As such, the call center singled out a particular employee for “improvement” because her call times were much longer than those of other call center employees.

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Additional research indicated that this “laggard” employee was actually the most effective employee when measured in terms of the number of customer problems solved per day. In short, the call center’s primary customer service metric—the time length of customer calls—was different from the customer’s primary customer service metric—solving the problem at hand.\(^\text{16}\)

Although customer service must be measured if it is to be managed, organizations should resist the tendency to “measure everything that moves.” Excessive measurement can strain an organization because it requires the collection of tremendous amounts of data, and once collected, the data must be analyzed. This can result in “analysis paralysis,” or the idea that so much time is required for analysis that there’s little, if any, time left to make decisions based on the data. Rather, organizations should utilize a limited number of meaningful and relevant metrics; and it is possible for organizations to use only one customer service metric, as illustrated in the previous paragraph’s call center anecdote.

**Customer Profitability Analysis**

**Customer profitability analysis** (CPA) refers to the allocation of revenues and costs to customer segments or individual customers to calculate the profitability of the segments or customers. Customer profitability analysis suggests that different customers (segments) consume differing amounts and types of resources; for example, some customers might require telephone-based communication with an organization, whereas other customers are able to communicate electronically with an organization.

Customer profitability analysis explicitly recognizes that all customers are not the same, and some customers are more valuable than others to an organization. CPA can be used to identify different groups of customers from a profitability perspective, and such a grouping can better help in allocating an organization’s resources. One suggested classification, for example, divides customers into four groups (high revenues/high costs; high revenues/low costs; low revenues/high costs; low revenues/low costs); “high revenues/low costs” represents the most attractive customers while “low revenues/high costs” represents the least attractive customers.\(^\text{17}\) From a resource allocation perspective, an organization should pursue different logistical approaches for different customer groups. With respect to product selection, for example, an organization might provide a substantial number of product offerings for “high revenues/high costs” customers (sometimes referred to as “demanding customers”\(^\text{18}\)), whereas limited product offerings might be provided to “low revenues/low costs” customers.

Thorough customer profitability analysis only works if it is grounded in activity-based costing in the sense that activity-based costing suggests that different products are characterized by differences in the amount and types of resources consumed. (Appendix 7A provides a closer look at activity-based costing.) Consider the experience of a specialty distributor of fluid-related products that established activity-based costing as the foundation of its customer profitability analysis program. The distributor, which served approximately 2,000 customers prior to initiating customer profitability analysis, learned that 150 customers accounted for 90% of company profits. In addition, the customer profitability analysis identified over 1,000 unprofitable customers and the distributor no longer does business with them.\(^\text{18}\)

**Service Failure and Recovery**

Regardless of how well run an organization is, some situations will occur in which actual performance does not meet the customer’s expected performance (i.e., a service failure). Service failure has emerged as a prominent business issue in recent years, in part because organizations have learned that customers can easily become disaffected. For example, it has been estimated that poor customer experiences cost U.S. business in excess of $40 billion per year.\(^\text{20}\) From a logistics perspective, service


\(^{18}\)Ibid.


failure is particularly relevant to the order cycle; examples of order-related service failures include lost delivery, late delivery, early delivery, damaged delivery, and incorrect delivery quantity, among others.

Given that service failures are inevitable, organizations will be faced with service recovery decisions. For our purposes, service recovery will refer to a process for returning a customer to a state of satisfaction after a service or product has failed to live up to expectations. Excellent response to a service failure can sometimes result in the service recovery paradox, in which a customer holds the responsible company in *higher regard* after the service recovery than if a service failure had not occurred in the first place. In addition, service recovery can also result in a better performing organization in the sense that an organization can learn from failure and then implement processes and policies to lessen the occurrence of future service failures.\(^{21}\)

There is no set formula for service recovery, in part because each service failure is unique in its impact on a particular customer. Having said this, there are general guidelines for dealing with service recovery, and it is important to recognize that these guidelines may not only assuage the customer but also result in an organization improving its operations.\(^{22}\) For example, one recovery guideline is fair treatment for customers. In the logistics discipline, one example of fair treatment involves service guarantees by transportation companies; if a shipment misses various delivery parameters (e.g., on time, undamaged), then customers might receive a full refund (or aren’t billed for the transportation). Besides reducing customer risk, many transportation companies that have implemented service guarantees have improved relevant aspects of their performance such as on-time delivery, which has meant a decrease in the amount of payouts for deficient service.

### Summary

Demand management deals with determining what customers want, and a key component involves demand forecasting. The chapter discussed basic demand forecasting models along with select forecasting issues such as cost and accuracy. The chapter also looked at order management and the order cycle, which refers to the period of time from when the order is placed until it is received. Four components of an order cycle—order transmittal, order processing, order picking and assembly, and order delivery—were identified and discussed in some detail.

Customer service was the third major topic addressed in this chapter. The four dimensions of customer service—time, dependability, communication, and convenience—were discussed. The chapter also looked at managing customer service, with a specific focus on establishing customer service objectives, measuring customer service, customer profitability analysis, and service failure and service recovery.

### Key Terms

<table>
<thead>
<tr>
<th>Activity-based costing (ABC)</th>
<th>Make-to-order</th>
<th>Order to cash cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmarking</td>
<td>Make-to-stock</td>
<td>Order transmittal</td>
</tr>
<tr>
<td>Cause-and-effect forecasting</td>
<td>Multichannel marketing systems</td>
<td>Order triage</td>
</tr>
<tr>
<td>Collaborative planning, forecasting and replenishment (CPFR)</td>
<td>Order cycle</td>
<td>Pick-to-light technology</td>
</tr>
<tr>
<td>Customer profitability analysis (CPA)</td>
<td>Order delivery</td>
<td>Service recovery</td>
</tr>
<tr>
<td>Customer service</td>
<td>Order fill rate</td>
<td>Service recovery paradox</td>
</tr>
<tr>
<td>Demand management</td>
<td>Order management</td>
<td>Time series forecasting</td>
</tr>
<tr>
<td>Judgmental forecasting</td>
<td>Order picking and assembly</td>
<td>Voice-based order picking</td>
</tr>
</tbody>
</table>

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Questions for Discussion and Review

7.1 What is the relationship between demand management, order management, and customer service?
7.2 Discuss the three basic demand forecasting models.
7.3 Discuss several demand forecasting issues.
7.4 Define and describe the order cycle. Why is it considered an important aspect of customer service?
7.5 What are some causes of order cycle variability? What are the consequences of order cycle variability?
7.6 List the various methods of order transmittal and discuss relevant characteristics of each.
7.7 What are some advantages and disadvantages to checking all orders for completeness and accuracy?
7.8 Define order triage and explain how it can affect order processing.
7.9 Discuss how the effectiveness and efficiency of order processing can be improved without large expenditures.
7.10 What is pick-to-light technology, and how can it improve order picking?
7.11 Discuss the order delivery stage of the order cycle.
7.12 How can customer service act as a competitive weapon?
7.13 How are macroenvironmental factors causing organizations and individuals to demand higher levels of customer service?
7.14 List and discuss the three elements of the dependability dimension of customer service.
7.15 What are some advantages and disadvantages of technological advances designed to facilitate buyer–seller communications?
7.16 What is customer profitability analysis and how might it be used in logistics?
7.17 Define and explain how organizations might engage in benchmarking.
7.18 How do characteristics such as substitutability and product life cycle stage influence the development of customer service goals and objectives?
7.19 Describe some of the key issues associated with measuring customer service.
7.20 What is meant by service recovery? How is it relevant to logistics?

Suggested Readings


CASE

CASE 7.1 SUPERAUTO SPARE PARTS SERVICES

Peng Zhang is a project manager with SuperAuto Ltd., a large automobile manufacturer based in Shanghai, China. Three years ago, he led a project to outsource spare parts management to DailyFreight Ltd., a third-party logistics provider. Outsourcing is the practice of transferring specific processes from in-house to a third party. It involves a change of process ownership. In Peng Zhang’s project, the outsourced processes included: spare parts inventory management, receiving spare parts orders from dealers, and dispatching orders to dealers. Yun Li, the vice president of customer services, recently asked Zhang to assess the impact of the outsourcing arrangement on customer service quality. In the service level agreements (SLAs), DailyFreight needs to meet an availability rate of 95% of spare parts orders. DailyFreight marks up 10% on SuperAuto’s sales prices to cover the inventory financing, transportation, and administrative costs.

The demand for spare parts is sporadic and urgent. Before the outsourcing, all the authorized 3S (sales, services, and spare parts) dealers of SuperAuto ordered spare parts directly from SuperAuto, which dispatched available spare parts from its national warehouse in Shanghai the next day using a courier service. The courier has a delivery lead time of one day to major cities and two days to the rest of China. SuperAuto has over 100 authorized dealers across the country. It was a huge administrative burden for SuperAuto to manage the small quantity of spare parts orders, which were highly unpredictable. Dealers complained that the courier service sometimes cost more than the spare parts shipped.

In the outsourcing arrangement, DailyFreight orders spare parts in bulk from SuperAuto and owns spare parts at its seven regional warehouses at strategic locations in China. Dealers order spare parts from DailyFreight and expect a next-day delivery from DailyFreight’s regional warehouse. Immediately after the implementation of outsourcing, many dealers praised the service model as they got spare parts faster and paid a lower freight rate due to a reduced transportation distance. SuperAuto’s logistics department was also very happy with the ease of processing bulk purchase orders in the outsourcing arrangement. Because of the overwhelmingly positive feedback, SuperAuto decided to discontinue its annual dealers’ refresher training on spare parts services, given that it was no longer directly supplying spare parts to dealers.

When Peng Zhang accepted the task from Yun Li, he thought it would be simple—apparently all parties involved in the outsourcing arrangement were better off. He followed the routine procedure of conducting a random survey among all the stakeholders involved by phone. However, he was shocked as he spoke to some vehicle owners: they were very angry about their dealer experiences. They complained that their local authorized dealer had asked them to replace expensive components that were still in a good condition, just to make more profit. When asked how they had discovered the dishonesty of a dealer, some vehicle owners said that their view was based on their experience and knowledge. A few vehicle owners had taken their SuperAuto cars to an independent inspection agency, where the dishonesty was proved. These angry vehicle owners said that they would never visit a SuperAuto authorized dealer again, nor would they consider buying another SuperAuto vehicle. This was very troubling for Peng Zhang, although the problem that surfaced did not fall within the scope of the task assigned to him by Yun Li.

When Zhang started to ring dealers, he got a mixed response. For the frequently used spare parts, all dealers acknowledged the benefits of faster delivery and reduced freight cost. However, dealers complained that DailyFreight often ran out of stock of some slow-moving items. Consequently, the dealers had to wait many more days, which delayed the fixing of vehicles. Also, some dealers complained that DailyFreight was not professional in handling deliveries. Sometimes a DailyFreight driver might throw a parcel on a working desk in a rush, without even speaking to or informing anybody at a dealer’s premises. Zhang tried to probe into the possibility of deceitful diagnosis by the dealers for unnecessary replacement of expensive components. However, all the surveyed dealers denied this.

Lastly, Zhang called the account manager at DailyFreight who oversaw the services to SuperAuto and its dealers. He did not give a direct answer when asked whether DailyFreight was not keeping a sufficient stock of slow-moving spare parts. He was confident that DailyFreight met the 95% SLA. He promised to email the statistics of orders and delivery lead times. Somehow, totally unexpected, Zhang complained about the cost of financing spare parts inventories and proposed that the price mark-up be increased from 10% to 20%.

Zhang reported his findings to Li. A day later, Li called him to join a meeting with Fei Wang, the dealer (continued)
relationship manager, and Yu Chen, the logistics manager. Fei Wang looked very upset. He asked Zhang, “Could you provide me with a list of dishonest dealers? I am going to be very tough with them!”

“Sorry, I cannot give you a list,” replied Zhang. “I can only give you the names of the few dealers said to be dishonest by the vehicle owners I surveyed. My telephone survey was not meant to investigate into the integrity of dealers. I randomly rang just 30 vehicle owners. We have over 300,000 customers!”

“It is not enough to be just tough with them—we need to fire them! How can we still trust these people? They have caused a huge damage to our reputation. I wish I had the time to take them to court!” said a furious Yun Li.

“I’m terribly sorry, sir,” said Fei Wang, turning his eyes away from Li. “Nobody has ever told us... Perhaps we shouldn’t have stopped our annual dealers’ refresher training. We used to emphasize our zero tolerance of dishonesty in the training.”

“No excuses, please,” said Li, proceeding to give instructions: “You three, please find out which dealers are dishonest. You also need to come up with an effective procedure to continuously monitor and manage other dealers to ensure that they act with integrity in serving vehicle owners. Furthermore, please review the SLAs with DailyFreight to see if any revisions are necessary.”

After Li left the meeting room, Wang, Zhang, and Chen discussed how to conduct a large-scale survey of vehicle owners to identify possible dishonest dealers. Chen showed the others an old spare parts services survey
form (Exhibit 7). The form had been used ten years ago for a mail survey.

**QUESTIONS**

1. Does SuperAuto have a customer service problem? Why or why not?
2. Based on the reports of some vehicle owners, it is apparent that some dealers have an integrity issue. Why has SuperAuto not been aware of the issue?
3. Does the spare parts outsourcing arrangement have any negative implications for the quality of spare parts services offered to vehicle owners? If yes, why?
4. Assuming DailyFreight’s claim on meeting SLAs is true, what possible revisions should be made to the outsourcing SLAs? Why?
5. What revisions may be made to the old spare parts services feedback form to help SuperAuto collect customer information for continuously monitoring and managing the performance of dealers in the future? Why?
6. Is it too late for SuperAuto to attempt service recovery with vehicle owners who were cheated by dishonest dealers? Why or why not?
7. What lessons can we learn from the SuperAuto case for managing customer service quality in outsourcing?
Inventory refers to stocks of goods and materials that are maintained for many purposes, the most common being to satisfy normal demand patterns. In production and selling processes, inventories serve as cushions to accommodate the fact that items arrive in one pattern and are used in another pattern. For example, if you eat one egg a day and buy eggs by the dozen, every 12 days you would buy a new container of eggs, and the inventory of eggs remaining in your refrigerator would decline at the rate of one egg per day.

Inventory management is a key component in logistics and supply chain management, in part because inventory decisions are often a starting point, or driver, for other business activities, such as warehousing, transportation, and materials handling. Moreover, different organizational functions can have different inventory management objectives. Marketing, for example, tends to want to ensure that sufficient inventory is available for customer demand to avoid potential stockout situations—which translate into higher inventory levels. Alternatively, the finance group generally seeks to minimize the costs associated with holding inventory, which translates into lower inventory levels. As if managing these seemingly conflicting objectives within one organization isn’t challenging enough, supply chains are made up of multiple organizations—each of which may have its own distinct inventory management philosophy. Indeed, each link in the supply chain may prefer having other links maintain the inventory.

Organizations strive for the proper balance (i.e., right amount) of inventory, but achieving the proper balance can be quite difficult because of the trade-offs between inventory carrying cost and stockout cost, both of which will be discussed in greater detail later in this chapter. More specifically, holding high levels of inventory (overstock) result in high inventory carrying costs and low (or no) stockout costs. Alternatively, holding low levels of inventory result in low inventory carrying costs and some (high) stockout costs.

It is important to note here that inventory carries its greatest cost after value has been added through manufacturing and processing. Finished goods inventories are, therefore, much more expensive to hold than raw materials or work in progress. Carrying costs for inventories can be significant, and the return on investment to a firm for the funds it has tied up in inventory should be as high as the return it can obtain from other, equally risky uses of the same funds.

**Learning Objectives**

8.1 To learn about the ways that inventory can be classified
8.2 To discuss inventory costs and the trade-offs that exist among them
8.3 To identify when to order and how much to order, with a particular emphasis on the economic order quantity
8.4 To differentiate the various inventory flow patterns
8.5 To discuss special concerns with inventory management
8.6 To identify several contemporary approaches to managing inventory
This chapter begins with a brief look at various classifications of inventory, followed by a discussion of inventory costs. Next we examine when to order inventory and how much inventory to order. This chapter also looks at inventory flows and special concerns with inventory and concludes by discussing several contemporary issues with managing inventory.

**INVENTORY CLASSIFICATIONS**

It is important to understand the various classifications of inventory because the classification can influence the way that inventory is managed. Inventory generally exists to satisfy demand and can be classified as cycle (base) stock, safety (buffer) stock, pipeline (in-transit) stock, or speculative stock. Each type is explained in the following paragraphs.

**Cycle, or base, stock** refers to inventory that is needed to satisfy normal demand during the course of an order cycle. With respect to the egg example at the beginning of this chapter, one dozen (12) eggs represents the cycle stock—we use one egg per day, and we buy eggs every 12 days. Recall that Chapter 7 indicated that order cycle times continue to decrease in length, meaning that the associated levels of cycle stock continue to decrease as well.

**Safety, or buffer, stock** refers to inventory that is held in addition to cycle stock to guard against uncertainty in demand or lead time. For example, uncertainty in demand could come from the fact that you occasionally decide to make a three-egg omelet as opposed to eating one egg per day. As an example of lead-time uncertainty, you may sometimes buy eggs every 14 days, rather than every 12 days. In both cases, a few extra eggs would ensure that you won’t run out of eggs. As pointed out in Chapter 7, higher levels of uncertainty lead to higher levels of safety stock.

**Pipeline, or in-transit, stock** is inventory that is en route between various fixed facilities in a logistics system such as a plant, warehouse, or store. Pipeline inventory is represented here by eggs that are in transit between a chicken farm and, say, a food wholesaler’s distribution center or between the retail store and your kitchen.

**Speculative stock** refers to inventory that is held for several reasons, including seasonal demand, projected price increases, and potential shortages of product. For example, the fact that eggs are associated with Easter (e.g., Easter egg rolls, colored eggs) tends to cause an increase in demand for them prior to the Easter holiday.

Although inventory generally exists to satisfy demand, in some situations inventory is carried to stimulate demand, also known as **psychic stock**. This type of inventory is associated with retail stores, and the general idea is that customer purchases are stimulated by inventory that they can see.\(^1\) This concept helps explain, in part, why some retailers stock huge amounts of certain merchandise.

**INVENTORY COSTS**

You might remember the basic accounting equation that assets are equal to liabilities plus stockholder’s equity. The managerial significance of the accounting equation is that assets must be paid for in some manner; quite simply, **assets cost money**, which means that inventory costs money. Not only does inventory appear as an asset on company balance sheets, but inventory tends to be one of the largest assets (in terms of dollar value) on the balance sheets. As such, it’s important for logisticians to have an understanding of inventory costs.

The data in Table 8.1 offer insights about the absolute and relative magnitude of inventory costs in the United States between 2010 and 2014. From an absolute perspective, Table 8.1 indicates that the value of business inventory ranged between $2.1 trillion and $2.5 trillion between 2010 and 2014. In relative terms, inventory costs between 2010 and 2014 represent approximately one-third of total logistics costs.

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We will take a closer look at three inventory costs—carrying cost, ordering cost, and stockout cost—that should factor into an organization’s inventory management policy. The logistics manager must understand both the nature of each of these costs as well the trade-offs among them.

**Inventory Carrying Costs**

A prominent concern involves the costs associated with holding inventory, which are referred to as inventory carrying (holding) costs. In general, inventory carrying costs are expressed in percentage terms, and this percentage is multiplied by the inventory’s value. The resulting number represents the dollar value associated with holding the particular inventory. As an example, referring to Table 8.1, when the value of business inventory in 2010, $2064 billion, is multiplied by the carrying cost in 2010, 19.2%, the relevant carrying costs are $396 billion.

Not surprisingly, an increase or decrease in the carrying cost percentage will affect the relevant inventory expense. Generally speaking, companies prefer to carry lower inventory as the carrying cost percentage increases, in part because there is greater risk (e.g., obsolescence) to holding the inventory. As a result, the determination of a carrying cost percentage should be quite important for many companies. However, the reality is that many companies don’t know their actual inventory carrying costs. Rather, many companies simply assign carrying costs as 25% of the value of their inventory—and this 25% figure has been used since the mid-1950s. Table 8.1 suggests that U.S. inventory carrying costs since 2010 consistently have been between 19% and 20%.

Inventory carrying costs consist of a number of different components (see Table 8.2), and the importance of these factors can vary from product to product. For example, perishable items such as dairy products, meat, and poultry are often sold with expiration dates, causing them to have little or no value after a certain date. By contrast, a box of lead pencils loses its value much more slowly through time. These two examples illustrate the obsolescence category of inventory carrying costs and refer to the fact that products lose value through time. Note that some products (e.g., perishables) lose their value much more quickly than others (e.g., pencils).

**Inventory shrinkage** is another component of inventory carrying cost and refers to the fact that more items are recorded entering than leaving warehousing or retailing facilities. Theft—both by employees and customers accounts for a majority of inventory shrinkage. Moreover, despite tremendous advances in technology, administrative error, such as inaccurate inventory counts when receiving shipments, continues to account for approximately 10% of inventory shrinkage.

**TABLE 8.1 Magnitude of Inventory Costs**

<table>
<thead>
<tr>
<th>Year</th>
<th>Value of Business Inventory ($ billion)</th>
<th>Inventory Carrying Cost (%)</th>
<th>Inventory Carrying Cost ($ billion)</th>
<th>Total Logistics Cost ($ billion)</th>
<th>Inventory as a Percentage of Total Logistics Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>2064</td>
<td>19.2</td>
<td>396</td>
<td>1211</td>
<td>32.7</td>
</tr>
<tr>
<td>2011</td>
<td>2184</td>
<td>19.1</td>
<td>418</td>
<td>1282</td>
<td>32.6</td>
</tr>
<tr>
<td>2012</td>
<td>2269</td>
<td>20.1</td>
<td>457</td>
<td>1354</td>
<td>33.8</td>
</tr>
<tr>
<td>2013</td>
<td>2459</td>
<td>19.1</td>
<td>469</td>
<td>1410</td>
<td>33.3</td>
</tr>
<tr>
<td>2014</td>
<td>2495</td>
<td>19.1</td>
<td>476</td>
<td>1450</td>
<td>32.8</td>
</tr>
</tbody>
</table>

Sources: Annual State of Logistics Report, various years, prepared by Rosalyn Wilson for the Council of Supply Chain Management Professionals (www.csclmp.org)

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Another component of inventory carrying costs, storage costs, refers to those costs associated with occupying space in a plant, storeroom, or warehousing facility. Some products have very specialized storage requirements; ice cream, for example, must be stored at a temperature below –20 degrees Fahrenheit. You should recognize that specialized storage requirements, such as refrigeration, result in higher storage costs. Handling costs, another component of inventory carrying costs, involve the costs of employing staff to receive, store, retrieve, and move inventory. Note that specialized storage requirements may also increase handling costs; a refrigerated warehouse requires workers to wear gloves, head coverings, and coats to protect them from the cold temperatures.

Insurance costs, which insure inventory against fire, flood, theft, and other perils, are another component of inventory carrying costs. Insurance costs are not uniform across products; diamonds, for example, are more costly to insure than shampoo. Taxes represent yet another component of inventory carrying costs, and they are calculated on the basis of the inventory on hand on a particular date; considerable effort is made to have that day’s inventory be as low as possible. Finally, interest costs take into account the money that is required to maintain the investment in inventory. In the United States, the prime rate of interest has traditionally provided a convenient starting point when estimating the interest charges associated with maintaining inventory.

Some inventory items have other types of carrying costs because of their specialized nature. Pets and livestock, for example, must be watered and fed. Tropical fish must be fed and have oxygen added to the water in which they are kept. Another cost, although it is generally excluded from carrying cost, is opportunity cost—the cost of taking a position in the wrong materials. This can be an issue for those companies that engage in speculative inventory. Opportunity costs are also incurred by firms that hold too much inventory in reserve for customer demand.

### Ordering Costs

Ordering costs refer to those costs associated with ordering inventory, such as order costs and setup costs. Order costs include, but are not limited to, the costs of receiving an order (for example, the wages of a person who takes orders by telephone), conducting a credit check, verifying inventory availability, entering orders into the system, preparing invoices, receiving payment. Note that a number of the ordering costs involve the order transmittal and order processing components of the order cycle. Setup costs are those necessary to modify production processes to make the products to satisfy particular orders.

### Trade-Off Between Carrying and Ordering Costs

The trade-off that exists between carrying and ordering costs is that they respond in opposite ways to the number of orders or size of orders. That is, an increase in the number of orders leads to higher order costs and lower carrying costs. We’ll illustrate this trade-off with a mathematical example, but before doing so it is necessary to understand how to calculate ordering costs and carrying costs.

Ordering cost can be calculated by multiplying the number of orders per year times the ordering cost per order. Because of the assumption of an even outward flow of goods, inventory carrying costs are applied to one-half of the order size, a figure that represents the average inventory. Average
inventory is multiplied by the carrying costs of the inventory (expressed as a percentage of the dollar value).

Suppose weekly demand is 100 units, order cost per order is $80, the value of an item is $50 and carrying cost is 20% of the value of an item. If we place one order per year for the product,

\[
\text{ORDERING COST} = \text{number of orders per year} \times \text{ordering cost per order} (\$80),
\]
or

\[
\text{ORDERING COST} = 1 \times \$80 = \$80
\]

\[
\text{CARRYING COST} = \text{average inventory} \times (\text{value of the product} \times \text{carrying cost})
\]

\[
\text{CARRYING COST} = 2,600 \times \$10 = \$26,000
\]

Alternatively, look what happens to ordering and carrying costs if we place one order per week:

\[
\text{ORDERING COST} = 52 \times \$80 = \$4,160
\]

\[
\text{CARRYING COST} = 50 \times \$10 = \$500.
\]

### Stockout Costs

If avoiding oversupply were the only problem associated with inventories, the solution would be relatively simple: Store fewer items. However, not having enough items can be as bad as, and sometimes worse than, having too many items. Such costs can accrue during stockouts, when customers demand items that aren’t immediately available.

Although calculation of stockout costs can be difficult and inexact, it is important for organizations to do so because such knowledge can be beneficial when determining how much inventory to hold, keeping in mind that a trade-off must be balanced between inventory carrying costs and stockout costs. Stockout costs, or estimating the costs or penalties for a stockout, involve an understanding of a customer’s reaction to a company being out of stock when a customer wants to buy an item.

Consider the following customer responses to a particular stockout situation. How should they be evaluated?

1. The customer says, “I’ll be back,” and this proves to be so.
2. The customer says, “Call me when it’s in.”
3. The customer buys a substitute product that yields a higher profit for the seller.
4. The customer buys a substitute product that yields a lower profit for the seller.
5. The customer places an order for the item that is out of stock (a back order) and asks to have the item delivered when it arrives.
6. The customer goes to a competitor only for this purchase.
7. The customer goes to a competitor for this and all future purchases.

Clearly, each of these situations has a different cost to the company experiencing a stockout. For example, the loss in situation 1 is negligible because the sale is only slightly delayed. The outcome from situation 2 is more problematic in that the company doesn’t know whether the customer will, in fact, return. Situation 7 is clearly the most damaging, because the customer has been lost for good, and it’s necessary to know the cost of developing a new customer to replace the lost customer. As pointed out in Chapter 7, a commonly used guideline is that it costs five times as much to acquire a new customer as it does to retain an existing one.

To illustrate the calculation of stockout costs, assume for simplicity’s sake that customer responses to a stockout can be placed into three categories: delayed sale (brand loyalty), lost sale
(switches and comes back), and lost customer. Assume further that, over time, of 300 customers who experienced a stockout, 10 percent delayed the sale, 25 percent switched and came back, but the remaining 65 percent were lost for good (see Table 8.3).

The probability of each event taking place can be used to determine the average cost of a stockout. More specifically, as illustrated in Table 8.3, each probability is multiplied by the respective loss to yield an average cost per event. These average costs are then summed, and the result is the average cost per stockout. A delayed sale is virtually costless because the customer is brand loyal and will purchase the product when it becomes available. The lost sale alternative results in a loss of the profit that would have been made on the customer's purchase. In the lost customer situation, the customer buys a competitor's product and decides to make all future purchases from that competitor; the relevant cost involved is that of developing a new customer.

Having an understanding of how to calculate stockout costs highlights several key managerial issues. As a general rule, the higher the average cost of a stockout, the better it is for the company to hold some amount of inventory (safety stock) to protect against stockouts. In addition, the higher the probability of a delayed sale, the lower the average stockout costs—and the lower the inventory that needs to be held by a company. For example, if we switch the probabilities in Table 8.3 for brand loyalty and lost customer (i.e., brand loyal probability is .65, lost customer probability is .10), then the average cost of a stockout becomes $129.25 (as opposed to Table 8.3's $789.25).

**Trade-Off Between Carrying and Stockout Costs**

The trade-off between carrying and stockout costs is that both move in opposite directions—higher inventory levels (hence higher inventory carrying costs) result in lower chances of a stockout (hence lower stockout costs). One way to illustrate this relationship is to look at the trade-offs between levels of safety stock and the number of stockouts prevented, as illustrated in Table 8.4. In this example, we assume that inventory can only be ordered in multiples of 10 and that each unit of inventory is valued at $480 with carrying costs of 25 percent. As a result, the incremental carrying costs of moving from 0 units of safety stock to 10 units of safety stock are \((10 \times 480) \times .25\), or $1,200. Likewise, the incremental carrying costs of moving from 10 to 20 units of safety stock are $1,200.

This example also assumes that the various levels of safety stock prevent a certain number of stockouts. For example, holding 10 units of safety stock for an entire year allows the firm to prevent 20 stockouts; moving from 10 units to 20 units of safety stock allows 16 additional orders to be filled. Using an average cost per stockout of $400, a safety stock of 10 units allows the firm to prevent 20 stockouts, which saves the firm $8,000 ($400 \times 20). The savings of $8,000 is much greater than the additional carrying costs of $1,200, so the firm wants to hold at least 10 units of safety stock. Twenty units of safety stock result in $1,200 of additional carrying costs, whereas the additional stockout costs avoided are $6,400 (16 \times $400). According to the data in Table 8.4, the optimum quantity of safety stock is 70 units. At this point, the cost of 10 additional units of inventory is $1,200, and $1,200 is saved in stockout costs.
WHEN TO ORDER AND HOW MUCH TO ORDER

A key issue with respect to inventory management involves the determination of when product should be ordered; one could order a fixed amount of inventory (fixed order quantity system), or orders can be placed at fixed time intervals (fixed order interval system). In a fixed order quantity system, the time interval may fluctuate while the order size stays constant; for example, a store might always order 200 cases of soft drinks. Its first order might be placed on January 3, a second order placed on January 6 (three-day interval), with a third order placed on January 11 (five-day interval). By contrast, in a fixed order interval system, the time interval is constant, but the order size may fluctuate. For example, suppose a man goes grocery shopping with his wife every Sunday. Although the time interval for shopping is constant at seven days, the shopping list (inventory requirements) differs from week to week.

There needs to be a reorder (trigger) point (i.e., the level of inventory at which a replenishment order is placed) for there to be an efficient fixed order quantity system. Reorder points (ROPs) are relatively easy to calculate, particularly under conditions of certainty; a reorder point is equal to the average daily demand (DD) in units times the length of the replenishment cycle (RC):

$$\text{ROP} = \text{DD} \times \text{RC}$$

Suppose, for example, that average daily demand is 40 units, and the replenishment cycle is 4 days. The reorder point in this example is $40 \times 4$, or 160 units; in other words, when the inventory level reaches 160 units, a reorder is placed.

The reorder point under conditions of uncertainty can be calculated in a similar manner; the only modification involves including a safety stock (SS) factor:

$$\text{ROP} = (\text{DD} \times \text{RC}) + \text{SS}$$

Continuing with the previous example, suppose that the company decides to hold 40 units of safety stock. The reorder point becomes $(40 \times 4) + 40$, or 200 units.

The fact that a fixed order quantity system works best when there is a predetermined reorder point indicates that this system requires relatively frequent, if not constant, monitoring of inventory levels. Under a fixed order quantity system, if sales start to increase, the reorder point will be reached more quickly, and a new order will automatically be placed. In most fixed order interval systems, by contrast, inventory levels are monitored much less frequently—often just before the scheduled order time. The infrequency of inventory monitoring makes the fixed interval system much more susceptible to stockout situations, and one is more likely to see higher levels of safety stock in a fixed interval system. It’s entirely possible that a company could have some of its inventory under a fixed order quantity system, whereas other inventory uses a fixed order interval system.

### TABLE 8.4 Determination of Safety Stock Level

<table>
<thead>
<tr>
<th>Number of Units of Safety Stock</th>
<th>Additional Safety Stock ($480 per Unit)</th>
<th>25% Annual Carrying Cost</th>
<th>Total Value of Incremental Safety Stock</th>
<th>Additional Orders Filled</th>
<th>Stockout Costs Avoided</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>$4,800</td>
<td>$1,200</td>
<td>$1,200</td>
<td>20</td>
<td>$8,000.00</td>
</tr>
<tr>
<td>20</td>
<td>9,600</td>
<td>2,400</td>
<td>1,200</td>
<td>16</td>
<td>6,400.00</td>
</tr>
<tr>
<td>30</td>
<td>14,400</td>
<td>3,600</td>
<td>1,200</td>
<td>12</td>
<td>4,800.00</td>
</tr>
<tr>
<td>40</td>
<td>19,200</td>
<td>4,800</td>
<td>1,200</td>
<td>8</td>
<td>3,200.00</td>
</tr>
<tr>
<td>50</td>
<td>24,000</td>
<td>6,000</td>
<td>1,200</td>
<td>6</td>
<td>2,400.00</td>
</tr>
<tr>
<td>60</td>
<td>28,800</td>
<td>7,200</td>
<td>1,200</td>
<td>4</td>
<td>1,600.00</td>
</tr>
<tr>
<td>70</td>
<td>33,600</td>
<td>8,400</td>
<td>1,200</td>
<td>3</td>
<td>1,200.00</td>
</tr>
</tbody>
</table>
Economic Order Quantity

A long-standing issue in inventory management concerns how much inventory should be ordered at a particular time. The typical inventory order size problem, referred to as the economic order quantity (EOQ), deals with calculating the proper order size with respect to two costs: the costs of carrying the inventory and the costs of ordering the inventory. The EOQ determines the point at which the sum of carrying costs and ordering costs is minimized, or the point at which carrying costs equal ordering costs. More specifically, “The economic order quantity (EOQ) is the quantity of product that will minimize your total costs of inventory per piece.” The nature of carrying costs and ordering costs are presented in Figure 8.1.

The basic EOQ model is grounded in the following assumptions:

1. A continuous, constant, and known rate of demand
2. A constant and known replenishment or lead time
3. A constant purchase price that is independent of the order quantity
4. All demand is satisfied (no stockouts are allowed)
5. No inventory in transit
6. Only one item in inventory or no interaction between inventory items
7. An infinite planning horizon
8. Unlimited capital availability.

Mathematically, the EOQ can be calculated in two ways; one presents the answer in dollars, the other in units. In terms of dollars, suppose that $1,000 of a particular item is used each year, the order costs are $25 per order submitted, and inventory carrying costs are 20 percent. The EOQ can be calculated using this formula:

\[
EOQ = \sqrt{\frac{2AB}{C}}
\]

![Figure 8.1 Determining EOQ Using a Graph](image)

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Where

\[ EOQ = \text{the most economic order size, in dollars} \]

\[ A = \text{annual usage, in dollars} \]

\[ B = \text{administrative costs per order of placing the order} \]

\[ C = \text{carrying costs of the inventory (expressed as an annual percentage of the inventory dollar value)} \]

Thus:

\[ EOQ = \sqrt{\frac{2 \times 1,000 \times 25}{.20}} = \sqrt{250,000} = \$500 \text{ order size} \]

Alternatively, the EOQ can be calculated in terms of the number of units that should be ordered. Using the same information as in the previous example, and assuming that the product has a cost of $5 per unit, the relevant formula is

\[ EOQ = \sqrt{\frac{2DB}{IC}} \]

Where

\[ EOQ = \text{the most economic order size, in units} \]

\[ D = \text{annual demand, in units (200 units; $1,000 value of inventory/$5 value per unit)} \]

\[ B = \text{administrative costs per order of placing the order} \]

\[ C = \text{carrying costs of the inventory (expressed as an annual percentage of the inventory’s dollar value)} \]

\[ I = \text{dollar value of the inventory, per unit} \]

Thus:

\[ EOQ = \sqrt{\frac{2 \times 200 \times 25}{.20 \times 5}} = \sqrt{10,000/1} = 100 \text{ units} \]

Although we’ve calculated EOQs, how do we know that the answers are correct? Because the EOQ is the point where carrying costs equal ordering costs, we need to calculate both of these costs (see Table 8.5). Recall that we calculated $500 (100 units) to be the EOQ. As shown in Table 8.5, a $500 order size means that we’ll be ordering twice per year; the corresponding ordering costs are $50. Average inventory for a $500 order size is $250, meaning that our carrying costs are $50. Thus, we’ve proven that at an order size of $500, our ordering costs and carrying costs are equal. Table 8.5 presents the total cost calculations for several other order sizes. Note that ordering costs equal carrying costs at the EOQ and that the total cost (i.e., sum of ordering costs and carrying costs) is minimized as well.

<table>
<thead>
<tr>
<th>Number of Orders per Year</th>
<th>Order Size ($)</th>
<th>Ordering Cost ($)</th>
<th>Carrying Cost ($)</th>
<th>Total Cost (Sum of Ordering and Carrying Cost ($))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,000</td>
<td>25</td>
<td>100</td>
<td>125</td>
</tr>
<tr>
<td>2</td>
<td>500</td>
<td>50</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>333</td>
<td>75</td>
<td>33</td>
<td>108</td>
</tr>
<tr>
<td>4</td>
<td>250</td>
<td>100</td>
<td>25</td>
<td>125</td>
</tr>
<tr>
<td>5</td>
<td>200</td>
<td>125</td>
<td>20</td>
<td>145</td>
</tr>
</tbody>
</table>
Conditions of Uncertainty

You should recognize that organizations rarely, if ever, are lucky enough to manage inventories in an environment characterized by certainty for all eight of the EOQ assumptions presented above. Consider, for example, how an unexpected event might impact the continuous, constant, and known rate of demand assumption. An excellent illustration involves the 2016 deaths of singer-songwriters David Bowie and Prince; there was a tremendous surge in the sales of their recorded music in the weeks immediately following their deaths.

Because the contemporary business world is characterized by a great deal of uncertainty, the basic EOQ model can be modified to account for one or more conditions of uncertainty. For example, an economic order quantity can be calculated under conditions of demand uncertainty, under conditions of lead time uncertainty, or under conditions of demand and lead time uncertainty. These and other modifications increase the mathematical complexity in calculating an economic order quantity and because of this mathematical complexity are beyond the scope of this text.5

INVENTORY FLOWS

The figures from the fixed order quantity (e.g., EOQ) and the safety stock calculations can be used to develop an inventory flow diagram, which graphically depicts the demand for, and replenishment of, inventory. Figure 8.2 presents an illustration of inventory flow based on the following assumptions: an EOQ of 120 units, safety stock of 60 units, average demand of 30 units per day, and a replenishment or order cycle of 2 days. Further, the beginning inventory is equal to the safety stock plus the EOQ (60 + 120 = 180). Recall from earlier in this chapter that the reorder point can be calculated as (daily demand × replenishment cycle) + (safety stock), or (30 × 2) + (60) = 120 units.

As shown in Figure 8.2, 180 units of inventory are available for sale at the beginning of day 1 (point A). The daily demand of 30 means that 150 units are available for sale at the beginning of day 2, and 120 units are available at the beginning of day 3. Because 120 units represent the reorder point (point B), an order is placed at the beginning of day 3. Because safety stock is not to be used under normal circumstances, reordering at 120 units means that 60 units (safety stock) will be on

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5 A number of supply chain management textbooks contain detailed examples of the EOQ modified for various conditions of uncertainty.
hand 2 days later when the EOQ arrives. The EOQ of 120 units arrives at point C, and then total inventory increases to 180 units at point D.

The rate of sales doubles to 60 beginning on day 5, the reorder point is hit at 120 units at the beginning of day 6 (point E), and another order is placed. Demand continues at 60 units on day 6, meaning that the regular inventory is exhausted, and at point F the safety stock is starting to be used. Demand is also 60 on day 7, leaving us with no inventory (point G) at the end of day 7. The EOQ arrives before opening on day 8, boosting the inventory to 120 units (point H), which is also the reorder point. Beginning on day 8, the demand settles back to 30 units per day.

Continuing with Figure 8.2, from point H, inventory is depleted 30 units on day 8 and 30 more on day 9, leaving the inventory at 60 (point I). The inventory ordered on day 8 arrives prior to opening on day 10, meaning that we have 180 units in stock at the beginning of day 10 (point J). On days 10 and 11, 30 units are demanded; inventory is thus 120 units (point K), and another reorder is placed at the beginning of day 12. Demand is 30 units on days 12 and 13, and inventory has reached 60 units (point L). However, because of a transportation delay, the replenishment cycle is 3 days instead of 2, and instead of arriving at the beginning of day 14, it arrives at the beginning of day 15. Day 14’s demand of 30 units will be satisfied from safety stock (point M), and the EOQ arrives shortly thereafter.

The inventory flow example presented in Figure 8.2 illustrates that safety stock can act as a safeguard against two problem areas: an increased rate of demand and a longer-than-normal replenishment cycle. This example also illustrates that when a fixed order quantity system such as an EOQ is used, the time between orders may vary. As long as demand was normal at 30 units and the replenishment cycle took 2 days, the time between orders was 4 days. However, when sales doubled to 60 units per day, the time between orders fell to 2 days.

As noted earlier in this chapter, one requirement for the utilization of a fixed order quantity system is that the level of inventory must constantly be monitored; when the reorder point is hit, the fixed order quantity is ordered. With continuing technological advances, many firms have the capability to constantly monitor their inventory and hence have the option of using a fixed order quantity system such as the EOQ. A reorder point for each item can be established electronically so it can indicate when the stock has been depleted to the point where a new order should be placed. Increasingly, these orders are transmitted electronically.

INVENTORY MANAGEMENT: SPECIAL CONCERNS

The discussion up to this point illustrates that generalizations concerning inventory management are often hard to make. For example, it might seem like a good idea for a company to strive for minimizing stockouts, except that to actually accomplish this might require inordinately large safety stocks. Alternatively, a fixed order interval policy might be attractive because of its simplicity (e.g., an order is placed every 7 days); however, irregular demand patterns could create either stockouts or overstocks under such a policy. Because of difficulties in generalizing about inventory management, what follows is a discussion of select factors that organizations might face when managing inventories.

ABC Analysis of Inventory

ABC analysis of inventory, which can be applied in several different ways, recognizes that inventories are not of equal value to a firm and that, as a result, all inventory should not be managed in the same way. An individual firm may stock hundreds or thousands of items, and it is a real challenge to determine the relative importance of each item. One common rule of thumb, the 80/20 rule, is that 80 percent of a company’s sales come from 20 percent of its products (conversely, 20 percent of sales come from 80 percent of products). From a managerial perspective, this suggests that the primary focus should be on the 20 percent of products that generate the 80 percent of sales. For example, it might not be in a company’s best interest to store very slow moving inventories in all its warehousing facilities; doing so increases inventory carrying costs.
Measures that can be used to determine ABC status include sales volume in dollars, sales volume in units, the fastest-selling items, item profitability, or item importance. For example, with respect to item importance, a firm supplying medicine to hospitals might need to stock certain items because they are critically important. Thus, in terms of item importance, ABC might be operationalized as follows: A items could be the ones with the highest criticality, B items could be those with moderate criticality, and C items could have low criticality. Similar approaches could be applied to other measures of ABC status such as sales volume in dollars and item profitability.

One issue with ABC analysis involves a determination of what percentage of items should be classified as A, B, and C, respectively. Although there are no right or wrong answers for percentages in this classification scheme, it’s important to recognize that either too high or too low a percentage of A items may reduce the potential efficiencies to be gained from this classification technique.

A second issue with ABC analysis involves how it can be used by managers. One use is that ABC analysis can determine stocking patterns in warehousing facilities. For example, one company achieved a 25 percent space reduction in its logistics network by locating safety stock at only one warehousing facility. In addition, ABC analysis could be used to determine how frequently inventory gets monitored; A items might be checked daily (or, increasingly, hourly), B items weekly, and C items monthly.

Dead Inventory

Some companies have added a fourth category, D, to ABC analysis. D stands for either “dogs” or dead inventory (dead stock), which refers to product for which there are no sales during a 12-month period. Organizations occasionally resort to seemingly desperate measures to manage their dead inventory. Consider the organization with a storage facility located next to a river that flooded on a seasonal basis. During one particularly rainy year, the organization placed all of its dead stock on a deck attached to the storage facility—and discovered one day that the dead stock had been carried away by rising floodwater from the river. Companies can also throw away dead inventory, if for no other reason than to free up space in a warehousing facility. A well-known example of this behavior involved Atari, a video game maker, which in 1983 dumped between 10 and 20 trailerloads of video games at a New Mexico landfill! However, such behavior should only be a last resort, because in so doing a company is, in effect, throwing away money.

Dead inventory increases inventory carrying costs and takes up space in warehousing facilities, and a structured process should be in place for managing it. For example, because dead inventory has often been associated with overproduction of items that customers don’t want (or need), one suggestion would be to make items to order, as opposed to make items to stock. However, an increasing source of dead inventory involves special, highly customized orders that never end up with the customer, perhaps because the customer no longer wants or needs the product. Suggestions for dealing with this situation include partial (or full) prepayment by the customer as well as a no-return policy.

Companies might also market their dead stock more aggressively, perhaps through drastic price reductions or bunching it with more attractive merchandise. Companies might also attempt to sell their dead inventory to companies that specialize in selling such items. Internet sites are available that specialize in selling off dead stock (e.g., deadstockbroker.com). Some dead items can be donated to charitable causes; for example, grocery items that haven’t been sold by their expiration dates are sometimes donated to local food banks.

In some countries, such as the United States, donations of dead inventory to charitable organizations allow businesses to qualify for federal income tax deductions. Other advantages to

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donating dead stock include allowing an organization to focus on its better selling products, freeing up warehousing space, and eliminating the challenges of managing problematic products.9

**Inventory Turnover**

**Inventory turnover** refers to the number of times that inventory is sold in a one-year period, and can be calculated by dividing the cost of goods sold by the average inventory, where average inventory is the sum of beginning and ending inventory divided by 2. For example, suppose the cost of goods sold is $675,000, beginning inventory is $200,000, and ending inventory is $250,000. The inventory turnover for these data is:

\[
\text{COST OF GOODS SOLD} \div \text{AVERAGE INVENTORY} = \left(\frac{\text{beginning inventory} + \text{ending inventory}}{2}\right)
\]

or

\[\frac{675,000}{225,000}, \text{ which equals } 3.\]

Although there is no optimal inventory turnover ratio, inventory turnover figures can provide important insights about an organization’s competitiveness and efficiency. Thus, a particular organization can compare its turnover figures to those of direct competitors or other organizations with “desirable” turnover ratios. With respect to efficiency, low turnover indicates that a company is taking longer to sell its inventory, perhaps because of product obsolescence or pricing problems.10

By contrast, high turnover may signal low inventory levels, which can increase the chance of product stockouts. Despite this, most organizations today strive to increase their inventory turnover. One way to do this is by reducing average inventory. Although reducing average inventory is easier said than done, you should recognize that an understanding of two concepts discussed earlier in this section, ABC analysis and dead inventory, can help reduce average inventory. For example, eliminating some or all of a company’s dead inventory automatically reduces both beginning and ending inventory—hence average inventory is also reduced.

The inventory turnover concept provides an excellent example of trade-offs involving multiple organizational functions such as finance, logistics, and marketing. One illustration of these trade-offs is provided by used-car dealers, who must balance price (marketing), profit (finance), and inventory turnover (logistics). As an example, the used-car dealer that decides to maximize average profit per vehicle will likely charge a higher price for each vehicle, and the higher price might result in a longer selling time, hence slower inventory turnover, for each vehicle.11

**Complementary and Substitute Products**

This book takes a rather narrow view of **complementary products** and defines them as inventories that can be used or distributed together, such as razor blades and razors. These products may only intensify the pressures on retailers or wholesalers concerned with inventory maintenance. For example, consider the following dilemma: “So many complementary items exist for cooking meat and fish that you’ll never be able to display them in the same section (of the store).” Possible complementary products for the meat and fish section include cheeses, seasonings, skewers, skillets, and wines, among others.12

Another issue associated with complementary products involves the amount of inventory to be carried. Purchasing a canister vacuum cleaner, for example, generally means that a customer will periodically need to buy replacement bags for the canister. As such, the canister bags might be slow

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sellers, and some might argue that the bags should be dropped in favor of faster-moving products. Others, however, would point out that the sale and display of these bags is necessary to support the sale of canister vacuums.

**Substitute products** refer to products that can fill the same need or want as another product. The substitutability can occur at a specific product level (e.g., one brand of cola is viewed as a substitute for another brand of cola), or it can occur across product classes (e.g., potatoes may be viewed as a substitute for rice). As pointed out previously in this chapter, knowledge of substitutability has important implications with respect to stockout costs and the sizes of safety stocks to be maintained. Thus, if a consumer has little hesitation in making substitutions, there would appear to be minimal penalties for a stockout. However, a point may be reached where customers become sufficiently annoyed at having to make substitutions that they decide to take their business elsewhere. Because of the many possibilities for substitutability, many grocery chains target in-stock rates of 95 percent for individual stores so that sufficient substitutes exist for a customer to purchase a substitute item rather than go to a competing store.

Moreover, some substitute product decisions are much more challenging than others. Consider, for example, some of the issues that hospitals confront with respect to substitute products:

- What safety risks does a substitute product pose for patients and hospital staff?
- Is the substitute product compatible with current equipment?
- How will information about the substitute product be communicated to hospital staff?
- How do a patient’s insurance requirements impact the ability to use a substitute product?13

It’s also important that companies have a thorough understanding of substitution patterns. For example, in many cases, substitutions are two-way, meaning that if brand A is substitutable for brand B, then brand B is substitutable for brand A. In some situations, however, one-way relationships exist; a bolt 7/16 inch in diameter could be used in place of a bolt that is 1/2 inch in diameter, but the reverse may not hold.

**CONTEMPORARY ISSUES WITH MANAGING INVENTORY**

Much of what has been discussed to this point represents traditional thinking about inventory management. Although traditional thinking about inventory continues to be relevant, this chapter concludes with a look at three contemporary issues with managing inventory—lean manufacturing, service parts logistics, and vendor-managed inventory.

**Lean Manufacturing**

Broadly speaking, *lean manufacturing* (also referred to as *lean*) focuses on the elimination of waste and the increase in speed and flow. The lean manufacturing approach identifies seven major sources of waste, one of which is inventory. Just-in-time (JIT) is one of the best known lean inventory practices. We will take a closer look at JIT in the paragraphs that follow.

From an inventory perspective, the **Just-in-time (JIT) approach** seeks to minimize inventory by reducing (if not eliminating) safety stock, as well as by having the required amount of materials arrive at the production location at the exact time that they are needed. Although the JIT approach is generally associated with inventory management because of its focus on minimizing inventory, the consequences of JIT actually go far beyond inventory management. The JIT approach has a number of important implications for logistical efficiency, one of which is that suppliers must deliver high-quality materials to the production line; because of JIT’s emphasis on low (no) safety stock, defective materials result in a production line shutdown. Improved product quality from suppliers can be facilitated by looking at suppliers as partners, as opposed to adversaries, in the production process.

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JIT emphasizes minimal inventory levels, and as a result, customers tend to place smaller, more frequent orders. As such, it is imperative that suppliers’ order systems be capable of handling an increased number of orders in an error-free fashion. In addition, because the transit-time reliability tends to decrease with distance, suppliers need to be located relatively close to their customers.

The combination of smaller, more frequent shipments and close supplier location means that trucking is an important mode of transportation in the JIT approach. As such, production and distribution facilities should be designed to support truck shipments—that is, there should be truck docks to facilitate product loading and unloading. Although this may appear to be the proverbial “no-brainer,” consider the case of a U.S. manufacturer that designed a state-of-the-art distribution facility to be served by rail, only to switch to a JIT approach, thus making the new facility totally worthless. In fact, some companies involved in JIT have designed their production facilities so that trucks can drive inside them, thus bringing the product that much closer to the actual production point. Figure 8.3 shows a truck trailer that opens on its side for rapid discharge of parts for JIT inventory management.

Other examples of lean inventory include Efficient Consumer Response (ECR), which is associated with the grocery and beverage industries, and Quick Response (QR), which is associated with the apparel industry. Where JIT tends to encompass movement of materials and component parts from supplier to producer, ECR and QR tend to focus on product movement from manufacturer to retailer.
Although lean is an important concept in contemporary logistics, a confluence of events suggests that organizations should carefully consider the potential trade-offs before adopting a lean philosophy. More specifically, the lean philosophy was conceived and nurtured in an environment—local or regional sourcing, fewer man-made or natural disasters, to name two factors—far different from today's environment. For example, today's emphasis on global sourcing translates into longer and more erratic transit times, in part because many shipments are moving by water transportation (which is a slow form of transportation); longer and more erratic transit times don't align very well with lean's emphasis on shipments that arrive exactly when needed. With respect to man-made natural disasters, the August 2015 explosion at China's Port of Tianjin caused tremendous supply chain disruptions—lost inventories, delayed shipments, rerouted shipments—that are antithetical to the lean philosophy.

Service Parts Logistics

Service parts logistics involves designing a network of facilities to stock service parts, deciding upon inventory ordering policies, stocking the required parts, and transporting parts from stocking facilities to customers. Long viewed as an afterthought or—even worse—as a nuisance, service parts logistics has gained greater attention and appreciation in recent years. One reason for this is that the customer expectations associated with service parts logistics continue to increase, particularly in the automotive industry where the maximum customer wait time for repair or replacement parts is one day. Another reason for increased emphasis on service parts logistics is that tepid worldwide economic conditions result in some organizations repairing, rather than replacing, aging or defective equipment.

Service parts logistics creates a variety of potential challenges for logisticians; one challenge is that it can be extremely difficult to forecast the demand for the necessary parts. For example, although companies might have some knowledge about the repair parts needed for routine or preventive maintenance of products, it is virtually impossible to forecast when the product might break down or fail. The difficulties in forecasting demand lead to challenges with respect to which parts to carry, the appropriate stocking levels for the parts that are carried, and higher inventory levels, among others. Another challenge involves the number of warehousing facilities that should be used in service parts logistics. One possibility is to locate the parts at numerous warehousing facilities. This allows the parts to be fairly close to potential customers, and in emergency situations, where time is of the essence, this can be critical to customer satisfaction. Alternatively, the parts could be located at one centralized facility; although this would require use of premium transportation for some shipments, this cost can be offset by the inventory cost savings that result from inventory being held in only one facility.

These and other challenges have led some organizations to outsource their service parts logistics to companies that specialize in this area. For example, UPS, often thought of as a specialist in the delivery of small packages, has expertise in service parts logistics that offers four distinct services to prospective customers—critical order fulfillment; reverse logistics; network and parts planning; test, repair, and refurbish.

This discussion of service parts logistics offers an opportunity to point out the importance of informal considerations when managing inventories and making logistics-related decisions. Some years ago, the owner of an automotive parts distributor became concerned about the amount of inventory his company was holding. A visit to the distributor's storage facility revealed that it was literally overrun with oil filters from one particular manufacturer. This one brand of oil filters accounted for approximately 20 percent of the facility's total inventory, a figure far higher than the brand's actual demand.

17 www.ups-scs.com/logistics/postsales.html
At first glance, the solution seemed clear: Reduce the inventory of oil filters to a level more in line with demand. However, there was a reason for the high inventory of oil filters: The oil filter manufacturer sponsored annual contests that offered all-expenses-paid trips for two to attractive vacation locations such as Hawaii, and the trips were awarded based on the amount of oil filters purchased in a particular time frame. Because the distributor's spouse had become quite fond of these annual trips, each year the owner placed very large orders for that particular brand of oil filters, despite that fact that they weren't needed. As a result, the “obvious” solution to the problem—reducing the inventory of oil filters—wasn’t feasible because the owner wanted to please his spouse. In this situation, personal considerations were more important than professional ones. You must recognize that personal considerations often play a very important role when making decisions in family-run businesses.

**Vendor-Managed Inventory**

In traditional inventory management, the size and timing of replenishment orders are the responsibility of the party using the inventory, such as a distributor or a retailer. Under vendor-managed inventory (VMI), by contrast, the size and timing of replenishment orders are the responsibility of the manufacturer. Operationally, VMI allows manufacturers to have access to a distributor's or retailer's sales and inventory data, and this access is accomplished electronically by electronic data interchange (EDI) or the Internet. Although VMI is often associated with consumer products, it also has been applied to industrial products such as airplanes, construction equipment, fasteners (e.g., bolts, screws), and heating and cooling systems, among others.

VMI represents a huge philosophical shift for some organizations in the sense that they are allowing another party to have control over their inventories. This is a situation that necessitates tremendous trust on the part of distributors and retailers because of the potential for unscrupulous manufacturers to abuse the system by pushing unneeded inventories onto downstream parties.

One potential benefit to VMI is better inventory management in the sense that vendors might be more proficient than their customers at managing inventories. VMI often leads to fewer stockouts. VMI can allow vendors to do a better job of supplying their customers because VMI gives vendors more control over when and how inventory is shipped to customers. Alternatively, one drawback to VMI is inadequate data sharing between the relevant parties, in part because of trust and control concerns. In addition, organizations that adopt VMI must recognize that the process will not produce immediate benefits and that its adoption will likely result in some errors in the short run.

**Summary**

Inventory is a key component in logistics because inventory decisions are often a starting point for other business activities. The chapter began with a look at the various classifications of inventory, followed by a discussion of inventory costs. When deciding what levels of inventories to maintain, companies try to minimize the costs associated with both too much and too little inventory. Too much inventory leads to high inventory carrying costs; too little inventory can lead to stockouts and the associated stockout costs. The worst outcome of a stockout is to lose both a sale and all future business from the customer.

The chapter also addressed when to order inventory, as well as how much inventory to order. We learned that reorder points signify stock levels at which a new order should be placed. With respect to how much to order, the economic order quantity (EOQ) minimizes ordering costs and inventory carrying costs.

The chapter looked at special concerns associated with inventory management, including ABC analysis and inventory turnover. We learned that an understanding of ABC analysis can help organizations increase their inventory turnover. The chapter concluded with a discussion of several contemporary issues associated with managing inventory.

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18 http://ramproducts.com/advantages-disadvantages-vendor-managed-inventory/

Key Terms

- ABC analysis of inventory
- Back order
- Complementary products
- Cycle (base) stock
- Dead inventory (dead stock)
- Economic order quantity (EOQ)
- Fixed order interval system
- Fixed order quantity system
- Inventory
- Inventory carrying (holding) costs
- Inventory shrinkage
- Inventory turnover
- Just-in-time (JIT) approach
- Lean manufacturing (lean)
- Ordering costs
- Pipeline (in-transit) stock
- Psychic stock
- Reorder (trigger) point
- Safety (buffer) stock
- Service parts logistics
- Speculative stock
- Stockout costs
- Substitute products
- Vendor-managed inventory (VMI)

Questions for Discussion and Review

8.1 How might different organizational functions have different inventory management objectives?

8.2 What makes it difficult for managers to achieve the proper balance of inventory?

8.3 Distinguish among cycle, safety, pipeline, and speculative stock.

8.4 Define what is meant by inventory carrying costs and list its primary components.

8.5 What are ordering costs? What is the tradeoff between inventory carrying costs and ordering costs?

8.6 Discuss the concept of stockout costs. How can stockout costs be calculated?

8.7 Distinguish between a fixed order quantity and a fixed order interval system. Which one generally requires more safety stock? Why?

8.8 Explain the logic of the EOQ model.

8.9 What assumptions are associated with the EOQ model?

8.10 How can inventory flow diagrams be useful to a logistics manager?

8.11 Discuss what is meant by ABC analysis of inventory. Name several measures that can determine ABC status.

8.12 Define what is meant by dead inventory. What are several ways to manage it?

8.13 In what ways can inventory turnover provide important insights about an organization’s competitiveness and efficiency?

8.14 Discuss some of the managerial challenges that complementary products present.

8.15 What are substitute items? How might they affect safety stock policies?

8.16 How might a hospital’s decisions regarding substitute products differ from a supermarket’s decisions regarding substitute products?

8.17 How do the consequences of JIT go far beyond inventory management?

8.18 Why should organizations carefully consider potential trade-offs before adopting a lean philosophy?

8.19 Discuss some challenges that service parts logistics creates for logistics managers.

8.20 How does vendor-managed inventory differ from traditional inventory management?

Suggested Readings


Stanger, Sebastian H.W., Richard Wilding, Nicky Yates, and Sue Cotton. “What Drives Perishable Inventory Manage-
CASE

CASE 8.1 LOW NAIL COMPANY

After making some wise short-term investments at a race track, Chris Low had some additional cash to invest in a business. The most promising opportunity at the time was in building supplies, so Low bought a business that specialized in sales of one size of nail. The annual volume of nails was 2,000 kegs, and they were sold to retail customers in an even flow. Low was uncertain how many nails to order at any time. Initially, only two costs concerned him: order-processing costs, which were $60 per order without regard to size, and warehousing costs, which were $1 per year per keg space. This meant that Low had to rent a constant amount of warehouse space for the year, and it had to be large enough to accommodate an entire order when it arrived. Low was not worried about maintaining safety stocks, mainly because the outward flow of goods was so even. Low bought his nails on a delivered basis.

QUESTIONS

1. Using the EOQ methods outlined in the text, how many kegs of nails should Low order at one time?

2. Assume all conditions in question 1 hold, except that Low’s supplier now offers a quantity discount in the form of absorbing all or part of Low’s order-processing costs. For orders of 750 or more kegs of nails, the supplier will absorb all the order-processing costs; for orders between 249 and 749 kegs, the supplier will absorb half. What is Low’s new EOQ? (It might be useful to lay out all costs in tabular form for this and later questions.)

3. Temporarily, ignore your work on question 2. Assume that Low’s warehouse offers to rent Low space on the basis of the average number of kegs Low will have in stock, rather than on the maximum number of kegs Low would need room for whenever a new shipment arrived. The storage charge per keg remains the same. Does this change the answer to question 1? If so, what is the new answer?

4. Take into account the answer to question 1 and the supplier’s new policy outlined in question 2 and the warehouse’s new policy in question 3. Then determine Low’s new EOQ.

5. Temporarily, ignore your work on questions 2, 3, and 4. Low’s luck at the race track is over; he now must borrow money to finance his inventory of nails. Looking at the situation outlined in question 1, assume that the wholesale cost of nails is $40 per keg and that Low must pay interest at the rate of 1.5 percent per month on unsold inventory. What is his new EOQ?

6. Taking into account all the factors listed in questions 1, 2, 3, and 5, calculate Low’s EOQ for kegs of nails.
Facility location is a logistics/supply chain activity that has evolved from a tactical decision to one of tremendous strategic importance in numerous organizations. In particular, this chapter discusses facility location, which refers to choosing the locations for distribution centers, warehouses, and production facilities to facilitate logistical effectiveness and efficiency. We begin with an overview of the location process, followed by a discussion of the strategic importance of facility location. Next we discuss how to determine the optimum number of facilities. We then look at general and specific influences on facility location. We next describe several basic techniques for choosing general locations. We conclude with a discussion of facility relocation and facility closing.

The location decision process involves several layers of screening or focus, with each step becoming a more detailed analysis of a smaller number of areas or sites. The initial focus is on the region, the delineation of which can vary depending on whether a company has a multinational or domestic focus. Thus, a multinational company might initially focus on a region of the world, such as Western Europe, the Pacific Rim, or North America. By contrast, a domestic focus might target a state (province/territory) or group of states (provinces/territories).

The next focus is more precise; it usually involves a selection of the area(s) in which the facility will be located; once this has been determined, a detailed examination of various locations within the selected area is appropriate. This detailed examination should include a physical inspection of the location as well as a thorough analysis of relevant zoning and regulatory considerations. Failure to take these measures can result in costly—and potentially embarrassing—mistakes, as illustrated by the unfortunate experience of a supermarket chain.

The company picked a site for a new grocery store, obtained the appropriate construction permits, built the store, hired relevant personnel, and stocked the store with products. Several days before the store’s grand opening, the parent company was threatened with legal action by a competing supermarket that had a store located across the street from the new store. The legal action referred to the relevant zoning laws—which had not been checked prior to beginning construction—that prohibited any new grocery store from being built within a one-mile radius of the existing grocery store! As a result, the supermarket chain had to cancel its grand opening, close the brand-new store, transfer the products to other stores, and lay off many of the newly hired personnel.1

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1 Example drawn from one author’s personal experience.
THE STRATEGIC IMPORTANCE OF FACILITY LOCATION

Logistics managers face a marketplace that is dynamic and ever-changing. This dynamism and change are two reasons why facility location has evolved from a tactical to a strategic consideration. Facilities such as manufacturing plants and warehousing represent fixed points where goods are produced, processed, assembled, or stored. Because these facilities can be very expensive to lease or build, companies are often hesitant to close them. However, poorly located facilities can negatively impact logistical effectiveness (e.g., due to longer and less reliable delivery times) and efficiency (e.g., due to increased delivery costs). This section discusses several overarching factors that can influence facility location decisions.

Cost Considerations. Cost considerations are hardly new to logistics managers. You will recall from Chapter 1 that the systems approach to logistics is predicated on the total costs of various logistics activities. Today's cost considerations arise because many consumers have become sensitized to buy products only when prices are low, due in part to lingering effects from the 2007–2009 recession. Businesses have also contributed to consumer fixation with low prices, as illustrated by the following quote: “Price cuts are like management heroin. They’re addictive. Customers develop a craving for big discounts and an aversion to full prices.” If retailers offer consistently low prices, then their costs must also be consistently low for organizations to be profitable.

For many years, this low price/low cost framework led many companies to manufacture in countries characterized by plentiful and low-cost labor. In recent years, however, some organizations, particularly those with more than $1 billion (U.S. dollars) in sales, are reexamining the low-cost labor paradigm. For one, low-cost labor countries are often located long distances from consumer markets, which means longer order cycles due to long transit times. Second, several low-cost labor countries have experienced workplace disasters, such as fires and building collapses, in which many workers died and many others were injured. Furthermore, some traditionally low-cost labor countries, such as the People's Republic of China (China), are no longer considered sources of low-cost labor.

As a result, organizations are reconfiguring their network designs. The rising labor costs in China have caused some companies to move production to lower-cost Asian-Pacific countries such as Vietnam and Laos. Alternatively, some organizations have adopted nearsourcing, in which companies reconfigure their logistics networks to bring some production facilities closer to key consumer markets. For example, Mexico is the most popular location for nearsourcing among companies that do business in North America.

Customer Service Expectations. One point that has been repeatedly emphasized in this text is that customer service expectations continue to increase over time. We know, for example, that today’s customers are looking for faster and more reliable order cycles, but how are faster and more reliable order cycles operationalized from a facility location perspective? Should an organization rely on one or two facilities to serve its customers, or should it rely on multiple facilities to serve them? The former alternative leads to fewer facilities and lower inventory costs, but higher transportation costs; the latter leads to more facilities and higher inventory costs, but lower transportation costs. When the online retailer Amazon began operations in the mid-1990s, it serviced orders from more than 120 fulfillment centers located in the United States, Europe, and Asia.

Location of Customer or Supply Markets. Improvements in transportation and technology (e.g., air conditioning) allow consumers to migrate relatively easily from one region or country to another. An example of such migration can be seen in Table 9.1, which lists the five most populous countries.
states in the United States in 1970, 1990, and 2014. Note that in 1970, three of the five most populated states were located in the Northeast and Midwest, and thus in relatively close geographic proximity. By 2014, the most populous states were located in the West, Southwest, Southeast, Northeast, and Midwest, respectively—and thus are much more geographically diverse than in 1970. This population shift necessitates different production and distribution facility locations than in the 1970s. Cities like Atlanta, Dallas, and Reno (Nevada) are today important distribution hubs in the United States.

Economic growth is another variable that influences the location of customer markets; organizations sometimes expand their geographic scope to serve new customers. From purely a population perspective, China and India have been potentially attractive markets because the two countries account for approximately one-third of the world’s population. What makes China and India even more attractive today is that both are experiencing tremendous growth in the number of middle-class families—families that often prefer name-brand western goods and services.

For example, Starbucks, which at the beginning of 2016 operated approximately 2,000 stores in China, plans to open 500 new stores per year there through 2020. In addition to selecting the new store locations, the new stores will need to be supplied with coffee and foodstuffs, which may necessitate additional distribution facilities to be located in China. This expansion also highlights supply location issues, such as will Starbucks use current, or new, suppliers for the new stores? The use of current suppliers would allow Starbucks to work with familiar companies, but will these companies be capable of meeting ramped-up supply considerations? Alternatively, new suppliers might be able to meet Starbucks’ supply considerations, but Starbucks will need to learn how to work with the new suppliers.

The sustainability concept is another strategic consideration that can potentially impact the location of supply markets. You might recall from Chapter 1 that sustainability refers to products that meet present needs without compromising the ability of future generations to meet their needs. A key sustainability issue involves the sourcing of products and an emerging concept involves a locavore strategy, that is, purchasing locally grown or produced foods. A locavore strategy is desirable from a sustainability perspective because it minimizes the transportation of products (thus reducing air pollution) and allows one to support a local economy. Locavore suppliers also tend to limit their use of harmful chemicals in producing food.

### DETERMINING THE NUMBER OF FACILITIES

Few firms start business on one day and have a need for large-scale production and distribution the next day. Rather, distribution and production facilities tend to be added (or subtracted) over time, as needed. The need for additional distribution and production facilities often arises when an organization’s service performance from existing facilities drops below “acceptable” levels. Retailers, for example, might add a distribution center when some of its stores can no longer consistently

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be supplied within two days by existing facilities. Alternatively, expansion into new markets might require additional distribution and/or production facilities.

Most analytical procedures for determining the number of facilities are computerized because of the vast number of permutations involved and the complementary relationships between current facilities in a distribution network. Analyzing, for example, whether an organization with 250 stores and five distribution centers should add or remove one distribution center is challenging enough in and of itself. Factoring in that each distribution center is designed to serve a specific number of retail locations—and may serve as a backup to one or more of the other distribution centers—makes the decision even more complex. Furthermore, conducting sensitivity analysis on varying levels of customer service could result in an entirely different series of ideal facility locations, depending on the level of customer service that is expected.

Fortunately, a number of software packages are available that help organizations determine both the number and location of facilities in their logistics networks. “Chicago Consulting, for example, annually develops “The 10 Best Warehouse Networks,” which provides suggested locations for companies looking to serve the U.S. population with between one and 10 distribution centers, and Chicago Consulting has developed a similar warehouse network for China (see Figure 9.1) looking to serve the U.S. population with between one and ten distribution facilities. Although this network only looks at one component in location (how long it takes to get from a particular city—or cities—to the majority of the country’s population), the network is valuable in highlighting trade-offs between the number of facilities and transit time considerations. “For example, Figure 9.1 indicates that going from two to five warehouses in China allows a company to save nearly one day of lead time. By contrast, moving from five to ten warehouses saves a bit less than one-half day in lead time.’’

**GENERAL FACTORS INFLUENCING FACILITY LOCATION**

Tangible products are the combination of raw materials, component parts, and labor—with the mixture varying from product to product—made for sale in various markets. Thus, raw materials, component parts, labor, and markets all influence where to locate a manufacturing, processing, or assembly facility. Warehouses, distribution centers, and cross-docking facilities exist to facilitate the distribution of products. Their locations are in turn influenced by the locations of plants whose products they handle and the markets they serve.

The discussion that follows covers the location of manufacturing, processing, assembly, and distribution facilities along the supply chain. The relative importance of each factor varies with the type of facility, the product being handled, its volume, and the geographic locations being considered. Although much of the discussion deals with single facilities, the decision process often involves a combination of facilities, in which case one must take into account the relationships among them.

**Natural Resources**

The materials used to make a product must be extracted directly from the ground or sea (as in the case of mining or fishing) or indirectly (as in the case of farm products). In some instances, these resources may be located great distances from the point where the materials or their products will be consumed. For materials that lose no weight in processing, known as pure materials, the processing point can be anywhere near the raw material source and the market.

However, if the materials must be processed at some point between where they are gathered and where they are needed, their weight-losing or weight-gaining characteristics become important for facility location. If the materials lose considerable weight in processing, known as weight-losing products, then the processing point should be near the point where they are mined or harvested, largely to avoid the payment of unnecessary transportation charges. If the raw materials gain weight...

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**Learning Objective 9.3**
### THE 10 BEST CHINESE WAREHOUSE NETWORKS

Networks with the Lowest Possible "Time-to-the-Chinese Population"

<table>
<thead>
<tr>
<th>Number of</th>
<th>Average Distance to the Chinese Population (Miles)</th>
<th>Average Transit Lead-Time to the Chinese Population (Days)</th>
<th>Best Warehouse Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>ONE</td>
<td>504</td>
<td>3.38</td>
<td>XINYANG</td>
</tr>
<tr>
<td>TWO</td>
<td>377</td>
<td>2.55</td>
<td>LIANYUAN FEICHENG</td>
</tr>
<tr>
<td>THREE</td>
<td>309</td>
<td>2.15</td>
<td>PINGXIANG JINAN ZIYANG</td>
</tr>
<tr>
<td>FOUR</td>
<td>265</td>
<td>1.87</td>
<td>PINGXIANG JINING ZIYANG</td>
</tr>
<tr>
<td>FIVE</td>
<td>228</td>
<td>1.65</td>
<td>SHAOGUAN CHANGCHUN</td>
</tr>
<tr>
<td>SIX</td>
<td>207</td>
<td>1.53</td>
<td>SHAOGUAN CHANGCHUN HANDAN NANJIANG URUMQI ZIYANG</td>
</tr>
<tr>
<td>SEVEN</td>
<td>184</td>
<td>1.42</td>
<td>GUANGZHOU CHANGCHUN HONGHU Urumqi</td>
</tr>
<tr>
<td>EIGHT</td>
<td>168</td>
<td>1.31</td>
<td>GUANGZHOU CHANGCHUN HONGHU YIBIN URUMQI</td>
</tr>
<tr>
<td>NINE</td>
<td>154</td>
<td>1.24</td>
<td>BEILIU CHANGCHUN YUEYANG LIAOCHENG YIXING BAOJI YIBIN URUMQI</td>
</tr>
<tr>
<td>TEN</td>
<td>141</td>
<td>1.20</td>
<td>BEILIU CHANGCHUN YUEYANG TIANJIN KAI FENG YIXING BAOJI YIBIN ZHANGZHOU</td>
</tr>
</tbody>
</table>

The 10 Best Chinese Warehouse Networks have been developed based on the lowest possible transit lead-times to "customers" represented by the Chinese population. For example, Xinyang provides the lowest possible lead-time for one warehouse. Any other place will increase transit lead-time to the Chinese population. Similarly putting any three warehouses in any locations other than Pingxiang, Jinan or Ziyang will cause the transit lead-time to be higher than 2.15 days.

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**Figure 9.1** Chicago Consulting's 10 Best Warehouse Networks  
*Source: Courtesy of Terry Harris, Managing Partner of Chicago Consulting.*

In processing, known as **weight-gaining products**, then the processing point should be close to the market. Sugar derived from sugar beets provides an example of a weight-losing product (a yield of roughly 1 pound of sugar from 6 pounds of sugar beets), whereas bottled soft drinks are an example of a weight-gaining product.

In addition to its use for bottling, water (of one type or another) is a requirement for the location of many facilities. For some industrial processes, water is used for cooling, and in some
climates it is possible to use naturally flowing water for air conditioning during warm months. Some processing operations require water both for cleaning purposes and as a medium for carrying away waste. Water is also necessary for fire protection; the fire insurance premiums charged depend on the availability of some type of water supply.

Land requirements are another natural resource consideration in facility location, and distribution and production facilities may require large parcels of land to facilitate effective and efficient operations. For example, in 2014 Rooms To Go, a retailer that specializes in home furniture and décor, purchased 100 acres of land to build a 1.1-million-square-foot distribution center. In general, real estate tends to be more plentiful and less costly in more rural locations—locations that might not have adequate transportation or labor resources.

Historically, the relationship between natural resources and facility location revolved around how the natural resources would be incorporated into products making their way toward consumers. Over the past quarter century, however, discussion of natural resources and facility location has increasingly factored in environmental and sustainability considerations. One set of considerations involves the various types of pollution, namely, air, noise, and water, while another environmental consideration involves the conservation of natural resources.

### Population Characteristics—Market for Goods

Population can be viewed as both a market for goods and a potential source of labor. Customer considerations, particularly as they affect customer service, play a key role in where consumer goods companies tend to locate their distribution facilities. In fact, the popular press is replete with stories involving distribution facilities being located in a particular area so that companies can better serve their current and potential customers.

Planners for consumer products pay extremely close attention to various attributes of current and potential consumers. Not only are changes in population size of interest to planners, but so also are changes in the characteristics of the population—particularly as those characteristics influence purchasing habits. With respect to population characteristics, longer life spans can increase the demand for health-related products such as prescription medications.

In an effort to learn more about population size and characteristics, many countries conduct a detailed study, or census, typically once every 10 years or so. Although census methodologies and the type of information collected often vary across countries, the resulting data can provide valuable insights for distribution planners in terms of where populations are growing and at what rates. For example, Nigeria, the world’s seventh most populous country in 2010 (approximately 159 million residents), is expected to be home to nearly 260 million residents by 2030—representing a population increase of more than 60 percent in 20 years.

### Population Characteristics—Labor

Labor is a primary concern in selecting a site for manufacturing, processing, assembly, and distribution. Organizations can be concerned with a number of labor-related characteristics: the size of the available workforce, the unemployment rate of the workforce, the age profile of the workforce, its skills and education, the prevailing wage rates, and the extent to which the workforce is, or might be, unionized. These and other labor characteristics should be viewed as interrelated rather than as distinct attributes. For example, there may be a positive relationship between the age of the workforce and the prevailing wage rates (i.e., higher wage rates may be associated with an older workforce). Alternatively, there may be an inverse relationship between unemployment and wages (i.e., higher unemployment rates may be associated with lower relative wage rates).

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10 [www.unfpa.org](http://www.unfpa.org)
Labor wage rates are a key locational determinant as supply chains become more global in nature. For example, hourly compensation data (including benefits) among manufacturing firms in 2012 indicate average compensation of $63.36 in Norway, $45.79 in Germany, and $35.67 in the United States. By contrast, hourly compensation rates were $9.46 in Taiwan, $6.36 in Mexico, and $2.10 in the Philippines.\(^{11}\)

Thus, in relative terms, a company could have approximately similar compensation costs by hiring either six Mexican workers or one U.S. worker. This wage differential at least partly explains the popularity of the maquiladora plants, assembly plants located just south of the U.S.–Mexican border. These plants, which began in the mid-1960s, provided much needed jobs to Mexican workers and allowed for low-cost, duty-free production so long as all the goods were exported from Mexico. Maquiladoras continue to be popular today in part because of a substantial narrowing of the wage gap between Mexico and China in recent years. In addition, Mexican maquiladoras can deliver orders to U.S. customers within a week—compared to upwards of four weeks if goods were manufactured in China.\(^{12}\)

Companies interested in locating in countries with low-cost labor should recognize that there are sometimes limits to the number of supervisory personnel that can be brought in from other countries. The host country’s government may also insist that its own nationals be trained for and employed in many supervisory posts. In addition, countries with low-cost labor may house a multitude of sweatshops, which can be viewed as organizations that exploit workers and that do not comply with fiscal and legal obligations toward employees. Although sweatshops have often been associated with the toy, textile, and apparel industries, the electronics industry is a prominent sweatshop industry in the twenty-first century. Key shortcomings in the electronics industry include violations of working hours and days of rest provisions, violations of wage and benefits agreements, and discriminatory practices based on sex or age.\(^{13}\)

A workforce's union status is also a key locational determinant for some organizations. From management’s perspective, unions tend to result in increased labor costs, due to higher wages, and less flexibility in terms of job assignments, which often forces companies to hire additional workers. As a result, some organizations prefer geographic areas in which unions are not strong; in the United States, for example, some states have right-to-work laws, which mean that an individual cannot be compelled to join a union as a condition of employment. Indeed, in 2012, Airbus, the European-based commercial aircraft manufacturer, chose the right-to-work state of Alabama for the location of its first U.S. assembly plant.

However, the mere presence of a union doesn’t necessarily mean that the union is a strong advocate for workers. Consider that the All China Federation of Trade Unions (ACFTU), which represents over 275 million Chinese workers, is controlled by the Chinese government. As such, the ACFTU sometimes faces conflicting objectives when confronted with deciding what’s good for the government versus what’s good for the workers—and the workers’ concerns aren’t always the top priority.\(^{14}\)

Racial, ethnic, and cultural considerations may also be important population characteristics that factor into facility location decisions. Organizations are sometimes hesitant to establish facilities in areas that are not racially, ethnically, or culturally diverse because of the difficulty in attracting workers to transfer to such locations. Not surprisingly, organizations often provide very generous incentive packages to entice workers to move to more problematic locations.

Employees who are sent to other countries for extended periods of time are known as expatriate workers. These workers often present unique managerial challenges. For example, expatriate

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11 www.bls.gov/ibs/ichcc.pdf
assignments can be costly, ranging up to $1 million per assignment, and turnover rates can run between 20 and 40 percent. What makes the expatriate situation relevant to the current discussion is that the turnover tends to be caused by socialization rather than technical (i.e., employee knowledge and skills) factors. Indeed, a leading cause of expatriate turnover involves health-related issues of family members that cannot be addressed in the country of assignment.15

**Taxes and Incentives**

Although labor considerations are important for location decisions, taxes can also be important, particularly with respect to warehousing facilities. Warehousing facilities, and the inventories they contain, can be a prime source of tax revenues for the relevant taxing organizations. From a community’s standpoint, warehousing facilities are desirable operations to attract because they add to the tax base while requiring relatively little in the way of municipal services. No list of taxes is complete; a partial list includes sales taxes, real estate taxes, corporate income taxes, corporate franchising taxes, fuel taxes, unemployment compensation taxes, social security taxes, and severance taxes (for the removal of natural resources).

Of particular interest to logisticians and supply chain managers is the **inventory tax**, analogous to personal property taxes paid by individuals. As a general rule, the inventory tax is based on the value of inventory that is held on the assessment date(s). Not surprisingly, many logistics managers strive to keep their inventories as low as possible on the assessment date(s), and businesses may offer sales to reduce their inventory prior to the assessment date.

Fewer than 15 U.S. states currently assess inventory taxes. Their relevance to the current discussion is that inventory taxes can inhibit facility investment as well as discourage facility expansion within a state that levies inventory taxes. The application of inventory taxes is far from uniform in the sense that inventory can be assessed different values depending on the applicable methodology (e.g., valuation on the basis of first in, first out versus last in, first out). In addition, exemptions from what inventory is taxed can differ from state to state. For example, some states exempt goods that are stored in public warehouses; some states exempt goods passing through the state on a storage-in-transit bill of lading.

As if business taxes are not difficult enough to understand, they represent only one side of the coin; the other side is to know the value of services being received in exchange for the taxes. A general rule of thumb is that the services received represent only about 50 percent of the taxes paid, and this imbalance may cause businesses to invest more money to receive the required level of service. For example, inadequate police services might cause a warehousing facility to hire its own security force.

To further complicate matters, governments may offer incentive packages as an inducement for firms to locate facilities in a particular area. To give you an example of the potential magnitude of incentive packages, in early 2016 the state of Massachusetts provided General Electric with approximately $145 million in incentives to move its corporate headquarters to Boston from out of state. The $145 million incentive package included property tax breaks as well as funding for new roads and parking spaces.16

**Transportation Considerations**

Transportation considerations in the form of transportation availability and costs are a key aspect of facility location decisions because transportation often represents such a large portion of total logistics costs. Indeed, the accessibility of highway transportation often ranks as one of the most impor-

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tant criteria in facility location and its importance has increased as more and more companies strive
to reduce product delivery times.\textsuperscript{17}

Transportation availability refers to the number of transportation modes (\textit{intermodal competition}) as well as the number of carriers within each mode (\textit{intramodal competition}) that could serve a proposed facility. The evaluation of transportation availability is likely to depend on the type of facility that is being considered. For example, a manufacturing plant might need both rail service (to bring in raw materials) and truck service (to carry the finished goods), whereas a distribution center might need just truck service.

As a general rule, the existence of competition, whether intermodal, intramodal, or both, tends to have both cost and service benefits for potential users. Limited competition generally leads to higher transportation costs and means that users have to accept whatever service they receive. Thus, a poor location can significantly increase transportation costs as well as negatively affect customer service.

Geographically central facility locations are often the result of transportation costs and service considerations. With respect to transportation costs, centralized facilities tend to minimize the total transit distances, which likely results in minimum transportation costs. A centralized location can also maximize a facility's service area, as shown in Figure 9.2, which illustrates truck distances from the state of Nebraska. Note how many states are located within 1,000 miles (generally considered two-day service by truck) of Nebraska.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Figure92.png}
\caption{Truck Distances from Nebraska} \textit{Source: Reprinted with permission from Inbound Logistics magazine (September 2011). www.inboundlogistics.com/subscribe. Copyright Inbound Logistics 2014.}
\end{figure}

\textsuperscript{17} Beth Mattson-Teig, “Top Site Selection Factors: Highway Accessibility—the Need for Speed,” \textit{Area Development Online}, November 2011.
Part III • Elements of Logistics Systems

Proximity to Industry Clusters

When looking at facility location considerations, early business logistics textbooks discussed the agglomeration concept, which “refers to the net advantages which can be gained by a sharing of common locations by various enterprises.”\(^\text{18}\) Although agglomeration continues to be a key factor in facility location, it is better known today as the industry cluster concept. Industry clusters differ in size and shape and, not surprisingly, one type is focused on a particular industry. Silicon Valley, a collection of high-technology firms located in the southern part of San Francisco, California, is a well-known cluster based on a particular industry.

Another type of cluster offers organizations proximity to key suppliers. Proximity to key suppliers has been the catalyst in the development of supplier parks, a concept that developed around automakers and their suppliers in Europe and has spread to other continents, including North America. Key suppliers locate on the site of, or adjacent to, automobile assembly plants, which helps reduce shipping costs and inventory carrying costs.

Industry clusters can provide potential advantages to prospective participants in terms of facility and transportation considerations. With respect to facilities, the relative proximity of manufacturers in a particular cluster could allow for capacity pooling in the sense that a manufacturer with excess capacity could produce goods for a manufacturer with an excess of orders. From a transportation perspective, industry clusters could allow for faster and more consistent delivery, particularly in the case of supplier parks where many suppliers are located a short distance from their customer(s). Inbound and outbound transportation costs could also be lower in industrial clusters; lower inbound transportation costs result from volume purchases of inbound goods while lower outbound transportation costs result from volume shipments of finished goods.\(^\text{19}\)

Trade Patterns

As pointed out earlier in this chapter, firms producing consumer goods follow changes in population to better orient their distribution systems—and there are shifts in the markets for industrial goods as well. General sources of data regarding commodity flows can be studied, much like population figures, to determine changes occurring in the movement of raw materials and semiprocessed goods. The availability and quality of such data often vary from country to country, and it may be difficult to compare data across countries because of different methodologies used to collect the data.

With respect to commodity flows, logisticians are especially interested in (1) how much is being produced and (2) where it is being shipped. If a firm is concerned with a distribution system for its industrial products, this information would tell how the market is functioning and, in many instances, how to identify both the manufacturers and their major customers. At this point, the researcher would understand the existing situation and would try to find a lower-cost production–distribution arrangement.

The development and implementation of multicountry trade agreements have generated profound impacts on trade patterns. For example, the United States, Canada, and Mexico are part of the North American Free Trade Agreement (NAFTA). Although Canada has long been the largest trading partner of the United States, since NAFTA’s passage, Mexico has become the United States’ third-largest trading partner. From a logistics perspective, this has increased the north–south movement of product, and the Interstate 35 corridor (which runs north–south between Mexico and Canada) has become a hotbed for distribution activity. Oklahoma City, Oklahoma, and Dallas, Texas, are two locations along Interstate 35 that have seen a dramatic increase in the construction of distribution facilities.


Trade patterns have also been influenced among those countries that are members of the European Union (EU). When the EU consisted of 15 countries, the central location and strong transportation infrastructures of the so-called “Benelux” countries (Belgium, the Netherlands, and Luxembourg) were a favored location for distribution facilities to serve EU countries, and many companies operated only one distribution facility to serve their EU customers. However, the EU’s expansion into Central and Eastern European countries has substantially increased the EU’s geographic footprint. The vast geographic territory of the expanded EU has caused many companies to operate one major distribution facility and several regional facilities to serve their EU customer base. In addition, as EU expansion has pushed eastward, Poland and the Czech Republic have become favorite distribution sites because of their relatively central geographic location.20

Quality-of-Life Considerations

An increasingly important locational factor is what can broadly be called quality-of-life considerations, which incorporate nonbusiness factors into the business decision of where to locate a plant or distribution facility. Indeed, one branding expert argues that in the twenty-first century quality of life is the leading reason why businesses located in a particular area.21 Examples of quality-of-life factors include cost of living, educational opportunities, crime rates, employment opportunities, the weather, and cultural amenities, among others.

There are a number of reasons for including quality-of-life considerations as a factor in facility location. First, employees who are able to live a reasonable lifestyle tend to be happier and more loyal; happy and loyal employees are less likely to leave their jobs and less likely to offend prospective customers. Second, because many organizations now compete nationally and internationally for talent, less-than-desirable geographic locations might hinder the recruiting process. Quite simply, the quality of life in a region—is it a nice place to live?—impacts both employee retention and the ability to attract new employees.22

Locating in Other Countries

The general factors (e.g., population, transportation, quality of life, etc.) that we’ve looked at also apply when companies are thinking of locating facilities in non-domestic countries. You should recognize that other general factors come into play when an organization is looking for a plant, office, or distribution site in non-domestic countries. Many of these considerations are governmental in nature and deal with the relevant legal system, political stability, bureaucratic red tape, corruption, protectionism, nationalism, privatization, and expropriation (confiscation), as well as treaties and trade agreements.

For example, the Middle East has been a hotbed of widespread political instability in recent years; a short list of Middle Eastern countries impacted by political turmoil in recent years includes Iraq, Libya, Syria, and Yemen. One challenge of this political instability is that alternative systems of governance have been slow to emerge and this uncertainty is causing many organizations to delay, or even cancel, expansion into this region. As another example, Indonesia has identified bureaucratic red tape as a major contributor to the country’s highly inefficient water ports. This inefficiency has caused business to be diverted to Asian ports characterized by less bureaucratic red tape.23

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22 Dan Olson, “Six Keys to Plant Site Selection,” Industry Week, September 2010, 22.
23 Satria Sambijantoro, “Reforms on Table to Boost Port Efficiency,” The Jakarta Post, March 5, 2015, 13.
The preceding discussion focused on some of the more common general considerations in selecting the site of a manufacturing, distributing, or assembling facility. This section deals with more specialized, or site-specific, considerations that should be taken into account in the facility location decision. Most of these considerations are invisible boundaries that can be of great significance in the location decision.

Land may be zoned, which means that there are limits on how the land can be used. For example, a warehouse might be allowed only in areas set aside for wholesale or other specified commercial operations. Restrictions on manufacturing sites may be even more severe, especially if the operation might be viewed as an undesirable neighbor because of the fumes, noise, dust, smoke, or congestion it may create. Distribution facilities are often considered to be more desirable than manufacturing facilities because the primary complaints tend to involve only traffic volume and congestion caused by the trucks that serve the facilities. If a community is attempting to encourage, or discourage, business activity, zoning classifications can be changed, although the process may be time-consuming.

Union locals have areas of jurisdiction, and a firm’s labor relations manager may have distinct preferences for the locals with which he or she is willing to deal. Even though an individual union may ratify national labor agreements, local supplemental agreements often reflect the unique characteristics of a particular area. The different supplemental agreements provide companies with differing levels of managerial flexibility (or inflexibility).

Once a precise site is under consideration, many other issues should be addressed before beginning construction or operations. For example, a title search may be needed to ensure that a particular parcel of land can be sold and that there are no liens against it. Engineers should examine the site to ensure that it has proper drainage and to ascertain the load-bearing characteristics of the soil.

A second site-specific characteristic involves due diligence of environmental factors. For example, one environmental issue in some economically developed countries involves the use of brownfields, or locations that contain chemicals or other types of industrial waste. Environmental factors that can be considered in facility location include air pollution, water pollution, biodiversity protection, energy consumption, and waste generation, among others.24

Another specialized characteristic involves the weather, and location decisions can be influenced by the potential for tornadoes, floods, and hurricanes, among others. The twenty-first century has been characterized by tremendous weather extremes and there is little indication that these extremes will diminish going forward in time. For example, California’s drought during the 2010s is regarded as the worst in 500 years. In a similar fashion, a record number of hurricanes (typhoons, cyclones) occurred in the northern hemisphere during 2015.25 One suggestion for dealing with these weather extremes is to hire experts to evaluate site-specific climate risks and the associated mitigation costs.26

**Free Trade Zones**

Highly specialized sites in which to locate are free trade zones, also known as foreign trade zones, export processing zones, or special economic zones. In a free trade zone nondomestic merchandise may be stored, exhibited, processed, or used in manufacturing operations without being subjected to duties and quotas until the goods or their products enter the customs territory of the zone country. Free trade zones have become extremely popular in recent years; as an example, there are currently approximately 200 operational special economic zones in India, up from fewer than 10 in 2000.27 Free trade zones are often located at, or near, water ports, although they can also be located at, or near, airports.

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27 [http://www.sezindia.nic.in/writereaddata/pdf/ListofoperationalSEZs.pdf](http://www.sezindia.nic.in/writereaddata/pdf/ListofoperationalSEZs.pdf)
Free trade subzones refer to specific locations at an existing free trade zone—such as an individual company—where goods can be stored, exhibited, processed, or manufactured on a duty-free basis. There are over 600 free trade subzones in the United States; they are particularly popular among automotive manufacturers. For example, 11 of the 16 subzones in Detroit, Michigan, involve automobile manufacturers.28

**FINDING THE LOWEST-COST LOCATION USING GRID SYSTEMS**

Many products are a combination of several material inputs and labor. Traditional site location theory can be used to show that one or several locations will minimize transportation costs. Figure 9.3 shows a laboratory-like piece of equipment that could be used to find the lowest-cost location, in terms of transportation, for assembling a product consisting of inputs from two sources and a market in a third area.

Although most solutions to locational problems currently involve computer analysis, such analysis may not be needed if the relevant parameters are not too complex. Thus, grid systems can be used to determine an optimal location (defined as the lowest cost) for one additional facility.

**Grid Systems**

Grid systems are important to locational analysis because they allow one to analyze spatial relationships with relatively simple mathematical tools. Grid systems are checkerboard patterns that are placed on a map, as in Figure 9.4. The grid is numbered in two directions: horizontal and vertical. Recall from geometry that the length of the hypotenuse of a right triangle is the square root of the sum of the squared values of the right triangle’s two legs. Grid systems are placed so that they coincide with north–south and east–west lines on a map (although minor distortion is caused by the fact that east–west lines are parallel, whereas north–south lines converge at both poles).

A center-of-gravity approach can be used for locating a single facility so that the distance to existing facilities is minimized. Figure 9.4 shows a grid system placed over a map of five existing retail stores. At issue is where a warehousing facility to serve these stores should be located. Assuming that each store receives the same volume and that straight-line distances are used, the best (lowest-cost) location for a warehousing facility to serve the five stores is determined by taking the average north–south coordinates and the average east–west coordinates of the retail stores.

In Figure 9.4, the grid system has its lower left (southwest) corner labeled as point zero, zero (0,0). The vertical (north–south) axis shows distances north of point 0,0. The horizontal (east–west) axis shows distances to the east. In this example, the average distance north is \((3 + 1 + 3 + 2 + 3) / 5\) or 12. This figure is divided by the number of stores (5), resulting in a north location of 12/5 or 2.4 miles. The average distance east is \((1 + 2 + 3 + 4 + 6) / 5\) or 16; 16 divided by 5 equals 3.2 miles. Thus, the best (lowest-cost) location is one with coordinates 2.4 miles north and 3.2 miles east of point zero.

Because it’s not likely that each store will place equal demands on a prospective warehousing facility, the center-of-gravity approach can be easily modified to take volume into account—the weighted center-of-gravity approach. The idea behind the weighted center-of-gravity approach is that a prospective warehousing facility will be located closer to the existing sites with the greatest current demand.

To illustrate the weighted center-of-gravity approach, consider the preceding five-store example, but modify the assumption that each store receives the same volume. Assume that store 1 receives 3 tons of shipments per month, store 2 receives 5 tons, store 3 receives 4 tons, store 4 receives 2 tons, and store 5 receives 6 tons. To calculate the north weighted center-of-gravity location, each north coordinate is multiplied by the corresponding volume, and these values are summed;

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28 See www.foreign-trade-zone.com
this total is then divided by the sum of the monthly volume. This procedure is repeated to calculate the east weighted center-of-gravity location.

The new data (see Table 9.2) indicate that the monthly volume for the five locations is 20 tons ($3 + 5 + 4 + 2 + 6$) and that the weighted center-of-gravity location is 2.6 miles north and 3.7 miles east. Thus, the weighted approach locates a warehousing facility slightly more north and more east than what was determined in the basic center-of-gravity approach (2.4 miles north; 3.2 miles east).

The two approaches just described are relatively simple and straightforward, and the calculations can be done relatively quickly to provide approximate locations of centralized facilities, at least in a transportation sense. Because neither the center-of-gravity nor the weighted center-of-gravity approach is very sophisticated, adjustments may have to be made to take into account real-world considerations such as taxes, wage rates in particular locations, volume discounts, the cost and quality of transport services, and the fact that transport rates taper with increased distances. These considerations increase the complexity, as well as the time, to do the necessary calculations and partially explain why many companies have turned to specialized software packages to help them with facility location decisions.
FACILITY RELOCATION AND FACILITY CLOSING

Two specialized situations conclude this discussion of location choice, one involving facility relocation (associated with business growth) and the other involving facility closing (associated with business contraction). More specifically, **facility relocation** occurs when a firm decides that it can no longer continue operations in its present facility and must move operations to another facility to better serve suppliers or customers. **Facility closing**, by contrast, occurs when a company decides to discontinue operations at a current site because the operations may no longer be needed or can be absorbed by other facilities.

A common reason for facility relocation involves a lack of room for expansion at a current site, often because of a substantial increase in business. In the United States, this has involved the relocation of industrial plants and warehousing facilities from aging and congested central cities to more attractive sites in suburban locations. Land costs and congestion in the central cities often make expansion difficult (or impossible), and transportation companies generally prefer the suburban sites because there is less traffic congestion to disrupt pickups and deliveries.

In theory, the relocation decision involves a comparison of the advantages and disadvantages of a new site to the advantages and disadvantages of an existing location. Although this inevitably involves quantitative comparisons, companies should also consider the potential consequences of relocation on their human resources—consequences that may not be easily quantified. At a minimum, employers should keep current employees informed of planned relocations and how such relocations might affect them. Relocation information from other sources could lead to confusion, anger, and lower morale and could easily affect the productivity of the existing facility at a time when hiring replacements is likely to be very difficult.

Companies should also recognize that, no matter how well planned beforehand, a relocation from one facility to another is rarely trouble free; at a minimum, relocation glitches can add to logistics costs and detract from customer service. For example, transferring equipment, furniture, and supplies from an old facility to a new one may take longer than expected. Also, a newly constructed plant or warehousing facility is likely to have flaws or shortcomings that are only discovered after occupancy.

Facilities close for many reasons, including eliminating redundant capacity in mergers and acquisitions, improving supply chain efficiency, poor planning, or an insufficient volume of business. Whatever the reason(s), it is imperative for an organization to clearly specify why a plant is being closed. As an example, Nestlé announced the closing of a coffee plant in Hayes (a London suburb) and the transfer of production elsewhere in the United Kingdom. Nestlé cited several reasons for the plant closing, such as challenges to redeveloping the existing site.29

<table>
<thead>
<tr>
<th>Store</th>
<th>North Location</th>
<th>East Location</th>
<th>Monthly Volume (tons)</th>
<th>North × Volume</th>
<th>East × Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>(3 × 3) = 9</td>
<td>(1 × 3) = 3</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>(3 × 5) = 15</td>
<td>(3 × 5) = 15</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>(2 × 4) = 8</td>
<td>(4 × 4) = 16</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>(1 × 2) = 2</td>
<td>(2 × 2) = 4</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>6</td>
<td>6</td>
<td>(3 × 6) = 18</td>
<td>(6 × 6) = 36</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>52</td>
<td>74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weighted average</td>
<td>2.6</td>
<td>3.7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
It is also important for employers to be cognizant of relevant legislation at the federal and state levels. For example, U.S. federal legislation in the form of the Worker Adjustment and Retraining Notification (WARN) Act mandates that employers give 60 days notice about plant closings and mass layoffs. Many individual states have additional requirements concerning large-scale employee layoffs.

The human impact of facility closings should be a top priority; individuals are not only losing their jobs and pay, but some individuals may suffer a loss of self-esteem as well. Unpleasant as it may be, employees should be kept informed by their employers throughout the closing process. Poorly handled facility closings can result in unwanted negative publicity for a company, which does little more than exacerbate an already unpleasant situation. For example, in late 2015 some employees of a Kraft Heinz production facility in Pennsylvania learned of their facility’s impending closing from media sources and not from plant management.30

Summary

This chapter discussed several issues associated with the location of warehousing, manufacturing, and assembly facilities. Facility location has moved from a tactical to a strategic consideration at many organizations; this chapter analyzed the strategic importance of facility location. General factors in facility location were reviewed, including population characteristics and trade patterns. Population characteristics are a double-edged sword in facility location in that a population serves both as a market for goods as well as a source of labor. Changing trade patterns, spurred in part by multicountry trade alliances, have had a profound influence on the location of distribution facilities.

This chapter also discussed specialized location characteristics and presented several examples of how grid systems can be useful for determining the lowest-cost location for a facility. The chapter concluded with a look at facility relocation and facility closing; companies should be cognizant of the human dimension associated with both relocation and closing.

Key Terms

<table>
<thead>
<tr>
<th>Agglomeration (industry cluster)</th>
<th>Grid systems</th>
<th>Quality-of-life considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brownfields</td>
<td>Intermodal competition</td>
<td>Right-to-work laws</td>
</tr>
<tr>
<td>Center-of-gravity approach</td>
<td>Intramodal competition</td>
<td>Supplier parks</td>
</tr>
<tr>
<td>Expatriate workers</td>
<td>Inventory tax</td>
<td>Sweatshops</td>
</tr>
<tr>
<td>Facility closing</td>
<td>Locavore strategy</td>
<td>Weight-gaining products</td>
</tr>
<tr>
<td>Facility location</td>
<td>Maquiladora plants</td>
<td>Weight-losing products</td>
</tr>
<tr>
<td>Facility relocation</td>
<td>Nearsourcing</td>
<td></td>
</tr>
<tr>
<td>Free trade zone</td>
<td>Pure materials</td>
<td></td>
</tr>
</tbody>
</table>

Questions for Discussion and Review

9.1 Discuss the strategic impact of facility location decisions on logistics performance.

9.2 Discuss the rationale behind revisiting the low-cost labor paradigm.

9.3 What is nearsourcing? How is it a relevant approach in today’s logistical decisions?

9.4 In what way is the location of customer markets a strategic consideration in facility location?

9.5 Describe the locavore strategy in supply chains. Is this strategy always feasible?
9.6 Discuss the factors that influence the number of facilities that a firm chooses to operate.
9.7 How does a raw material’s status as pure, weight-losing, or weight-gaining influence the facility location decision?
9.8 Discuss how population can be viewed as both a market for goods and a source of labor.
9.9 What are sweatshops?
9.10 What are expatriate workers? What challenges do they face?
9.11 How can taxes and incentives impact facility location decisions?
9.12 How do transportation considerations influence facility location decisions?
9.13 What are industry clusters, and what are some of their potential advantages?
9.14 Discuss, with respect to your country, how multicountry trade agreements have influenced the location of production or distribution facilities.
9.15 Explain why quality-of-life issues should be considered in the facility location decision.
9.16 Beyond the general factors discussed in this chapter, what additional considerations are important when a firm is thinking of locating a facility (facilities) in other countries?
9.17 Briefly describe specialized, or site-specific, considerations that should be taken into account in the facility location decision.
9.18 What is a free trade zone? What functions might be performed in it?
9.19 Discuss advantages and disadvantages to grid systems, such as the center-of-gravity and weighted center-of-gravity approaches.
9.20 Distinguish between facility relocation and facility closing. How should companies deal with their human resources (workers) in both situations?

Suggested Readings

CASE

CASE 9.1 ALL-INDIAN LOGISTICS SERVICES

All-Indian Logistics Services (AILS) is a third-party logistics provider headquartered in South Delhi, India. The company was founded by two former logistics executives from Tata Steel (one of the biggest and oldest companies in India) with expertise in ocean shipping, customs clearance, forwarding, and land transportation. Over the last five years, AILS has been successful in building an infrastructure and pool of experienced personnel to handle a wide range of logistics activities. AILS considers itself a specialist in customized logistics solutions and services. Its services include:

- **Import consolidation.** AILS has a well-developed network of offices and trade connections in the United States, Europe, the Far East, and the Middle East.
East to render import consolidation by both air and sea to any part of India. It promises a personalized, prompt service with value for cost.

- **Door-to-door services.** AILS is fully equipped to deliver door to door, which includes cargo pickup from the supplier’s warehouse, warehousing prior to customs clearance, complete customs clearance of exports from overseas, and freight booking with airlines/shipping lines to receive cargo in India. It also undertakes local customs clearance and transportation to deliver to the door of the customer.

- **Exports.** AILS has expertise in handling exports of various kinds of cargo by ocean and by air freight, and ensures the timely movement of cargo at the most competitive rates. The company takes care of both the complete export documentation formalities and the physical movement of cargo.

- **Consultancy on customs and logistics.** AILS can guide customers regarding various modes of transportation and can help customers optimize utilization of space and save on freight. It acts as liaison with different Indian authorities like the RBI (Reserve Bank of India), the Ministry of Shipping, the Ministry of Railways, and the Ministry of Road Transport and Highways, among others, on behalf of clients for various permissions and quotas related to import and export of cargo. India’s red tape, bureaucracy, and corruption preclude anyone lacking clout or established relationship channels from conducting business in India.

Today AILS handles an average of 200-plus TEUs (20-foot container equivalents) of imports and exports every month between Delhi and Mumbai (Bombay), which is the nearest big port (a distance of 1,407 kilometers). (See Exhibit 9-A.) Luckily, most containers are used for traffic in both directions; moving empties is unproductive. Main items for export are bathroom fittings, agricultural equipment, chemicals, scientific equipment, medical equipment, food processing machinery, and furniture and kitchen equipment. Main items for import are automobile engines and spares, cotton yarn, food products, electronics, televisions and components, rice, stone for stone crafting, etc.

AILS has slowly expanded its consulting offerings to include site selection for manufacturing plants and warehousing facilities. Recently, AILS was retained on a site selection project by American Athletic Apparel (AAA), a large multinational supplier of athletic clothing. AAA has asked AILS to determine the best location for a manufacturing plant that will produce wickable athletic shirts for export to North America and Western Europe.

AAA has one key stipulation for the chosen site: The manufacturing plant must be located in a city with a population of between 1,500,000 and 3,500,000 residents, which excludes places like Delhi, Mumbai, and Bangalore, among others. Because the majority of shirts will be exported from India via water transportation (air freight may be utilized in extraordinary situations), AAA has agreed to let AILS leverage its existing relationships with logistics personnel at Mumbai Port. With this consideration in mind, after several months of arduous work AILS narrowed the plant location to two metropolitan areas: Patna (in the state of Bihar) and Lucknow (in the state of Uttar Pradesh).

**QUESTIONS**

1. With respect to the natural resources needed to make wickable shirts, is Patna or Lucknow the preferred location? Why?
2. With respect to transportation considerations, is Patna or Lucknow the preferred location? Why?
3. With respect to labor characteristics, is Patna or Lucknow the preferred location? Why?
4. With respect to quality-of-life considerations, is Patna or Lucknow the preferred location? Why?
5. Should AILS recommend that the manufacturing plant be located in Patna or Lucknow? Why?
6. Would your answer to question 5 change if the shirts are exported through the Port of Kolkata? Why or why not?
7. Suppose that AAA decides to nearsource production to Latin America. Keeping in mind the key stipulation presented in the case, where might AAA locate its production plant in Latin America? Why?
A recurring theme in previous chapters has been the changing nature of the logistics discipline and the individual functions that comprise it. In the systems approach of logistics, changes to one function affect other functions as well. Indeed, many of the changes described in previous chapters—such as electronic ordering, facility consolidation, and lean inventories—have especially affected warehousing management.

Many well-run companies today view warehousing as a strategic consideration—and thus a potential source of competitive advantage. For example, the continuing growth of e-commerce is causing some companies to shift away from warehousing’s traditional cost focus to an emphasis on customer satisfaction in terms of rapid, and correct, order fulfillment.\(^1\)

This chapter begins with an overview that defines what is meant by warehousing and discusses the role of warehousing in a logistics system. This is followed by analysis of public, private, contract, and multiclient warehousing. Next comes a section devoted to design considerations in warehousing, with particular attention to trade-offs in design considerations. The chapter concludes with an examination of some key operational issues in warehousing, such as productivity, safety, and security.

### THE ROLE OF WAREHOUSING IN A LOGISTICS SYSTEM

**Warehousing**, which refers to “that part of a firm’s logistics system that stores products (raw materials, parts, goods-in-process, finished goods) at and between points of origin and point of consumption,”\(^2\) and transportation are substitutes for each other, with warehousing having been referred to as “transportation at zero miles per hour.” Figure 10.1, which presents an example of the trade-off between warehousing and transportation, indicates that placing a warehousing facility between the producer and customers adds a new layer of costs (those associated with warehousing) into the system. Moreover, the warehousing facility generates shorter-haul transportation routes (from the producer to the facility; from the facility to the customers); as a general rule, short-haul transportation tends to be more costly per mile than long-haul transportation. However, the increased costs of short-haul transportation may be offset by lower transportation costs per unit of weight associated with volume shipments.

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If the introduction of warehousing into a supply chain simply shifts business costs across various logistics activities, then why is warehousing desirable? A key reason for warehousing is because patterns of production and consumption do not coincide, and warehousing serves to match different rates or volumes of flow. Canned fruits and vegetables are examples of one extreme in which production occurs during a relatively short period, but sales are spread throughout the year. The other extreme—sales concentrated in a relatively short time period, steady production rates throughout the year—is more likely to be addressed by having the production occur closer to the demand period.

Sometimes, larger quantities of goods are purchased than can be consumed in a short period of time, and warehousing space is needed to store the surplus product. This can occur for several reasons, such as guarding against anticipated scarcity or to benefit from a seller’s advantageously priced deal.

Much of the preceding discussion could be viewed as a market-oriented approach to warehousing. However, warehousing management can also be relevant to production and raw materials considerations. For example, an automobile manufacturer might purchase extra amounts of steel in response to anticipated steel shortages.

Moreover, warehousing facilitates the regrouping function in a supply chain. This function, which involves rearranging the quantities and assortment of products as they move through the supply chain, can take four forms—accumulating (also referred to as bulk-making), allocating (also referred to as bulk-breaking), assorting, and sorting out. Accumulating and allocating refer to adjustments associated with the quantity of product, whereas assorting and sorting out refer to adjustments associated with product assortment.

Thus, accumulating involves bringing together similar stocks from different sources, as might be done by a department store that buys large quantities of men’s suits from several different producers. Allocating, by contrast, involves breaking larger quantities into smaller quantities. Continuing with our suit example, whereas the department store might buy 5000 suits in size 42 short, an individual store might only carry 15 or 20 suits in this size.

Assorting refers to building up a variety of different products for resale to particular customers. Our department store example might want to supply individual stores with a number of different suit sizes (e.g., size 36, size 38, size 40, etc.) and styles (e.g., two-button suits, three-button suits, etc.). Sorting out refers to “separating products into grades and qualities desired by different target markets.” For example, a department store chain may sell $1,000 men’s suits only in stores located in high-income areas, whereas $600 men’s suits might be the highest priced suit sold in less-affluent areas.

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Warehousing can be provided by warehouses, distribution centers, fulfillment centers, or cross-docking facilities. **Warehouses** emphasize the storage of products, and their primary purpose is to maximize the usage of available storage space. **Distribution centers** emphasize the rapid movement of products through a facility, and thus they attempt to maximize **throughput** (the amount of product entering and leaving a facility in a given time period). **Fulfillment centers** represent a special type of distribution center that is focused on e-commerce orders.

The increased emphasis on time reduction in supply chains has led to the growth of cross-docking, which can be defined as “the process of receiving product and shipping it out the same day or overnight without putting it into storage.” Indeed, the length of time a product is in a facility is one factor that differentiates distribution centers and cross-docks, with 24 hours (or less) of storage time often being used to differentiate a cross-dock facility from a distribution center. Key benefits to cross-docking include improved service by allowing products to reach their destinations more quickly as well as reduced inventory carrying costs from less safety stock because of faster product delivery.

The experiences of Saks Inc., an upscale retail department store, illustrate some of the potential benefits of cross-docking. For example, it takes just **seven minutes** to move a carton from the inbound dock to an outbound trailer at the Saks cross-dock facility. Moreover, on a daily basis the Saks cross-dock can handle four times as much product, with one-half the labor, of its predecessor facility; in other words, the cross-dock facility is approximately **eight times** as productive as its predecessor.

Because cross-docking is predicated on time reduction, the design of cross-dock facilities is an important consideration. More specifically, cross-docks emphasize extremely rapid product movement, and they should be designed with a minimal amount of storage space and truck doors on two or more sides. Figure 10.2 shows an “I-shaped” cross-dock design—rectangular, long, and as narrow as possible. Other possible cross-dock designs include “H,” “L,” “T,” “U,” and “E,” and their applicability depends on the spatial configuration of the land used to build the cross-dock as well as the number of docks to be used.

### PUBLIC, PRIVATE, CONTRACT, AND MULTICLIENT WAREHOUSING

In addition to understanding the distinctions among warehouses, distribution centers, and cross-dock facilities, organizations must decide the proper mix in terms of owning (private warehousing) or renting (public, contract, multiclient warehousing) warehousing space. Because companies have different strategies, goals, and objectives, there is no correct mix of owning or renting. Thus, one organization might use only public warehousing, another organization might use only private warehousing, and a third organization might use a mix of public, private, contract, and multiclient warehousing. Each has distinct characteristics that might be either attractive or unattractive to potential users. These characteristics are discussed in the following sections.

### Public Warehousing

**Public warehousing** serves (is supposed to serve) all legitimate users and has certain responsibilities to those users. Public warehousing requires no capital investment on the user’s part, which can certainly be an important consideration when the cost of borrowing money (interest rates) is high.

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With public warehousing, the user rents space as needed, thus avoiding the costs of unneeded space. A related advantage is that users should have a fairly exact determination of their warehousing costs because public warehousing space tends to be rented on a month-to-month basis.

Public warehousing can also be attractive to prospective users because other parties have the responsibility for personnel decisions and regulatory issues. Warehousing is one of two major sources of labor in logistics (the other is transportation), and warehousing employees can be unionized, thus adding to the managerial challenges. At a minimum, when using public warehousing the recruitment, selection, compensation, motivation, and evaluation of warehousing employees are the responsibility of the warehousing company and not the customer (user).

With respect to regulatory issues, warehousing labor safety practices in the United States are monitored by the Occupational Safety and Health Administration (OSHA). From a managerial perspective, because OSHA standards are complex and lengthy, it can be quite costly and challenging to comply with OSHA regulations. It is worth pointing out that in recent years warehousing in the United States has been subjected to closer OSHA scrutiny because warehousing has been classified as a high-hazard workplace. As was the case with personnel decisions, when using public warehousing, regulatory issues are the responsibility of the warehousing provider and not the warehousing customer.

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Public warehousing offers more locational flexibility than do company-owned facilities, and this can be important when a company is entering new markets. For example, an organization may want to start off slowly in new markets or may be uncertain how well its products will be received in these markets. Public warehousing can provide storage services in these markets without an overwhelming capital commitment.

Public warehousing may provide a number of specialized services that are not available from other sources. For example, public warehousing is heavily involved in such value-added services as repackaging larger shipments into retail-size quantities and then shrink-wrapping them, assisting in product recalls, and doing price marking, product assembly, and product testing.

Perhaps the biggest drawback to public warehousing is the potential lack of control by the user. For example, sometimes public warehousing does not have the space availability required by a particular user. And even if space is available, users may have little say in where their goods are stored—they may be placed wherever space is available, which may result in part of a user’s inventory being stored in one area and the remainder in another. Moreover, some public warehousing is not open 24 hours a day, meaning that prospective users may not be able to access their products as needed or that users may need to tailor their operations to fit those of the public warehouse.

**Private Warehousing**

Private warehousing is owned by the firm storing goods in the facility. Private warehousing generates high fixed costs and thus should only be considered by companies dealing with large volumes of inventory. In so doing, the high fixed costs can be spread out over more units of inventory, thus reducing the cost per unit of storage. The largest users of private warehousing are retail chain stores; they handle large volumes of merchandise on a regular basis.

In addition to large volumes, private warehousing also tends to be feasible when demand patterns are relatively stable. Fluctuating demand patterns could at times lead to insufficient storage space for product, in which case the company might need to use public warehousing as a supplement, thus increasing total warehousing costs. At other times, by contrast, there could be too much space (excess capacity), which costs money as well.

Assuming both sufficient demand volume and stability of demand, private warehousing offers potential users a great deal of control over their storage needs. For example, the storage facility can be constructed to the user’s specifications, which is a particularly attractive feature when a company has unique storage or handling requirements, as is the case with steel beams and gasoline. Moreover, in private warehousing, companies can control product placement with a facility; some products, for example, should not be stored on the floor. Another aspect of control is that private warehousing offers access to products when an organization needs (or wants) them, as opposed to an organization having to tailor its activities to match a public facility’s operating hours.

Private warehousing is also characterized by several important drawbacks, including the high fixed cost of private storage and the necessity of having high and steady demand volumes. In addition, a high-fixed-cost alternative such as private warehousing becomes less attractive in times of high interest rates because it is more costly to secure the necessary financing to build or lease the facility (to be fair, interest rates in some nations, such as the United States, have been relatively low in recent years).

Private warehousing may also reduce an organization’s flexibility in responding to changes in the external environment. For example, companies that utilize private warehousing are susceptible to changing demand patterns, such as those experienced with the passage of multicity trade alliances. Likewise, organizational flexibility can be affected by mergers with, or acquisitions of, other companies, as illustrated by the case of a multibillion-dollar company that acquired a competitor’s production and private warehousing facilities. Although the production facilities added much-needed manufacturing capacity, the warehousing facilities were largely redundant in nature. Yet the acquiring company had little choice but to continue operating them because of substantial penalties (e.g., labor compensation) that would have been incurred if the facilities were closed.
Contract Warehousing

Organizations historically had two choices with respect to renting or owning warehousing facilities—public (renting) and private (owning). In the early 1990s contract warehousing (also referred to as third-party warehousing or dedicated warehousing) emerged as a second option for renting warehousing space. Although contract warehousing has been defined in a number of different ways, in this text it refers to “a long term, mutually beneficial arrangement which provides unique and specially tailored warehousing and logistics services exclusively to one client, where the vendor and client share the risks associated with the operation.” From a cost perspective, contract warehousing tends to be less costly than private warehousing but more costly than public warehousing.

Contract warehousing is a preferred alternative for many organizations because it simultaneously mitigates the negative aspects and accentuates the positive aspects of public and private warehousing. More specifically, contract warehousing allows a company to focus on its core competencies (what it does best), with warehousing management provided by experts—experts who solely focus on the client’s needs and wants. In addition, contract warehousing potentially offers the same degree of control as private warehousing because key specifications can be included in the contract. For example, if a certain product should not be stored on the floor, then this can be explicitly reflected in the particular contract.

With respect to changes in the external environment, contract warehousing is viewed as more flexible than private warehousing but less so than public warehousing. This flexibility depends in part on the length of the contract; as the contract length increases, the flexibility to respond to change decreases. Three- to five-year contracts appear to allow sufficient time for the warehousing provider to learn the client’s business while allowing the client some flexibility in case the agreement fails to produce acceptable results.

Multiclient Warehousing

Another warehousing alternative, multiclient warehousing, which mixes attributes of contract and public warehousing, has become popular in recent years. For example, where contract warehousing is generally dedicated to just one customer and public warehousing may be used by any number of customers, a limited number of customers (at least two, but generally no more than one dozen) utilize a multiclient facility. In a similar fashion, the services in a multiclient facility are more differentiated than those in a public facility, but less customized than would be found in contract warehousing.

Furthermore, where public warehousing services are purchased on a month-to-month basis, multiclient warehousing services are purchased through contracts that cover at least one year. Multiclient facilities can be attractive to organizations that (1) don’t have sufficient volume to build their own storage facilities; (2) don’t have sufficient volume to justify using contract warehousing; (3) have regular, but not continuous, need for specialized equipment or services; (4) can benefit from working with other companies that have similar needs or requirements (e.g., shared transportation to common locations).

DESIGN CONSIDERATIONS IN WAREHOUSING

General Considerations

One of the best pieces of advice with respect to the design of warehousing facilities is to use common sense, as illustrated by the businessperson who was convinced that warehouses were bland,

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boring, and visually unappealing. He decided to build a more aesthetically pleasing facility and designed a warehouse with black floors, reasoning that black floors would stand out compared to the floors in many other warehouses.

Although the black floor was certainly eye-catching, it was an unmitigated disaster in part because the floor showed more dirt than comparable facilities. Moreover, the black floor was extremely slippery—meaning that forklifts had a harder time stopping (some actually crashed into the walls!), and warehouse workers were more prone to falling. This anecdote provides an excellent example of form triumphing over function or style triumphing over substance. From a commonsense perspective, the primary design consideration should be the facility’s function—be it long-term storage or product movement—in the relevant logistics system, with aesthetics a secondary consideration.

One commonsense piece of advice is that prior to designing a warehousing facility, the quantity and character of goods to be handled must be known. Indeed, one of the early challenges of online commerce for bricks-and-mortar organizations was that many of them attempted to fulfill online orders through warehousing facilities largely designed to supply retail store locations. In contrast, the design of fulfillment centers should explicitly incorporate key attributes of online commerce, to include small order sizes, the necessity to store limited quantities of many SKUs, intense peaks in demand (e.g., holidays), and same-day (same-hour) fulfillment, among others.  

A second commonsense piece of design advice is that it is important for an organization to know the purpose to be served by a particular facility because the relative emphasis placed on the storage and distribution functions affects space layout. As such, a storage facility with low rates of product turnover should be laid out in a manner that maximizes utilization of the cubic capacity of the storage facility. Alternatively, a facility that emphasizes rapid product movement with limited time in storage should be configured to facilitate the flow of product into and out of it.

**Trade-offs**

Trade-offs must be made among space, labor, and mechanization with respect to warehousing design. Spaciousness may not always be advantageous because the distances that an individual or machine must travel in the storing and retrieving functions are increased. Moreover, unused space is excess capacity, and we know that excess capacity costs money. Alternatively, cramped conditions can lead to such inefficiencies as the product damage that can be caused by forklift puncture and movement bottlenecks caused by insufficient aisle width, to name but two.

Before layout plans are made, each item that will be handled should be studied in terms of its specific physical handling properties, the volume and regularity of movement, the frequency with which it is picked, and whether it is fast or slow moving compared to other items. Many trade-offs are inevitable when designing the structure as well as the arrangement of the relevant storage and handling equipment. Several of these trade-offs are discussed in this section. These trade-offs are often more complex than they appear because individual trade-offs are not independent of one another. Although there may not be “right” or “wrong” answers with respect to warehousing design, an understanding of the various trade-offs might help managers make more efficient, as opposed to less efficient, decisions.

**Fixed versus Variable Slot Locations for Merchandise**

You might remember from Chapter 7 that order picking and assembly represents the best opportunity to improve the effectiveness and efficiency of the order cycle. One possible way to improve the effectiveness and efficiency of order picking and assembly involves figuring out where to store (slot) product in a warehouse or distribution center. For example, **velocity slotting** is a popular strategy

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that slots the most frequently picked items in the most accessible location; velocity slotting generally reduces an order picker’s travel distance.\textsuperscript{15}

A well-thought-out slotting plan can reduce labor costs, increase pick and replenishment efficiencies, and increase order accuracy.\textsuperscript{16} To this end, organizations need to understand the attributes of fixed and variable slot locations for merchandise. With a \textit{fixed slot location}, each SKU has one or more permanent slots assigned to it (think of a parking garage that assigns particular parking spaces to certain individuals). This can provide stability in order picking in the sense that the company should always know where a specific SKU is located. However, this may result in low space utilization, particularly with seasonal products.

Alternatively, a \textit{variable slot location} involves empty storage slots being assigned to incoming products based on space availability. One example of variable slot location is the closest available storage position, with “closest” defined as the shortest travel time to an entrance or exit point. Although variable slot location generally results in more efficient space utilization, from an order picking perspective it requires a near-perfect information system because there must be flawless knowledge of each product’s location.

\section*{Build Out (Horizontal) versus Build Up (Vertical)}

A general rule of thumb is that it’s cheaper to build up than build out; building out requires more land, which can be quite expensive, particularly in certain geographic locations. As an illustration, during 2015 a 1.5-acre land parcel in London, England was priced at £25,000,000!\textsuperscript{17} Alternatively, although building costs decline on a cubic-foot basis as one builds higher, warehousing equipment costs tend to increase.

\section*{Order-Picking versus Stock-Replenishing Functions}

Organizations must decide whether workers who pick outgoing orders and those who are restocking storage facilities should work at the same time or in the same area. Although the latter scenario may result in fewer managerial personnel being needed, it may also lead to congestion within the facility due to the number of workers. One suggestion to reduce congestion is for order pickers and stock replenishers to use different aisles for their respective activities—again, this requires a very good information system to identify where a given employee is at any time.

\section*{Two-Dock versus Single-Dock Layout}

A two-dock layout generally has receiving docks on one side of a facility and shipping docks on the other side, with goods moving between them. In a one-dock system, each and every dock can be used for both shipping and receiving, typically receiving product at one time of the day and shipping it at another time. Viewed from overhead, the goods move in a U-shaped rather than a straight configuration. This alternative reduces the space needed for storage docks, but it requires carriers to pick up and deliver at specific times. In addition, this alternative may also result in an occasional mix-up in that received product is sometimes reloaded into the vehicle that delivered it.

\section*{Aisle width might seem like an arcane issue until you realize that as aisle space increases, the storage capacity of a facility decreases. For example, narrow aisles (defined as between 9.5 feet and 12 feet wide) can store 20\% to 25\% more product than conventional aisles (more than 12 feet wide), while very narrow aisles (defined as less than 8 feet) can store 40\% to 50\% more product than...
conventional aisles. However, it is easier to operate mechanical equipment in wider aisles and wider aisles reduce the chances of accidents and product damage.

Narrower aisles require specialized storage and handling equipment, such as narrow aisle (very narrow aisle) lift trucks, which are capable of simultaneously moving both vertically and horizontally. This specialized equipment is noticeably more expensive than traditional lift trucks, and it is not unusual for specialized lift trucks to cost twice as much as traditional lift trucks. However, specialized lift trucks can be twice as productive as traditional lift trucks.

**Degree of Warehouse Automation**

The degree of automation is another important consideration in warehousing design. For our purposes warehouse automation will refer to utilizing mechanical or electronic devices to substitute for human labor. Examples of warehouse automation include narrow aisle forklifts, automated guided vehicles, automated storage and retrieval systems, radio frequency identification, and robotic picking, among others. Although warehouse automation offers the potential to reduce labor costs and to improve warehouse productivity, it is important for managers to ensure that the automation results in noticeable improvement in warehousing effectiveness and efficiency. To this end, an organization should first assess whether it is ready for automation, because automation can be complex, expensive, and disruptive to day-to-day operations. If an organization is ready for automation, then it’s important to evaluate how the automation will support the organization’s logistics system.

**Other Space Needs**

Although many would assume that the primary role of warehousing involves the storage of product, it is not uncommon for a warehousing facility to operate with only 20 percent of the space being occupied by product. Because every warehousing facility sets aside areas for nonstorage activities, it’s important to know about them. These nonstorage activities include, but are not limited to, the following:

1. An area where transport drivers and operators can wait while their equipment is loaded or unloaded
2. Staging, or temporary storage, areas for both incoming and outgoing merchandise
3. Employee washrooms, lunchrooms, and the like
4. Pallet storage and repair facilities (Facilities that receive unpalletized materials but ship on pallets may require a pallet-assembly operation.)
5. Office space, including an area for the necessary computer systems
6. An area designed to store damaged merchandise that is awaiting inspection by claim representatives
7. An area to salvage or repair damaged merchandise
8. An area for repacking, labeling, price marking, and so on
9. An area for accumulating and baling waste and scrap
10. An area for equipment storage and maintenance (For example, battery-powered lift trucks need to be recharged on a regular basis.)
11. Specialized storage for hazardous items, high-value items, warehousing supplies, or items needing other specialized handling (such as a freezer or refrigerated space)
12. A returned or recycled goods processing area

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21http://www.iioptimizerealty.com/2012/12/21/measuring-utilization-warehouse/
When designing warehousing facilities, it is also important to keep in mind external space-related needs, which unfortunately are sometimes overlooked. These include areas for vehicles waiting to be loaded and unloaded, space for vehicle maneuvering (e.g., turning, backing up), and employee parking.

WAREHOUSING OPERATIONS

Because operating a warehousing facility has many facets, efficient and effective warehousing management can be an exacting task. Workforce motivation can be difficult because of the somewhat repetitive nature of the work. It can also be strenuous and physically demanding, and on occasion warehousing facilities can be dangerous places. Some of the more significant operational issues are discussed in the following sections.

Warehousing Productivity Analysis

Recall from Chapter 4 that productivity is a measure of output divided by input, and although a number of different productivity metrics can be used to assess warehousing productivity, not all are relevant to all kinds of facilities. Representative measures of warehousing productivity include cases shipped per person, product lines shipped per person, pallets shipped per person, average warehouse capacity used, and forklift capacity used, among others. These and other productivity metrics can be utilized to provide comparisons within an organization over time.

In addition, external data may be available that can be used for benchmarking purposes depending on the relevant metrics being analyzed. Suppose, for example, that the cases picked and shipped per hour at a particular warehouse increased from 72 to 84 over a two-year period. Although this represents a 16.7 percent \( \frac{84 - 72}{72} \) productivity improvement over the two years, the 84 cases per hour might be viewed much differently when compared to warehousing industry data that shows a median of 100 cases picked and shipped per hour and a best practice metric of more than 250 cases picked and shipped per hour.\(^{22}\)

It is important to recognize that increases in warehousing productivity do not always require significant investment in technology or mechanized or automated equipment. For example, one suggestion for improving warehousing productivity involves a review of existing procedures and practices to identify the tasks that are creating the largest inefficiencies and then developing methods to reduce or eliminate the inefficiencies without adding to or upgrading present technology or equipment. Organizations can also examine their facility layouts; long horizontal runs and frequent backtracking could be symptoms of layout problems. Something as basic as adding cross aisles could reduce the length of horizontal runs as well as the length of backtracking. Another low cost suggestion for improving warehousing productivity is to play music, if conditions permit; research suggests that worker productivity increases when music is playing.\(^{23}\)

Safety Considerations

Warehousing facilities can be dangerous places to work. In the United States, for example, forklifts account for one of every six workplace deaths.\(^{24}\) Figure 10.3 provides a listing of workplace safety issues, and many of these safety issues, such as falls and bodily reaction, are associated with warehousing facilities. You should recognize that many suggestions for dealing with warehousing safety are commonsense—and low cost—in nature. Consider, for example, several of the Occupational Safety and Health Administration’s (OSHA) suggestions to improve warehouse safety: “prohibit ‘dock jumping’ (jumping from dock plate to dock plate) by employees;” “prohibit stunt driving (of forklifts) and horseplay;” “keep floors clean and free of slip and trip hazards.”\(^{25}\)

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\(^{25}\)www.osha.gov/Publications/3220_Warehouse.pdf
Warehousing safety can be influenced by governmental regulations. In the United States, safety standards have been set for warehousing equipment and operations, and OSHA inspectors make frequent visits to industrial workplaces to ensure regulatory compliance. Forklift operations and equipment have received particular attention from OSHA in part because of the number of deaths and injuries associated with them. For example, only trained and certified warehousing employees are permitted to operate a forklift and forklift operators must be recertified every three years.

Warehouse safety considerations fall into three primary categories—employee, property, and motor vehicles—and we will discuss each of these in the paragraphs that follow. With respect to employee safety, consider one warehousing professional’s advice: “It costs more to recruit, train, and replace a worker than to provide a safe environment.”

Figure 10.3 Workplace Safety Issues  

Overexertion—Injuries from excessive lifting, pushing, pulling, holding, carrying, throwing
Bodily reaction—Injuries from bending, climbing, reaching, standing, sitting, slipping or tripping without falling
Struck by object—Such as a tool falling on a worker from above
Struck against object—Such as a worker walking into a door
Repetitive motion—Injuries due to repeated stress or strain

Real Growth Trends 1998-2010 (Percent change by category)

- Fall on same level
- Bodily reaction
- Assault/Violent act
- Fall to lower level
- Overexertion
- Struck by object
- Struck against object
- Caught in/Compressed by
- Highway incident
- Repetitive motion

Real Cost* of the Most Disabling Injuries 1998-2010

1Overexertion
2Bodily reaction
3Struck by object
4Struck against object
5Repetitive motion

lifting procedures, trying to carry too heavy a load, failing to observe proper hand clearances, and the like. Back and shoulder injuries are the most frequent among warehousing personnel; back support belts and braces are becoming more widely used, but they are only of value if workers also receive adequate training in how to safely lift various loads.

_Property._ Warehousing facilities generate large volumes of waste materials, such as empty cartons, steel strapping, and broken pallets, as well as wood and nails used for crating and **dunnage** (material that is used to block and brace products inside carrier equipment to prevent the shipment from shifting in transit and becoming damaged). The various waste materials must be properly handled because they pose threats to employee safety and may also be fire hazards.

Moreover, even with the best of practices, some goods that are received, stored, and shipped will be damaged. Special procedures must be established for handling broken or damaged items, if only from the standpoint of employee safety. A broken bottle of household ammonia, for example, results in three hazards: noxious fumes, broken glass, and a slippery floor. Aerosol cans pose hazards that are affected by the product in the cans. For example, cans of shaving cream cause little problem in fires because if they explode, the shaving cream serves to extinguish the fire; that is not the case with aerosol cans containing paints or lacquers, and such cans are often kept in special cages because in a fire they might become burning projectiles.

Indeed, fires are a constant threat in warehousing, in part because many materials used for packaging are highly flammable. In addition, although plastic pallets last longer, are cleaner, and are less likely to splinter than wooden pallets, plastic pallets tend to be a greater fire risk. High-rise facilities are more susceptible to fires because the vertical spaces between stored materials serve as flues and help fires burn. You should recognize that warehouse fires may result in substantial property damage as well as injury or death, as illustrated by the 2015 explosions at the Port of Tianjin (China). The explosions, which started with an initial explosion (and fire) at a warehouse that illegally stored thousands of tons of hazardous products, killed more than 100 people and cost insurance companies approximately $2 billion.28

A 2016 report by the National Fire Protection Association indicated that U.S. warehouses averaged approximately 1,200 fires per year between 2009 and 2013. The report indicated that the two most common causes of warehousing fires between 2009 and 2013 were those that were intentionally set and those caused by electrical distribution and lighting equipment. Moreover, the 2016 report indicated that the number of warehousing fires decreased by approximately 75% between the early 1980s and 2013.29 Many warehousing fires can be prevented by common sense; flammable products, for example, should not be stored near heat sources (such as space heaters).

_Motor vehicles._ We mentioned earlier that forklift operations and equipment have been a particular focus of governmental safety regulations. Indeed, in the United States approximately 85 employees are killed and there are approximately 35,000 serious injuries each year while operating forklifts; approximately 40% of deaths are caused by an operator being crushed by a forklift tipping over.30 An annual National Forklift Safety Day began in 2014 as an effort to provide greater awareness of safe forklift practices as well as to encourage safer operator behavior.

There are other vehicle-related safety considerations in warehousing; for example, tractor-trailer drivers who are backing into loading/unloading docks should utilize a lookout person to alert the driver about employees who might be walking behind the vehicle. Moreover, wheel chocks—hard-rubber wedges that are inserted under truck tires—can guard against intentional or unintentional trailer movements.31

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30http://forkliftsystems.com/national-forklift-safety-day-is-june-10th/
31Nowlan, “Safety Doesn’t Have to Hurt Your Budget.”
Hazardous Materials

Hazardous materials (hazmat) often receive special attention from logistics managers because of the injuries, death, and property damage they can cause. Broadly speaking, hazardous materials can negatively impact the health and/or safety of the general public. Examples of hazardous materials include explosives, flammable liquids, and flammable solids.

Government regulations often require that shipping documents indicate the hazardous nature of the materials being transported. Warehouse employees should note these warnings when receiving materials and similarly should include such warnings on outbound shipping documents when materials leave warehouses. Many countries also require organizations to create a safety data sheet (SDS) for each hazardous product to be stored in a facility. The SDS contains information about the physical and health hazards associated with a particular product as well as information about its proper storage.32

Hazmat experts generally agree that the applicable regulations should only provide a starting point for proper storage of hazardous materials, in part because for some situations no regulations exist. These experts further suggest that hazmat storage can be managed effectively by answering four questions: What material is being stored? Why is it being stored? Where is it being stored? How is it being stored?33

A number of design elements must also be considered with the storage of hazardous materials. Buildings that store hazmat often have specially constructed areas so that materials can be contained in the case of an accident. Likewise, these facilities may have walls and doors that can withstand several hours of intense fire. It is also important for a hazmat storage facility to have proper sprinkling systems as well as excellent ventilation.

Warehousing Security

Interest in providing building security for warehouses and other distribution facilities is a primary concern for many organizations because, according to FreightWatch International, a company that specializes in logistics security, “Freight at rest is freight at risk.”34 Potential threats to warehousing security include theft, pilferage, heat and humidity, vandalism, fire, and loss of electricity, among others.35 These threats can present a number of negative consequences such as lost sales and revenues, additional costs to enhance security, the time and costs to file the appropriate claims, and potential danger to the public.

Some of these consequences were well illustrated in the high-profile theft of nearly $80 million in pharmaceuticals from a Connecticut warehouse in 2010. The pharmaceutical manufacturer instituted an immediate review of its warehouse security processes and procedures and began implementing more stringent (and most costly) security practices. In addition, pharmaceuticals that are sold outside of traditional channels can create potential safety risks (e.g., lack of refrigeration could contaminate some pharmaceuticals) and the revenues from such sales are not realized by the manufacturer. And although the pharmaceuticals stolen from the Connecticut warehouse were eventually recovered, they became evidence in criminal and civil lawsuits and will be destroyed at the conclusion of all relevant legal proceedings—which means no revenues from their sale for the manufacturer.36

Warehousing security focuses on two primary issues, namely, protecting products and preventing their theft, and warehousing security can be enhanced by focusing on people, facilities, and processes. In terms of people, one area of focus should be the hiring process for warehousing workers; a starting point might be determining whether an individual facility even has a formal hiring process.

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One commonsense suggestion when hiring warehousing workers is not to hire people who might be predisposed to theft (e.g., individuals with substance abuse problems).

In terms of a facility's focus, experts recommend a combination of overt and covert surveillance methods. With respect to the former, electronic devices such as closed-circuit television systems can be helpful, particularly if they are monitored on a regular basis. One type of covert surveillance involves unannounced security audits that focus on shortages or overages of particular products. You should recognize that there is virtually no limit to the sophistication or cost of devices and techniques that can be used to monitor warehousing security. Having said this, the more sophisticated security devices also tend to be more expensive, and organizations need to weigh the trade-off of whether the devices' benefits exceed their costs.

In terms of processes to improve warehousing security, the more times a shipment is handled, the greater the opportunities for loss or damage. Thus, logisticians would do well to reduce the number of times an individual shipment is handled. Table 10.1 highlights some possible shortcomings in warehousing security.

### Cleanliness and Sanitation Issues

At first glance, cleanliness and sanitation might seem like issues that are more relevant to, say, restaurants and hospitals than to warehousing operations. However, warehousing cleanliness and sanitation are of paramount importance in many industries, such as the foodservice industry where clean and sanitary warehouses reduce the likelihood of foodborne illnesses. Moreover, clean and sanitary warehousing facilities can have a positive impact on employee safety, morale, and productivity while also reducing employee turnover.

Fortunately, warehouse cleanliness and sanitation are not predicated on complex theories or costly technology, but rather on common sense and diligence. For example, a leading provider of industrial cleaning equipment suggests that a company develop a schedule to clean its warehouse on a regular basis—and stick to the schedule. In addition, a company can instill a culture that focuses on warehouse cleanliness and that requires employees to clean up upon finishing a particular task. Another suggestion is to create teams of two or three people and assign each team a specific cleaning task. Rather than cleaning an entire warehouse, the teams can be assigned to one of four quadrants in order to make the task seem more manageable.

<table>
<thead>
<tr>
<th>Shortcoming</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Making it too easy for dock personnel to work in collusion with truck drivers</td>
<td>Fewer than 5% who commit crimes are prosecuted</td>
</tr>
<tr>
<td>Relying on safeguards that simply don't work</td>
<td>Security cameras aren't always turned on</td>
</tr>
<tr>
<td>Approach to theft is too reactive</td>
<td>Don't wait until theft reaches an &quot;unacceptable&quot; level</td>
</tr>
<tr>
<td>Not weeding out on-the-job substance abusers or dealers</td>
<td>Approximately 90% of drug users either steal or deal to support their habit</td>
</tr>
<tr>
<td>Not checking your checkers on a frequent basis</td>
<td>They may become complacent</td>
</tr>
<tr>
<td>Not making it easy to report theft and substance abuse</td>
<td>Outsourcing the reporting may be more effective</td>
</tr>
<tr>
<td>Hiring high-risk employees</td>
<td>An ounce of prevention is worth a pound of cure</td>
</tr>
</tbody>
</table>


---

Summary

This chapter focused on warehousing, the storage of inventories for varying periods of time. We began with a discussion of why warehousing exists in a logistics system. A key reason for warehousing is that production and consumption may not coincide, and warehousing can help smooth out imbalances between them. We discussed the differences among warehouses, distribution centers, and cross-docking facilities.

We also examined public, private, contract, and multiclient warehousing. Public warehousing managers have a number of established duties regarding the care of goods, and customers pay only for the space that is actually used to store their products. Private warehousing is owned by the firm using such facilities, and it is best used when an organization has large and steady demand patterns. Contract warehousing involves specially tailored warehousing services that are provided to one client on a long-term basis. Multiclient warehousing, a relatively new alternative, is a mixture of public and contract warehousing.

Various design considerations are relevant to warehousing, with trade-offs among them. For example, a decision to build up or out can affect a facility’s utilization of labor, mechanization, and automation. Similarly, organizations that prefer a fixed slot location for merchandise may have to build larger facilities to have a sufficient number of storage slots.

The chapter concluded with an examination of some key issues in warehousing operations. The material in this section emphasized that commonsense, low-cost approaches can facilitate effective and efficient management of warehousing operations. For example, warehousing safety could be enhanced if employees refrain from jumping from one dock plate to another.

Key Terms

Accumulating (bulk-making)  
Allocating (bulk-breaking)  
Assorting  
Contract warehousing  
Cross-docking  
Distribution centers  
Dunnage  
Fixed slot location  
Fulfillment centers  
Hazardous material(s)  
Multiclient warehousing  
Occupational Safety and Health Administration (OSHA)  
Private warehousing  
Public warehousing  
Regrouping function  
Sorting out  
Throughput  
Variable slot location  
Velocity slotting  
Warehouse automation  
Warehouses  
Warehousing

Questions for Discussion and Review

10.1 Why does warehousing exist in a supply chain?  
10.2 Explain the four ways that warehousing facilitates the regrouping function.  
10.3 Discuss the reasons for the popularity of cross-docking operations in contemporary logistics.  
10.4 Discuss the disadvantages to public warehousing.  
10.5 What are the advantages and disadvantages of private warehousing?  
10.6 Discuss why contract warehousing is a preferred alternative for many organizations.  
10.7 When might a multiclient warehousing arrangement be appropriate for a company?  
10.8 Explain how common sense can be helpful in terms of warehousing design.  
10.9 In terms of warehousing design, give examples of trade-offs involving space, labor, and mechanization.  
10.10 Distinguish between fixed and variable slot locations. How might they affect warehousing design?  
10.11 What are the major characteristics of single-dock layouts?  
10.12 Explain the relevance of aisle width in warehouse design.  
10.13 What are some of the prominent examples of warehouse automation according to the chapter? What are the pros and cons of warehouse automation?  
10.14 What are some potential nonstorage space needs that might impact warehousing design?  
10.15 How can warehousing productivity be improved without significant investment in technology or equipment?  
10.16 Discuss with the help of an example how governmental regulations have influenced warehousing safety in your country.  
10.17 Discuss how fires are a constant threat in warehousing.  
10.18 What is a hazardous material? What design elements should be considered when storing hazardous materials?  
10.19 What are the potential threats to warehousing security and what can be their consequences?  
10.20 How are cleanliness and sanitation relevant to warehousing operations?
CASE

CASE 10.1 FRESH PRODUCE CROSS-DOCKING FACILITY

Kevin Chong is the logistics manager of a fresh produce retailer in Singapore. As a fast-paced society, Singapore demands a very quick turnaround in many logistics operations. Kevin is undertaking a project to implement cross-docking at the retailer’s current distribution center at Tanjong Pagar, to substantially reduce the throughput time.

The distribution center replenishes all of the retailer’s outlets across the island country, 24 hours a day, 7 days a week. On an average, reefer containers arrive from overseas randomly at the rate of a twenty-foot equivalent unit (TEU) every two hours, with a deviation of plus or minus one. Due to the uncertainty at customs clearance, Kevin does not have control over the inbound containers’ exact arrival time. Whenever a container arrives, the cross-docking operations will need to quickly unload the goods, break bulk, sort, pick, and then load the goods onto outbound trucks. Kevin is evaluating cross-docking equipment systems. His primary concerns are the operating costs and the perishability loss of fresh produce. To simplify the decision making, it is estimated that a TEU container of goods loses $500 per hour due to the perishable nature of fresh produce. The speed of cross-docking operations does not affect the average waiting time for outbound delivery.

Kevin is evaluating the following four equipment systems proposed by different vendors:

1. A manual system that costs $400 and 110 minutes to cross-dock a TEU
2. A system aided by pick-to-light technology (the orders to be picked are identified by lights placed on shelves or racks) that costs $600 and 100 minutes to cross-dock a TEU
3. A system aided by pick-to-voice technology (the order pickers use a headphone and a microphone to communicate with a computerized system to pick orders) that costs $800 and 90 minutes to crossdock a TEU
4. A semi-automated system that costs $1,000 and 80 minutes to cross-dock a TEU

The times given above are average figures because the actual times taken could vary. The costs are all inclusive, including equipment depreciation, equipment running, and supporting labor costs. There are simplifications in the costs given above and the costs are assumed to be flat throughout the time.

Kevin needs to estimate how much time it will take for goods to flow through the cross-docking operations in each equipment system. He can then calculate the perishability loss on the basis of the throughput time.

Kevin recalls from college that queuing theory might be applicable to such a problem. Essentially, the theory of queuing deals with the trade-offs in a waiting line. Given a processing capacity, there is often a waiting line in front of a server due to the randomness in order arrivals and processing times. There is a cost, could be tangible or intangible, associated with keeping customers/goods waiting. Investments in the processing capacity can speed up the process and reduce the waiting times. However, an organization needs to find out the optimal capacity level to minimize the total cost, which includes both the capacity cost and the cost of waiting.

Suggested Readings


Use a software package that enables you to perform queueing analysis. Note that an M/M/1 queueing model assumes a single server, exponential arrival and service times, first come first served queueing rule, unlimited queue length, and infinite calling population. In the situation described above, the number of servers is always 1, although different equipment systems vary in terms of operating costs and cross-docking speed.

**QUESTIONS**

1. For each of the four equipment systems, calculate the expected number of inbound TEUs waiting in the queue for cross-docking.
2. For each of the four equipment systems, calculate the expected time of an inbound TEU in the queue, that is, the expected time a TEU must wait in line to be unloaded.
3. For each of the four equipment systems, what is the probability that an inbound TEU can be unloaded immediately upon arrival?
4. Which of the four equipment systems incurs the lowest total cost to the retailer? It is assumed that the retailer bears all the costs associated with perishability loss. The total cost involves operating costs and perishability loss of fresh produce.
5. What is the capacity utilization rate of each of the four equipment systems?
6. Kevin is also considering a fully automated system proposed by another vendor. The vendor believes that its fully automated system can set a record by taking only 70 minutes to cross-dock an inbound TEU. However, this system’s operating costs will be much higher than those of the other equipment systems, averaging $2,000 per TEU. Based on the total cost to the retailer, would you recommend that Kevin go for this fully automated system?
This chapter deals with the physical handling of products, and provides you with an example of the interconnectedness of logistics activities, with a particular emphasis on packaging and materials handling. You should keep in mind that packaging and materials handling decisions should not be made in isolation; rather, as Chapter 10 pointed out, certain warehousing decisions have distinct materials handling implications. For example, a decision to reduce aisle width to improve space utilization likely necessitates materials handling equipment capable of functioning in narrower aisles.

Each product has unique physical properties that, along with the normally accepted volumes or quantities in which it is traded or moved, determine how and when the product is packaged. A product may move in bulk from the manufacturer to a wholesaler, where the product may be placed into some type of container (e.g., barrel, box, or crate) prior to further distribution.

In turn, packaging attributes strongly influence materials handling concerns; nonpackaged products necessitate different handling than do packaged products. For example, bulk items (i.e., free flowing or loose) can be handled by pumps, shovels, or conveyor devices. Nonbulk materials can be placed in various types of containers and can be handled by such conveyances as carts, cranes, dollies, and forklifts.

This chapter begins with a discussion of product characteristics and how they might affect packaging and materials handling. Next, we look at several fundamentals of packaging, such as the promotional and protective functions as well as labeling considerations. This is followed by a discussion of select packaging issues that includes environmental protection and packaging inefficiencies. We then examine examines unit loads and unit load platforms such as pallets and slip sheets. The chapter concludes with a discussion of materials handling, with a particular emphasis on 10 materials handling principles and types of materials handling equipment.

PRODUCT CHARACTERISTICS

Various product characteristics can influence packaging and materials handling considerations. One is the product's physical characteristics. Substances exist in three forms—solid, liquid, gas—and each form has specific packaging requirements. For instance, metal cylinders are one method for the...
Packaging of gases, whereas metal pails can be used for the packaging of liquids. Another physical characteristic is the product's ability to withstand the elements; coal piles can be exposed to rain, whereas salt piles cannot. In a similar vein, some products can be exposed to freezing conditions, but others cannot. Product density (weight per volume) is yet another physical characteristic that can affect packaging considerations.

The physical characteristics of some goods can change while they are moving in the logistics channel. Consider natural rubber, for example. Exposure to moisture can make natural rubber moldy, while cold can cause it to crystalize. Alternatively, prolonged exposure to heat can cause natural rubber to soften, which makes it more difficult to handle and stack.¹

Products such as fresh produce, meats, fish, and baker's yeast are referred to as *perishables*. They require special packaging, loading, storage, and monitoring as they are moved from source to customer. The growth in popularity of washed, cut lettuce sold in plastic bags is an example of how packaging can benefit several members of the supply chain. The lettuce grower benefits because smaller, misshaped heads can be used, not merely the eye-pleasing, “perfect” heads. Both the retailer and the customer benefit because the shelf life is much longer for bagged lettuce than for head lettuce (bagged lettuce also carries a higher markup than does head lettuce).

Tropical fish are carried in plastic bags with enough water to cover them, but no more than necessary, to keep weight down. The area in the bag above the water is filled with oxygen. Sometimes tranquilizers are added to water to keep fish calm. The bag is sealed and placed in a plastic foam cooler, similar to a picnic cooler, which is then placed inside a cardboard box. Fish must be transported within 36 hours, although the time can be extended if oxygen is added to the bags.

In addition to physical characteristics, products also possess chemical characteristics that affect the manner in which they should be handled. Certain pairs of products are incompatible. For example, commodities that are sensitive to ethylene, such as broccoli, lettuce, and watermelon, should never be held for more than a few hours in the same area as products that emit ethylene, such as apples, pears, and tomatoes. Prolonged exposure to ethylene can cause ethylene-sensitive products to yellow, soften, and decay.

The various properties of goods must also be made known to consumers to help them make the correct buying decision and care for the product properly. For instance, Figure 11.1 shows a fabric care label that contains both symbols and words. Figure 11.2, which shows lumber markings, provides information about the type of wood (S-P-F) and its moisture content (KD-HT). More specifically, S-P-F indicates that the stud comes from a spruce, pine, or fir tree. The KD marking indicates that the stud is kiln-dried with a moisture content of between 16 and 19 percent, while HT signifies that the lumber is heat treated. In recent years, interest has grown in having an additional symbol that indicates the wood used for packing was free of insects. Nations in various parts of the world are concerned that untreated wood and wood materials used in packing carry a wide variety of unwanted insects.

### Packaging Fundamentals

**Packaging**, which refers to materials used for the containment, protection, handling, delivery, and presentation of goods,² can be thought of in terms of the building-blocks concept, in which a very small unit is placed into a slightly larger unit, which then might be placed into a larger unit, and so on. Consider the various bags, cans, cartons, jars, and so on that the customer sees on the shelves of a grocery store. These units were likely unpacked from some larger container, such as a crate or box, and these crates or boxes might have been delivered to the store on a unit load (which will be discussed later in the chapter).

² *Logistics Dictionary*, www.tntfreight.com
The building-blocks hierarchy is important to remember because each of the different building blocks is inside another, and their total effect should be to protect the product. They function in a complementary sense. When the consumer-size package is very solid, the larger packaging elements require less-sturdy packaging materials because the smaller packages are themselves sturdy. Alternatively, when the smallest package isn’t very solid (e.g., the retail packaging for lightbulbs), the larger packaging elements will require very sturdy packaging materials and/or careful arrangement of the smallest product to minimize damage.

Organizations should be aware of a number of packaging fundamentals. We will discuss three of them—functional tradeoffs, package testing and monitoring, and labeling—in this section.

**Functional Tradeoffs**

Packaging serves three general functions, namely, to promote, to protect, and to identify the relevant product. These disparate functions mean that packaging design decisions involve a number of separate departments within an organization, such as engineering, manufacturing, marketing, quality control, transportation, and warehousing. Moreover, upstream and downstream supply chain members
can also be involved in packaging design decisions; the departments and supply chain members tend to pursue different packaging design objectives.\textsuperscript{3}

With so many potential entities involved in packaging decisions, a natural question arises— which entity(ies) drive(s) the packaging design process?\textsuperscript{4} For example, the marketing department and retailers might prefer packaging designs that are attractive and that encourage consumers to purchase the product. Alternatively, quality control might be interested in packaging design that minimizes loss and damage. As such, while attractive packaging might encourage consumers to purchase a product, the attractive packaging might increase the chances of a product being stolen. As another example, transportation and warehousing might be interested in packaging designs that minimize the amount of a package container’s excess space—so that purchasing additional transportation or warehouse space might be minimized. Doing so, however, might lead to an overwhelming number of different-sized packaging containers—which would create an entirely different set of issues.

**Package Testing and Monitoring**

To properly design a protective packaging system requires three important kinds of information: the severity of the distribution environment, the fragility of the product to be protected, and the performance characteristics of various cushion materials. When new products or new packaging techniques are about to be introduced, it is sometimes advisable to have the packages pretested. Various packaging material manufacturers and trade organizations provide free package testing, and independent testing laboratories can also be used. The packages are subject to tests that attempt to duplicate all the expected various shipping hazards: vibrations, dropping, horizontal impacts, compression (having too much weight loaded on top), overexposure to extreme temperatures or moisture, and rough handling. In addition to the testing of new products or new packages, shippers should keep detailed records on all loss and damage claims. Statistical tests can be applied to the data to determine whether the damage pattern is randomly distributed. If it is not, efforts are made toward providing additional protection for areas in the package that are overly vulnerable. Some carriers also offer packaging test applications for their customers. For example, FedEx customers can ship a sample test package to the company, which will test the package at no cost to the customer. The package undergoes various tests to include multiple free-fall drops, vibration testing, and compression testing, among others.\textsuperscript{5}

Related to package testing is actual monitoring of the environment the package must pass through. This is done by enclosing recording devices within cartons of the product that are shipped. The measuring devices may be very simple, such as hospital-like thermometers that record only temperature extremes and springs that are set to snap only if a specified number of g’s (a measure of force) are exceeded. More sophisticated devices record a series of variables over time, such as temperature, humidity, and acceleration force and duration (in several directions). Acceleration force and duration are usually recorded along three different axes, making it possible to calculate the precise direction from which the force originated.

Package monitoring increasingly involves sensor technology that allows the transmission of real-time data. This real-time data quickly notifies shippers if something is amiss, such as whether a shipment isn’t where it should be at a particular time or whether a shipment’s temperature is too high or too low. This real-time data, in turn, allows shippers to quickly address the problem.\textsuperscript{6}

**Labeling**

Packaging is usually done at the end of the assembly line, so package labeling also occurs there because using this location avoids accumulating an inventory of preprinted packages. This is also a key


\textsuperscript{4}Ibid.

\textsuperscript{5}http://images.fedex.com/us/services/pdf/PKG_Testing_Under150Lbs.pdf

point for control because this is where there is an exact measure of what comes off the assembly line. As the packaged goods are moved from the end of the assembly line, they become stocks of finished goods and become the responsibility of the firm’s outbound logistics system. Near the point where product packaging occurs, it is necessary to maintain a complete inventory of all the packages, packing materials, and labels that will be used.

Once the material being packaged is placed into the box and the cover is closed, the contents are hidden. At this point, it becomes necessary to label the box. Whether words, pictures, or code numbers are used depends on the nature of the product and its vulnerability to pilferage. Retroreflective labels that can be read by optical scanners may also be applied. Batch numbers are frequently assigned to food and drug products, so they may be more easily traced in case of a product recall. Figure 11.3 shows a small sampling of labels that can be purchased for individual placement on cartons or pallets.

Figure 11.3  Examples of Shipping Labels  Source: Courtesy of Uline. www.uline.com
Many regulations govern the labeling of packaging, including the labeling of weight, specific contents, and instructions for use. Today, much of this information must also be placed outside the larger cartons as well, because some retail outlets sell in carton lots, and the buyer does not see the consumer package until he or she reaches home. In an increasingly global economy, it is important to recognize that labeling regulations differ from country to country. As a general rule, labeling requirements and enforcement tend to be more stringent in economically developed countries than in economically developing ones.

Moreover, labeling requirements within a particular country can differ from state to state (or province to province). In the United States, the liquor (alcoholic beverage) industry is heavily regulated, and states have liquor control boards that are responsible for regulating liquor-related activities, including labeling, within state borders. The labeling guidelines for liquor can be quite detailed and specific with respect to font type, font size, and label placement, among others. Failure to comply with the relevant labeling guidelines can result in surcharges, administrative fees, or penalty charges.

HAZARDOUS MATERIALS It is also important to recognize the special labeling requirements associated with hazardous materials. Although hazardous materials were defined and discussed in Chapter 10, almost any material can possess hazardous qualities under certain conditions; for example, flour dust can explode, and grain in elevators can self-ignite and burn. Special care is needed to handle these and many other substances.

Governmental regulations address labeling of hazardous materials. While the specific requirements differ for each hazardous commodity, all of the requirements involve labeling, packaging and repackaging, placing warnings on shipping documents, and notifying transportation carriers in advance. For example, a common requirement on transferring flammable materials is that the vehicle and the receiving or discharging device both be electrically grounded. Care must be taken to properly clean tanks, pumps, hoses, and cleaning apparatus to avoid contamination of the next cargo that is handled. Shipping documents must also indicate whether the cargo is of a hazardous nature, and sometimes additional documentation is required. Packages, containers, trailers, and railcars carrying hazardous materials must carry distinct signs, or placards, identifying the hazard.

Because hazardous materials are increasingly being stored and transported across country borders, the United Nations (UN) has played an active role in developing a global system to classify and label hazardous materials. One of the UN’s more recent efforts in this area involved its Globally Harmonized System of Classification and Labeling of Chemicals (GHS), which was first adopted in 2002. The GHS has been revised six times, most recently in 2015. It provides three key pieces of classification and labeling information: (1) a symbol; (2) a signal word (e.g., “danger”); and (3) a hazard statement (e.g., “explosion; severe projection hazard”). Unfortunately, to date fewer than 75 countries have implemented the GHS.

ISSUES IN PACKAGING

Environmental Protection

Public concern for environmental protection has profoundly impacted the packaging industry on a worldwide basis. Disposable packing materials are often viewed as wasteful, and their disposal is becoming increasingly expensive as costs increase for dumping in landfill sites. Plastic packaging, in particular, has become a frequent target for environmental critics. Although the use of plastic for packaging has grown dramatically over the past quarter century—plastic tends to be cheaper, more versatile, and more consumer friendly than paper—plastic leaves a great deal to be desired from an environmental perspective. One of plastic’s most frequently cited shortcomings is the length of time it takes to biodegrade, which can be up to several hundred years. Another environmental concern with

plastic packaging involves litter, and sometimes this litter has unintended ecological consequences. For example, plastic accounts for an overwhelming majority of the litter in marine habitats. At a minimum, this litter is visually unappealing and it also has negative consequences for wildlife which include entanglement, choking, and mortality.\(^8\)

A key problem facing those trying to choose packaging materials is that each nation’s (and, for that matter, each state’s or province’s) regulations can differ in terms of acceptable packaging. One reason that regulations differ is that different entities view environmental problems differently and enact regulations that address the issues of current concern to them. For instance, some jurisdictions focus on legislation that reduces plastic packaging because of litter-related as well as ecological considerations. Other plastic-related legislation, by contrast, aims to reduce the amount of packaging material that ends up in landfills.

Firms can adopt any number of environmentally friendly packaging strategies, and we’ll look at several of them. One strategy is to reduce the amount of packing materials used, but this is tempered by the fact that, as pointed out earlier, transportation carriers may have a great deal of influence on packaging specifications for goods they are transporting. Possible suggestions to reduce the amount of packing materials include the use of just one material, which should improve recyclability, as well as changing a product or format to minimize packaging waste.\(^9\) For example, the ability to download music to electronic devices has greatly decreased the sales of physical products—albums, cassettes, compact disks—with a concomitant elimination in the associated packaging for these product types.

Another packaging strategy is to use environmentally friendly packaging materials. For example, although plastic tends to be an environmentally unfriendly product, some plastics are less environmentally friendly than others. Polyvinyl chloride (PVC), commonly referred to as vinyl, is an extremely unfriendly plastic because it produces dioxin, a highly carcinogenic (cancer-causing) chemical.

Alternatively, biodegradable plastics (sometimes referred to as bioplastics), have found their greatest usage to date in packaging applications. Unlike traditional plastic packaging, biodegradable plastic packaging takes less time to break down, requires less energy to produce, is easier to recycle, and is non-toxic.\(^10\) For example, mushroom blocks, made from the roots of mushrooms and agricultural waste, have emerged in recent years as a biodegradable packaging alternative. Crate and Barrel, a retailer of housewares, furniture, and home accessories, currently uses mushroom blocks, as does Dell, the computer manufacturer. Importantly, the mushroom blocks are cost competitive with traditional plastic packaging such as styrofoam.\(^11\)

A third strategy is to use reusable containers, such as refillable glass beverage bottles. This cannot be done for all products because problems arise when goods in reused containers are contaminated by traces of whatever product had been carried earlier. As an example, dressed poultry (that is, the removal of blood and feathers after slaughter) often carries salmonella organisms (which are killed in cooking), and the organisms survive in the wooden crates used by the poultry processor and then may spread to vegetables if they are transported later in the same crate. As a result, the U.S. Food and Drug Administration (FDA) issued an order restricting the reuse of such containers to avoid food contamination.

An increasing number of companies currently utilize returnable containers of some type in their operations. For example, there has been a marked increase in the usage of reusable plastic containers by produce shippers due in part to improved and less expensive technological devices that allow shipments to be monitored while in transit. The reusable plastic containers provide benefits in

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\(^10\)http://www.biostockspro.com/7-advantages-of-biodegradable-plastics/

the produce cold chain such as improved product protection, improved packing efficiency that reduces transport and storage costs, and reduced labor costs.\textsuperscript{12}

A fourth environmentally friendly packaging strategy is to retain or support services that collect used packaging and recycle it. You might be familiar with these efforts if you live in a jurisdiction that has mandatory recycling requirements for newspaper and plastic and/or glass containers. This fourth strategy is well suited for companies that receive large quantities of packaged products; if sufficient units of waste material can be collected, it is easier to process for reuse. Recycling companies can specialize in plastic bottles, wooden pallets, cardboard cartons, aluminum cans, and glass bottles, among others.

Note that both the third and fourth strategies add a returned packaging loop to the supply chain and are examples of \textit{closed-loop systems}, or those that consider the return flow of products, their reuse, and the marketing and distribution of recovered products.

Before concluding our look at packaging and environmental protection, you should recognize that dust and vapors produced during bulk-cargo transfer operations are also being scrutinized more closely by public agencies. Coal dust can be blown for several miles from a large coal pile. In port areas, bulk materials that were once stored outside are now in enclosed structures. For products still left outside, elaborate vacuum systems are used to capture the dust created by handling, and ditches around the facility capture rainwater runoff so that it can be run through filters. Some states require handlers of petroleum products, including retail gasoline stations, to install vapor recovery systems. For liquids with vapor-escape problems, the transfer processes are redesigned so that tanks and other receptacles are loaded from the bottom rather than the top.

**Metric System**

The United States, along with Liberia and Myanmar (formerly Burma), are the only three countries in the world that do not currently use the metric system of measurement. Although this lack of uniformity might have been a relatively minor nuisance 30 years ago, economic globalization has led to increasing pressure on U.S. exporters to market their products overseas in metric units. Indeed, some importing nations levy fines against products that are not sold in metric measurements. More and more products are being packaged and sold in metric units, with the nonmetric equivalents printed in smaller type. For example, residents of the United States used to be able to purchase soft drinks in 16-ounce containers. Today, by contrast, the 16-ounce beverage container has been replaced by the 0.5-liter (approximately 16.9 ounces) beverage container.

One U.S. industry that has prominently embraced the metric system is the liquor-producing industry. This industry’s conversion to the metric system, which began in the 1970s, illustrates several of the potential challenges that might stand in the way of the United States formally adopting the metric system. As pointed out earlier in the chapter, the liquor industry is heavily regulated in the United States, and one example of this regulation is the high taxes that are applied to alcoholic beverages. These taxes became an issue in converting to the metric system because they were drawn up to be applicable to half pints, pints, quarts, and other English units of measure, as opposed to half liters and liters. Moreover, the liquor industry’s adoption of the metric system also caused some short-term packaging issues because the cartons that were used for transporting and storing quart bottles were in some cases just a bit too small to hold one-liter bottles.

**Identifying Packaging Inefficiencies**

We introduced the building-blocks concept of packaging earlier in this section. To refresh your memory, this means that a very small unit is placed into a slightly larger unit, which is then placed into a larger unit, and so on. The building-blocks concept is also useful for analyzing packaging inefficiency

in that packaging inefficiency tends to be compounded as one moves from a very small unit to a slightly larger unit, and so on. Packaging inefficiency can have a number of undesirable logistics consequences, including increased loss, increased damage, slower materials handling, higher storage costs, and higher transportation costs.

The compounding nature of packaging inefficiency is illustrated in the hypothetical example involving desktop tape dispensers that is presented in Table 11.1. According to Table 11.1, less than one-third of the available case cube is occupied by actual product, while approximately three-quarters of available pallet space is occupied by cases. Multiplying the case efficiency (31.6 percent) by the pallet load efficiency (75.4 percent) means that less than 25 percent (23.8 percent) of available pallet space is occupied by actual product. One implication of this level of inefficiency is that an increased number of pallets will be needed, which in turn leads to higher storage and transportation costs.

The identification of packaging inefficiencies is important because these inefficiencies have been described as the “last frontier” of logistics savings opportunities. Moreover, there can be impressive cost savings as well as operational improvements from improved packaging efficiency. For example, a leading packaging consultant indicates that a typical client achieves a 10% reduction in packaging, transportation, and warehousing costs. These savings are generated from fewer packing cartons, lower transport weights, improved case cube utilization, and less packaging support material (e.g., bubble wrap, packaging peanuts).13

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### TABLE 11.1  A Hypothetical Example of Packaging Inefficiency

<table>
<thead>
<tr>
<th>Product:</th>
<th>One (1) desktop tape dispenser (cube = 30 inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12 dispensers per carton</td>
</tr>
<tr>
<td>Product cube per carton:</td>
<td>30 cubic inches times 12 dispensers =</td>
</tr>
<tr>
<td>Carton dimensions:</td>
<td>1,140 cubic inches</td>
</tr>
<tr>
<td>Carton efficiency:</td>
<td>Product cube per carton divided by carton cube</td>
</tr>
<tr>
<td></td>
<td>360/1,140 = 31.6%</td>
</tr>
</tbody>
</table>

60 cartons can be put on a pallet
Pallet capacity: 90,720 cubic inches
Carton cube per pallet: 1,140 cubic inches per carton times 60 cartons =
68,400 cubic inches
Pallet load efficiency: Carton cube per pallet divided by pallet capacity
68,400/90,720 = 75.4%

Carton efficiency times pallet load efficiency = the amount of pallet cube that is actually product: 31.6% times 75.4% = 23.8%

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The carriers established these different classifications for two main reasons. First, packaging specifications determined by product density encourage shippers to tender loads in densities that make the best use of the equipment’s weight and volume capabilities. IKEA, the Swedish-based home furnishings chain, designs many of its products so that they can be shipped in a dense form. Such products are often displayed unassembled in retail stores, and customers realize that they can easily take them home in their automotive vehicles.

Second, carrier specifications for protective packaging reduce the likelihood of damage to products while they are being carried; this, in turn, reduces the amount of loss and damage claims placed against the carrier. Figure 11.4 shows the type of label (the “box maker’s certificate,” or BMC) that motor carriers and railroads require on fiber boxes used for shipping freight. It is the fiber box manufacturer’s assurance to the motor carriers and railroads that the boxes will be sturdy enough to meet their handling specifications. Note that a number of measures are used. For example, the size limit shown, 75 inches, means that the material should not be used in a package where the total length, width, and height, when added together, exceed 75 inches.

It is difficult to know exactly how much carrier tariffs and classifications control shippers’ packaging. Responsibility for damage in transit is one issue subject to carrier–shipper contract negotiation; if the carrier remains liable, the carrier specifies the level of packaging protection to be used. If the shipper assumes responsibility, the shipper may choose the type of packaging to use. Carrier deregulation has allowed corrugated packaging manufacturers and their customers to innovate with performance outside the traditional carrier packaging rules. As specific contract rates are negotiated between individual carriers and shippers, packaging requirements may, of course, be one element of negotiation.

Airlines, express delivery companies, and the U.S. Postal Service also have packaging requirements, although they are somewhat less detailed than those used by rail and motor carriers. These companies make extensive use of dimensional weight (also called dim weight), which considers a shipment’s density (the amount of space occupied in relation to actual weight) to determine a shipment’s billable weight. Dimensional weight assumed greater importance at the beginning of 2015 when both UPS and FedEx switched to calculating shipping rates based on dim weight, rather than

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actual weight. Because this switch is likely to increase shipping costs by approximately 30%, many companies are searching for ways to boost their dimensional weights.15

**UNIT LOADS IN MATERIALS HANDLING**

As mentioned earlier in this chapter, the packaging of materials is based on the building-blocks concept of putting products in containers that will provide efficient yet manageable units. This section discusses unit loads, an extension of the building-blocks concept to very large quantities. A unit load (unitization) refers to consolidation of several units (cartons or cases) into larger units to improve efficiency in handling and to reduce shipping costs.16 Handling efficiency can be facilitated by mechanical devices such as a pallet jack or forklift as well as by using a pallet or skid (a small platform made of plastic, metal, or wood on which goods are placed for handling by mechanical means). Figure 11.5 shows a number of unit loads resting on pallets and one unit load being moved with a pallet jack.

The unit load offers several advantages, one of which is additional protection to the cargo because the cartons are secured to the pallet by straps, shrink-wrapping, or some other bonding device that provides a sturdier building block. A second unit load advantage is that pilferage is discouraged because it can be difficult to remove a single package or its contents. Also, a pallet can be stacked so that the cartons containing the more valuable or more fragile items are on the inside of the unit load. The major advantage of the unit load is that it enables mechanical devices to be substituted for manual labor and numerous machines have been devised that can quickly build up or tear down a pallet load of materials. Indeed, robots are increasingly being used in conjunction with unit loads; Amazon, a major user of robots, estimates that robots allow orders to be picked two to three times faster than more labor-intensive practices.17

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16http://cscmp.org/digital/glossary/glossary.asp

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*Figure 11.5  Unit Loads  Source: Dmitry Kalinovsky/Shutterstock*
The unit load does have its limitations, however. It represents a larger quantity of an item than a single box—often 30 to 50 times as much. Therefore, it is of limited value to companies that deal in small quantities. And, although one unit load advantage is that mechanical devices can be substituted for manual labor, these mechanical devices cost money to purchase or lease. Manual pallet jacks (trucks) can range in price from $275 to $4,500 dollars, whereas conventional forklifts can range in price from $7,500 to $30,000. As a general rule, pallet jacks tend to have lower maximum load capacities than do conventional forklifts.

Yet another drawback to the unit load is the lack of standardization in terms of pallet sizes. Although the International Standards Organization (ISO) has established six international pallet size standards (see Table 11.2)—four in metric units, two in English units—literally hundreds of different pallet sizes are used by companies in the United States. If these shipments are exported from the United States, they must be repalletized, which means an increase in manual labor, and thus a diminution in potential advantages to the unit load concept.18

The discussion in this chapter thus far has emphasized the building of loads from small blocks into large blocks. However, the reverse is also true; that is, the large units or blocks must be broken down into their smaller component blocks, with the very smallest unit being the single item that the retail customer carries home.

### The Unit Load Platform

An important issue with respect to unit loading concerns the platform (basic unit) on which to place the unit load. The pallet is generally viewed as the basic unit in unit loading. In the United States, the wooden pallet has long been the backbone of the unit load in the sense that the vast majority (between 90 and 95 percent) of pallets are made of wood. Pallets can also be constructed from plastic, wood composites (such as fiberboard), paper, and metal. The choice of pallet material has increased in importance, in part because highly mechanized and automated materials handling systems subject pallets to greater stress than when materials handling involved less mechanization and automation.19

Each pallet material has its advantages and disadvantages, with price being a major drawback to both plastic and metal pallets. For example, a new 48” by 40” wood pallet costs around $25, whereas a new 48” by 40” plastic pallet costs approximately $110; a new 48” by 40” metal pallet costs approximately $200. However, one potential advantage to plastic and metal is their longevity relative to wood; wood pallets might last only one use, and their maximum life span is three years (and only with gentle use). Plastic pallets, by contrast, last at least five years, and life spans of over 10 years are not uncommon, whereas metal pallets can last for approximately 15 years. Another shortcoming

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of wood pallets is that they can break and splinter, which could pose safety dangers to workers and also necessitates pallet repairs (assuming the pallet is salvageable). Neither plastic nor metal pallets are likely to break and splinter, thus improving worker safety and resulting in minimal repair costs.

Another important consideration is pallet weight, with a typical 48\" x 40\" wood pallet weighing approximately 40 pounds, compared to 30 pounds for a similar-sized plastic pallet and 65 pounds for a similar-sized metal pallet. Fifty pounds is a significant weight in many logistics systems because it represents the approximate weight at which there is a noticeable increase in injuries, particularly back injuries, from manual handling. Furthermore, wood and plastic are much more flammable than is metal; you might recall from Chapter 10 that fires are a regular threat in warehousing.

Although pallets are a popular unit load platform, one disadvantage (regardless of material) is their height, and when goods are loaded aboard pallets into railcars, trailers, or containers, the space occupied by the pallet (approximately five inches) is unproductive. One alternative to the pallet is a slip sheet, a flat sheet of either fiberboard material or plastic, which is placed under the unit load. From a space utilization perspective, one pallet occupies 80 times more space than a plastic slip sheet. In addition, plastic slip sheets are lightweight, which reduces transportation costs.20

Until the early part of the twenty-first century, one major drawback to slip sheets was high product damage rates due to their fragility. However, advances in technology have created both stronger plastics and stronger fiberboard with which to construct slip sheets as well as improved materials handling equipment for moving slip sheets. As a result, the damage rates for slip-sheeted products are much improved.

**Beyond the Unit Load**

The next step in the building-blocks process is to stow the unit-load pallets into a waiting truck trailer, railcar, or container van. Increasingly this stowage is based upon load-planning software, and Figure 11.6 shows a computer printout from this type of software. The load-planning software depicted in Figure 11.6 suggests how to load a container with different sizes of cartons and tells where the loads for several customers should be loaded. The software recognizes, for example, that some cartons cannot be laid on their sides or cannot have other cartons placed on top of them. The software also takes into account the load’s center of gravity and the allowable weights on axles. When planning for refrigerated loads, the software will also take into account the need for air spaces.

Slight clearances must be maintained between pallets to allow for the loading and unloading processes. Bracing or inflatable dunnage bags (see Figure 11.7) are used to fill narrow empty spaces and, when inflated, they fill the void space and function as both a cushion and a brace. A problem involved with any bracing or cushioning device is that the load is subjected to forces from all directions. Even when cargoes are properly braced, various forces such as vibration, pitch, and roll can still cause damages. Continued vibrations may loosen screws on machinery or cause the contents of some bags or packages to settle, changing the type of support they give to the materials packed above them. For products that present this problem, special preloading vibrators are used to cause the load to settle immediately.

Some goods are so heavy that they utilize the railcar’s, trailer’s, or container’s weight capacity without filling its cubic capacity (a situation called **weighing out**). These loads, such as heavy machinery, must be carefully braced, and the weight must be distributed as evenly as possible. In highway trailers, for example, it is dangerous to have one side loaded more heavily than the other. In addition, the load should be distributed evenly over the axles.

**MATERIALS HANDLING**

As a supply chain is linked together, one of the concerns of those involved with logistics is the physical transfer of the product from one party to another: How will product be handled? In what form will it be? In what quantities? What kind of equipment is needed to handle or to store product?

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20www.desicant-solution.com
Materials handling generally receives little public attention, although there are periodic exceptions, perhaps most notably with respect to crane accidents. Indeed, a 2015 crane collapse in Mecca, Saudi Arabia that killed more than 100 people and injured upwards of 225 people received widespread attention around the world.

For our purposes, materials handling (also referred to as material handling) will be defined as “short-distance movement that usually takes place within the confines of a building such as a plant or
DC and between a building and a transportation service provider.”21 This short-distance movement distinguishes materials handling from transportation (which will be discussed in Chapters 12 and 13).

Nearly all products that are packaged—often in consumer-size boxes, bottles, or cans—are handled by the building-block concept of packaging that has been described previously. The other way that products, especially large quantities of products, are handled is in bulk. Bulk materials are in loose rather than in packaged form and are handled by pumps, shovel devices, conveyor belts (see Figure 11.8), or the mere force of gravity. The decision must be made as to where in the supply chain the bulk materials should be placed into smaller containers for further sale or shipment. Sometimes, bagged and bulk quantities of the same material are part of the same shipment; for example, bagged rice is placed on top of bulk rice to provide load stability on ocean vessels.

Bulk cargoes have various handling characteristics, one of which is density. Consider three different bulk materials, namely, iron ore, coal, and grain, each of which is characterized by a different density. One particular type of ship uses only two-thirds of its cubic capacity when carrying iron ore, yet the 15,800 tons of ore lower the vessel to its maximum allowable draft of 24 feet, 8 inches. Alternatively, when loaded with coal, the vessel cubes out; that is, the cubic capacity is filled before reaching its weight capacity, and the vessel is lowered to only 20 feet, 6 inches. Grain loads are lower density than either coal or iron ore; the ship’s draft when full of grain is slightly less than 20 feet.22

A material’s angle of repose is the size of angle that would be formed by the side of a conical stack of that material. The greater the angle, the higher the pile of materials that can be placed on a specific land area. Anthracite coal has an angle of repose of approximately 27 degrees, whereas for iron ore the angle is 35 degrees. This means more cubic yards of ore can be stockpiled on a given site and that the ore can be carried on a slightly steeper, narrower conveyor belt.


22 Correspondence from the Reiss Steamship Company to the authors.
Bulk liquids also have unique handling characteristics. Resistance to flow is measured as viscosity, which can be lowered by increasing the temperature of a liquid. Molasses, cooking oils, and many petroleum products are heated before an attempt is made to pump them.

Gases have unique handling properties, although most of them are handled within completely enclosed pipeline systems. An exception is liquefied natural gas, or LNG, which is cooled and compressed into liquid form that is 1/630 of its volume in gaseous state. In its liquefied, highly pressurized state, it is transported by oceangoing vessels in special tanks.

The handling process itself may change the characteristics (or quality) of the product. Rice grains cannot fall far without being broken. This influences the design of loading and unloading facilities so that the grains of rice never drop more than a few feet at any one time. When sugar is handled, a dust is formed because of abrasion between sugar crystals. This dust is also sugar, but it is in much finer form and has different sensitivities to moisture. The dust must be separated from the rest of the sugar, or the quality of the final bakery product in which the sugar is used will be affected.

An ideal equipment configuration for one bulk cargo may not be able to handle another. Another consideration is the size of particle of the cargo in question; costs are involved in pulverizing to a uniform size so it can be handled by pneumatic or slurry devices.

**Materials Handling Principles**

The Material Handling Institute, a leading non-profit trade association that represents the materials handling industry, has developed a list of 10 materials handling principles. The principles are particularly important when laying out the design of a warehousing facility or when troubleshooting to learn why a system is not performing well. Implementation of these principles may yield positive impacts on an organization’s profitability, customer service, and productivity. We will list and briefly describe each of the 10 material handling principles.

1. The **planning principle**. This principle focuses on proactive, rather than reactive, approaches to materials handling.
2. The **standardization principle**. This principle focuses on standardizing, where feasible, materials handling activities, processes, and equipment.
3. The **work principle**. This principle emphasizes working smarter, rather than harder, to achieve an organization’s productivity and customer satisfaction goals.
4. The **ergonomic principle**. Ergonomics refers to the science that seeks to adapt work or working conditions to suit the abilities of the worker. This principle recognizes that human limitations and capabilities should be considered when designing materials handling activities and operating materials handling equipment.
5. The **unit load principle**. This principle focuses on maximizing the value of unit loads.
6. The **space utilization principle**. This principle strives to make the best use of existing space.
7. The **system principle**. This principle emphasizes that the materials handling function impacts, and is impacted by, other logistics functions and activities.
8. The **automation principle**. This principle suggests that, where appropriate, automation can positively impact efficiency and reliability.
9. The **environmental principle**. Environmental impact and energy consumption should be considered as a criteria when designing or selecting alternative equipment and material handling systems.
10. The **life cycle cost principle**. A thorough economic analysis should account for the entire life cycle of all material handling equipment and resulting systems.

**Materials Handling Equipment**

A comprehensive discussion of materials handling equipment is beyond the scope of this text. Having said this, it is important to recognize that decisions about materials handling equipment can affect
the effectiveness, efficiency, and safety of logistics systems. Although forklifts, for example, facilitate the effective and efficient handling of unit loads, forklifts can be dangerous, and tens of thousands of forklift-caused injuries occur annually in the United States.

Moreover, it is important that the materials handling equipment be aligned with an organization’s objectives, customers, and products. This seems to be common sense, but the authors are aware of a consumer products company that redesigned one of its storage facilities with the primary purpose to be a state-of-the-art showcase in terms of materials handling equipment. Less than a year later, the storage facility had to be redesigned because the state-of-the-art materials handling equipment was inconsistent with the types of products sold by the company as well as with its customers’ ordering requirements.

Materials handling equipment can be divided into two categories—storage equipment and handling equipment. Examples of storage equipment include shelves, racks, and bins, whereas examples of handling equipment include conveyor systems, lift trucks, carts, and cranes. Although storage and handling equipment are very different, the choice of one often influences the choice of the other. For example, the use of storage racks might allow for narrow aisles, but narrow aisles require specialized handling equipment capable of moving both vertically and horizontally.

Materials handling equipment can also be categorized in terms of whether they are labor intensive, mechanized, or automated. True automation, such as automatic guided vehicles (AGVs), refers to an absence of human intervention, whereas mechanization refers to equipment that complements, rather than replaces, human contact (e.g., forklifts). A key trade-off among labor, mechanization, and automation involves the relevant volumes; because automation is a very high fixed cost option, sufficient volume is needed to make it cost-effective. It has been suggested that automation becomes economically viable only when a facility handles at least 50,000 cartons a day.

Decisions as to materials handling equipment can also be influenced by an organization’s order picking and assembly system. In picker-to-part systems, an order picker goes to where a product is located, such as with a forklift, whereas in part-to-picker systems, the pick location is brought to the picker, such as with carousels. These two systems involve trade-offs between travel time; recall that travel time accounts for between 60 and 80 percent of total order picking time.

Summary

Many considerations, such as a product’s physical characteristics, must be taken into account when thinking about packaging and materials handling decisions. Packaging can be thought of in terms of the building-blocks concept in which a very small unit is placed into a slightly larger unit, and so on. The chapter looked at a number of packaging issues. We began by distinguishing between packaging’s protective and promotional functions. We also learned that correct package labeling can impact the effectiveness and efficiency of logistics systems. Packaging has important environmental consequences and several environmentally friendly packaging strategies were identified and discussed.

Unit loads (unitization) were also discussed, with a particular emphasis on the characteristics of wood, plastic, and metal pallets. We then turned to an examination of materials handling and identified some of the challenges associated with handling the various types of bulk products. Ten materials handling principles were identified and described and these principles can improve the effectiveness and efficiency of logistics systems. The chapter concluded with a discussion of materials handling equipment and this equipment should be aligned with an organization’s objectives, customers, and products.

25Ibid.
### Key Terms

- Building-blocks concept
- Cubes out
- Dimensional weight (dim weight)
- Ergonomics
- Globally Harmonized System of Classification and Labeling of Chemicals (GHS)
- Materials handling (material handling)
- Packaging
- Pallet (skid)
- Part-to-picker system
- Picker-to-part system
- Slip sheet
- Unit load (unitization)
- Weighing out

### Questions for Discussion and Review

11.1 How do product characteristics influence packaging and materials handling considerations?
11.2 What is the building-blocks concept? How is it applied to the handling of packaged goods?
11.3 Discuss the functional tradeoffs in packaging.
11.4 What information is needed to design a protective package properly?
11.5 How is sensor technology used in package monitoring?
11.6 Why is it important to recognize that labeling requirements may differ from country to country?
11.7 Discuss some of the labeling requirements associated with hazardous materials.
11.8 What are some environmental disadvantages to plastic packaging?
11.9 What environmentally friendly packaging strategies might a firm adopt?
11.10 Discuss the relationship between packaging efficiency and logistics savings.
11.11 Why have carriers established different classifications of packaging?
11.12 What is dimensional weight and why is it an important consideration in logistics?
11.13 Discuss the advantages and disadvantages of the unit load.
11.14 What trade-offs exist between wood, plastic, and metal pallets?
11.15 What issues does the logistics manager face once unit loads have been placed onto a transportation vehicle?
11.16 Distinguish between weighing out and cubing out and explain how these concepts impact the logisician’s job.
11.17 Discuss the various handling characteristics associated with bulk cargoes.
11.18 Why is it important that materials handling be aligned with an organization’s objectives, customers, and products?
11.19 What are the different categories of materials handling equipment?
11.20 How might an organization’s order picking and assembly system influence its decisions on materials handling equipment?

### Suggested Readings


CASE

CASE 11.1 THE ADELAIDE DAIRY COMPANY

The Adelaide Dairy Company (ADC) is an Australian milk-processing company. Its plant near Adelaide currently produces infant milk powder for the domestic market. Recently, ADC won its first international customer when a retailer in Singapore placed orders for 60,000 3-kilogram tins of milk powder to be delivered progressively over 6 months.

ADC’s initial plan (which we refer to as Option A) was to package the milk powder in tins at its plant and ship the tins by sea to Singapore. ADC’s production cost, before packaging and logistics, was $3 per kilogram. The existing tin design was cylindrical and measured 21 centimeters in diameter and 22 centimeters in height externally. Each tin cost $3 from a local packaging materials supplier and weighed 0.3 kilogram. Therefore, each tin that was filled with milk powder weighed 3.3 kilograms. These tins would have to be palletized and shrink-wrapped to withstand a sea journey, before being loaded into temperature-controlled shipping containers. The internal dimensions of these containers were as follows: 2.28 meters wide by 2.12 meters high by 11.84 meters long. To stack and fit well within such a container, each palletized load must not exceed 1.067 meters in length, 1.067 meters in width, and 1 meter in height. Each wooden pallet (including shrink-wrapping materials) weighed 15 kilograms, cost $25, and was good for one-use only.

The loaded containers would be trucked from the processing plant to the Port of Adelaide at a cost of $500 per container. The total shipment weight could not exceed 20,000 kilograms per container because of highway weight restrictions. Insurance costs were 3 percent of the value of the shipment ready to be loaded aboard ship in Adelaide (that is, all of the company’s costs up to this point). The ocean freight cost from the Port of Adelaide to any address in Singapore was $2,500 per container.

For Option B, ADC’s supplier proposed a new tin design, so that pallet density could be increased. This new 3-kilogram capacity tin was also cylindrical, but measured 19.4 centimeters in diameter and 24.5 centimeters in height. Compared with the existing design, 20 more tins of the new design could be packed into the standard pallet under a triangular packing arrangement (similar to a honeycomb pattern). However, this redesigned tin would only be procured in smaller quantities, for the international market, and hence cost slightly more at $3.10 each.

To reduce wastage of packaging materials, ADC was also evaluating Option C. This involved first shipping milk powder in bulk (using unpalletized stackable drums loaded into shipping containers) from Adelaide to Singapore. Each airtight cylindrical drum, measuring 1 meter in height and 0.75 meter in diameter externally, had a capacity of 200 kilograms and weighed 32 kilograms when empty. Although a new drum cost $100, it could be resold for $80 in Singapore to be reused by a transporter of hazardous waste. A qualified contractor could then be hired in Singapore to repack the milk powder into 3-kilogram tins identical to the ones in Option A. While the repackaging contractor could supply these tins for just $2 each, it would charge a further $0.50 per kilogram to repack and deliver the milk powder locally to the retailer’s warehouse.

QUESTIONS

1. How many tins of milk powder can be loaded into a container under Option A?
2. How many tins of milk powder can be loaded into a container under Option B?
3. How many drums of milk powder can be loaded into a container under Option C?
4. What are the total costs of delivering the milk powder to the retailer under Option A?
5. What are the total costs of delivering the milk powder to the retailer under Option B?
6. What are the total costs of delivering the milk powder to the retailer under Option C?
7. Which option would you recommend? Why?
12
TRANSPORTATION

Learning Objectives

12.1 To compare and contrast transportation infrastructures in several countries
12.2 To identify the five modes of transportation and learn about their respective characteristics
12.3 To discuss intermodal transportation
12.4 To describe several types of transportation specialists
12.5 To explain how different types of regulation impact transportation
12.6 To identify the legal classification of transportation carriers

Transportation, which can be defined as the actual, physical movement of goods and people between two points, is pivotal to the successful operation of any supply chain because it carries the goods, literally, as they move along the chain. Transportation influences, or is influenced by, the logistics activities discussed in previous chapters. These include:

1. Transportation costs are directly affected by the location of the firm’s plants, warehouses, vendors, retail locations, and customers.
2. Inventory requirements are influenced by the mode of transport used. High-speed, high-priced transportation systems require smaller amounts of inventories in a logistics system, whereas slower, less-expensive transportation requires larger amounts of systemwide inventory.
3. The transport mode selected influences the packaging required, and carrier classification rules dictate package choice.
4. The type of carrier used dictates a manufacturing plant’s materials handling equipment, such as loading and unloading equipment and the design of the receiving and shipping docks.
5. An order-management philosophy that encourages maximum consolidation of shipments between common points enables a company to give larger shipments to its carriers and take advantage of volume discounts.
6. Customer service goals influence the type and quality of carrier and carrier service selected by the seller.

This chapter begins with a brief look at the transportation infrastructure in various countries throughout the world. This is followed by a thorough discussion of the five different types, or modes, of transportation: air, motor carrier (truck), pipeline, rail, and water (listed in alphabetical order). The chapter also discusses intermodal transportation and transportation specialists and concludes with an examination of transportation regulation and the legal classification of carriers.

In keeping with past practice in this and other basic logistics texts, the discussion of transportation will primarily be presented from the perspective of the United States and will primarily focus on domestic (within the U.S.) transportation. Having said this, readers should recognize that an individual country’s topology, economy, infrastructure, and other macroenvironmental factors could result in a different transportation system from that found in the United States. Moreover,
the globalization of the world’s economy means that an increasing number of shipments are being transported between multiple countries (international transportation), a topic that will be discussed in Chapter 14.

**COMPARING AND CONTRASTING TRANSPORTATION INFRASTRUCTURE**

Because many readers of this text reside outside the United States, we believe it would be helpful to present a brief comparison of the transportation infrastructure that exists in five highly populated countries located on various continents. These infrastructure data, shown in Table 12.1, indicate wide disparities in the various infrastructures; at a minimum, a lack of infrastructure makes it difficult to use that mode in domestic (within-country) transportation.

The relevant infrastructure statistic for air transportation in Table 12.1 is the number of paved runways over 3,047 meters (approximately 10,000 feet). This length is significant because a 10,000-foot runway has generally been viewed as adequate for accommodating the largest existing wide-body aircraft; wide-body aircraft are essential to long-haul international movements of both freight and passengers. According to Table 12.1, the United States by far has the most airports with paved runways of at least 10,000 feet, an indication that the United States is well positioned to participate in long-haul international movements. Although China currently reports over 70 airports with 10,000 foot runways, this number is expected to increase because the country plans to construct nearly 40 new commercial airports by 2020.

The infrastructure statistics for highway, pipeline, and water, presented in kilometers (1 kilometer is equivalent to approximately .62 miles), provide some interesting findings. For example, although Brazil and China are approximately the same geographic size, China currently has about 16 times more paved highway kilometers than Brazil. (It’s worth noting that China has added over 1,800,000 kilometers of paved highways since 2010.) The data also indicate that oil pipelines are much more prevalent in the United States, and that China has much more extensive inland waterways, relative to the four other countries listed in Table 12.1.

The Table 12.1 information on rail gauge (the distance between the inner sides of two parallel rail tracks) is also enlightening. The United States uses only one size—standard—rail gauge (1.435 meters) in its rail infrastructure. Brazil and China, by contrast, use broad gauge (1.676 meters), standard gauge, and narrow gauge (1.000 meter) in their rail infrastructure, whereas Nigeria primarily uses narrow gauge rail—with Nigeria’s narrow gauge measured at 1.067 meters rather than 1.000 meters.

<table>
<thead>
<tr>
<th></th>
<th>Brazil</th>
<th>China</th>
<th>Germany</th>
<th>Nigeria</th>
<th>United States</th>
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</thead>
<tbody>
<tr>
<td>Air</td>
<td>7</td>
<td>71</td>
<td>14</td>
<td>10</td>
<td>189</td>
</tr>
<tr>
<td>Highway (paved)</td>
<td>212,798 km</td>
<td>3,453,890 km</td>
<td>645,000 km</td>
<td>28,980 km</td>
<td>4,304,715 km</td>
</tr>
<tr>
<td>Pipeline (oil)</td>
<td>4,831 km</td>
<td>23,072 km</td>
<td>2,826 km</td>
<td>4,441 km</td>
<td>240,711 km</td>
</tr>
<tr>
<td>Broad gauge (1.676 meters) rail</td>
<td>5,822 km</td>
<td>100 km</td>
<td>194 km</td>
<td>190,000 km</td>
<td>43,209 km</td>
</tr>
<tr>
<td>Standard gauge (1.435 meters) rail</td>
<td></td>
<td></td>
<td></td>
<td>293 km</td>
<td>293,564 km</td>
</tr>
<tr>
<td>Narrow gauge (1.000 meter) rail</td>
<td>23,341 km</td>
<td>670 km</td>
<td>220 km</td>
<td>3,505 km</td>
<td></td>
</tr>
<tr>
<td>Water (inland)</td>
<td>50,000 km</td>
<td>110,000 km</td>
<td>7,467 km</td>
<td>8,600 km</td>
<td>41,009 km</td>
</tr>
</tbody>
</table>

*Number of paved runways over 3,047 meters (approximately 10,000 feet).

meter. The data on rail gauge are important because nonuniform rail gauge within a country, or between neighboring countries, means that shipments moving by rail will need to be transferred from one vehicle to another, which adds to both delivery time and costs. For example, China and India share a common border; while China primarily uses standard rail gauge, India, by contrast, primarily uses broad rail gauge.¹

### TRANSPORTATION MODES

Each of the five modes of transportation exists because of certain attributes that provide one or more advantages over the other modes of transportation. The attractiveness of a particular mode depends on the following attributes:²

- Cost (price that a carrier charges to transport a shipment)
- Speed (elapsed transit time from pickup to delivery)
- Reliability (consistency of delivery)
- Capability (amount of different types of product that can be transported)
- Capacity (volume that can be carried at one time)
- Flexibility (ability to deliver the product to the customer)

It is important to recognize that public policy can affect a mode’s performance on these attributes. Railroads, for example, were the dominant mode, as measured by ton miles (the number of tons multiplied by the number of miles transported) and revenues, in the United States from the nineteenth century through the middle part of the twentieth century. However, the development of the U.S. Interstate Highway System allowed motor carriers to improve their speed, reliability, and flexibility, and although railroads still have the largest share of ton miles, motor carriers now account for the majority of freight revenues.

From a public policy perspective, construction costs of the Interstate Highway System were primarily paid for by the U.S. government (90 percent), with the remaining construction costs paid for by state governments. This funding by both the federal and state governments is significant because U.S. railroads have been responsible for the construction costs of their track systems, whereas rail construction costs in other nations are often covered by the national government. As such, the U.S. railroads have a substantial cost disadvantage relative to motor carriers, and this cost disadvantage must be captured in railroad pricing practices.

We will take a rather detailed look at each of the five modes in this section. The discussion will be presented alphabetically by mode, beginning with airfreight.

### Airfreight

When one thinks of air transportation, one immediately thinks of speed, particularly on the line-haul (terminal-to-terminal movement of freight or passengers); modern jet aircraft are capable of traveling between 500 and 600 miles per hour, a speed that far exceeds any other form of transportation. Indeed, air is generally the fastest mode of transportation for shipments exceeding 600 miles although some motor carriers now offer overnight service of between 600 and 700 miles.

However, air transportation is a quite expensive form of transportation, and the line-haul cost of airfreight service is regarded as its primary disadvantage; many companies simply cannot afford to have their shipments travel by air. Moreover, because most shippers and consignees (receivers of freight) are not located at an airport, this requires transportation from the shipper to the origin airport as well as from the destination airport to the consignee. This accessorrial service (transportation service that is supplemental to the line-haul) adds to both transportation costs and transit time.

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and also increases the number of times a shipment is handled (thus increasing handling costs and the opportunities for loss and damage).

Unlike other forms of transportation, the great majority of airfreight is carried in the freight compartments of passenger airplanes (so called belly freight). This belly freight limits the capacity available for air shipments and is particularly problematic with respect to narrow-body (single-aisle) aircraft. For example, a United Airlines narrow-body Boeing 737-900 offers approximately 1,825 cubic feet of belly space, whereas a United Airlines wide-body Boeing 777-200 offers approximately 6,925 cubic feet of belly space. However, wide-body aircraft devoted to all-cargo service have impressive carrying capacity; the latest version of an all-cargo Boeing 747 can carry approximately 155 tons of freight.

The cost, speed, and capacity attributes mean that, for the most part, airfreight is best suited to high-value, lower-volume products that are of a perishable nature or otherwise require urgent or time-specific delivery. Airfreight rates discourage bulky cargo and use dimensional weight (also called dim weight), which considers a shipment’s density (the amount of space occupied in relation to actual weight) to determine a shipment’s billable weight. Examples of products that move by air include:

- Auto parts and accessories
- Cut flowers and nursery stock
- Electronic or electrical equipment, such as cell phones and iPods
- Fruits and vegetables
- Machinery and parts
- Metal products
- Photographic equipment, parts, and film
- Printed matter
- Wearing apparel

The reliability of airfreight is somewhat problematic. On the one hand, air’s tremendous speed relative to the other modes offers the potential to “make up lost time” that isn’t possible with the other modes. Alternatively, because so much airfreight is belly freight, the increasing congestion and resultant delays associated with air passenger transportation mean congestion and delays for airfreight. Moreover, weather conditions such as fog, snow, and thunderstorms can have an adverse effect on the reliability of airfreight transportation. Indeed, FedEx located its first (and still primary) air cargo hub in Memphis, Tennessee, in part because Memphis rarely experiences foggy conditions.

Motor Carriers

The backbone of the U.S. highway system is the Interstate Highway System (its formal name is the Dwight D. Eisenhower System of Interstate and Defense Highways), which was approved by federal legislation in 1956. This nearly 47,000-mile, high-speed, limited-access highway system has had a profound impact on economic development in the United States. From a logistics perspective, many companies began to locate manufacturing, assembly, and distribution facilities in close proximity to interstate highways. Indeed, accessibility to highways consistently ranks as the most important factor in annual surveys of corporate location decisions.

The most important business user of the highway system is the motor carrier (trucking) industry. One way of classifying motor carriers is according to whether they carry less-than-truckload (LTL) or truckload (TL) traffic. **Less-than-truckload (LTL)** shipments range from about 150 to 10,000 pounds; they are often too big to be handled manually, yet they do not fill an entire truck. Trucks that carry LTL freight have space for and plan to carry shipments of many other customers

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3 Data derived from www.unitedcargo.com/shipping
5 29th Annual Survey of Corporate Executives: A Realignment of Location Priorities
Simultaneously. Unlike TL carriers, LTL carriers operate through a system of terminals (a facility where freight is shifted between vehicles), and from each terminal small trucks go out to customers, delivering and picking up shipments. These shipments are then taken to a terminal, where they are loaded aboard line-haul trucks, which are driven to a terminal near the freight’s destination. The goods are unloaded from the line-haul carrier, move through the terminal, and are loaded aboard a small truck for local delivery. Prominent LTL carriers include ABF Freight, FedEx Freight, UPS Freight, and YRC Freight.

**Truckload (TL)** carriers focus on shipments of greater than 10,000 pounds, and although the exact weight depends on the product, it is close to the amount that would physically fill a truck trailer. For glassware, this might be 18,000 pounds; for canned goods, it might be 40,000 pounds. Although TL traffic may involve only one customer, it is possible that large shipments (greater than 10,000 pounds) from several customers can be consolidated into a truckload shipment. Whereas LTL shipments are routed through terminals, TL shipments tend to move directly from the shipper’s location to the consignee’s location. Prominent TL carriers include J.B. Hunt, Schneider National, Swift Transportation, and Werner Enterprises.

Although LTL companies tend to be limited in the type of freight that they haul—primarily dry freight such as apparel, books, and greeting cards, among others—TL companies can carry a plethora of freight types. These include, but are not limited to, dry freight, foodstuffs, refrigerated products, liquid products, animals and livestock, automobiles, and steel. Overall, although motor carriers have the ability to haul many different kinds of freight, their capacity is limited by highway weight and size (width, length) restrictions. For example, motor carriers using the Interstate Highway System are limited to a maximum gross vehicle weight of 80,000 pounds. With respect to size considerations, truck trailers can be a maximum of 102 inches wide; the maximum length for tractor-trailer combinations varies from state to state. You should recognize that some countries do not have size and weight restrictions for motor carriers.

Although U.S. motor carriers can travel wherever there are roads, their length of haul is mitigated by several factors, such as speed limits and hours-of-service (HOS) rules. HOS rules have been the subject of constant legislation and litigation in the United States since the beginning of the twenty-first century, and rather than trying to articulate the relevant rules, suffice it to say that—unlike automobile drivers—truck drivers are limited in terms of the number of hours that can be driven in a 24-hour period, as well as the number of hours that can be driven in a one-week period.

Both HOS and highway speed limits have long been justified on the basis of safety concerns, and several states (e.g., California, Oregon, Washington) mandate a two-tier speed limit policy in which the maximum speed for motor carriers is lower than for automotive vehicles. Having said this, several U.S. states have eliminated, or are in the process of eliminating, the lower maximum speed limit for truckers, which could potentially increase motor carriers’ length of haul. Readers should recognize that each country may have its own hours of service rules for motor carrier operators as well as its own speed limits. Canada, for example, has different hours of service rules depending on whether one is driving north or south of 60 degrees north latitude. In addition, 120 kilometers per hour (approximately 75 miles per hour) is the maximum speed limit in Canada’s British Columbia province, compared to 100 kilometers per hour in the province of Ontario.

Without question, the primary advantage for motor carriers is flexibility, or the ability to deliver the product to the customer (or where the customer has relatively easy access to it). For example, if you bought this textbook at your university’s bookstore, this book was delivered there by some type of motor carrier, perhaps an LTL carrier. If you bought this textbook from an online site, then it was most likely delivered to your residence by a truck, perhaps a small package truck. Indeed, a longtime slogan of the American Trucking Associations (a trade group that represents motor carrier interests) was, “If you have it, it moved by truck.”

As was the case with airfreight, weather considerations also affect the reliability of motor carrier delivery, and relevant weather considerations include ice, fog, snow, flooding, and high winds (which can affect bridge crossings). The reliability of motor carrier service is also affected by highway congestion, which is caused by increased travel demand, weather, roadway incidents (e.g,
disabled vehicle, accident), and construction. Highway congestion tends to be most severe in major metropolitan areas and is not likely to be alleviated by additional highway construction. Rather, technology-based approaches, such as intelligent transportation systems and computer routing software that factors in congestion, are being used to deal with road congestion.

Although the cost of motor carrier service is lower than for airfreight, motor carriers tend to be more costly than the remaining modes of transportation. Moreover, there can be significant cost variation depending on the type of motor carrier service that is purchased. Expedited trucking, such as provided by Panther Transportation and FedEx Custom Critical, tends to have the highest cost, whereas truckload transportation tends to have the lowest cost.

These cost variations highlight the importance of understanding the trade-offs between logistical activities that have been discussed throughout the text. For example, suppose an organization manufactures 8,000 pounds of cat litter per day. The company could have one 8,000-pound LTL shipment each day, or the company could accumulate five days of cat litter into one 40,000-pound TL shipment. This would be done to take advantage of the lower TL rate per hundredweight; however, to receive the lower TL rate, the company will need to hold an inventory of cat litter, thus increasing inventory and storage costs.

**Pipelines**

Pipelines are a unique mode of transportation because it is the only one without vehicles, and this is significant for several reasons. First, there is no need for vehicle operators, an important consideration given that some vehicle operators, such as airplane pilots and ship captains, can achieve annual compensation in excess of $200,000. In addition, vehicle operators sometimes engage in work stoppages (e.g., strikes) and can be the cause of accidents. The lack of vehicles also means that pipeline transportation is one way; other modes have two-way transportation, a fronthaul and a backhaul. The backhaul is often a significant source of excess capacity, or unused available space.

Pipelines’ lack of vehicles means that it is the most reliable form of transportation in part because there aren’t vehicle-related disruptions (such as accidents), and pipelines are virtually unaffected by adverse weather conditions. Having said this, pipelines tend to be the slowest form of transportation; the lack of vehicles means that the relevant product needs to be forced through the pipeline, often by pumping stations. The slow speed for pipelines is significant because this increases overall transit times and thus necessitates additional inventory in the logistics system.

From a capability perspective, pipelines are quite limited in the sense that products must be liquid, liquefiable, or gaseous in nature. Indeed, pipelines are probably best known for transporting petroleum products, and petroleum pipelines are characterized as either crude oil or product pipelines. Gathering lines, which are 6 inches or smaller in diameter, start at each well and carry crude oil to concentration points. Trunk lines carry crude oil from gathering-line concentration points to the oil refineries. Their diameter varies from 3 to 48 inches; 8- to 10-inch pipe is the most common size. Product pipelines carry products such as gasoline or aviation fuel from the refineries to tank farms (storage tanks) located nearer to customers. These products are stored at the tank farms and then delivered to customers by truck or by rail, an indication that pipelines have limited delivery flexibility.

Slurry systems allow bulk commodities to become liquefiable by grinding the solid material to a certain particle size, mixing it with a liquid to form a fluid muddy substance, pumping that substance through a pipeline, and then decanting the liquid and removing it, leaving the solid material. Although water is the most common liquid used in slurry systems, other liquids, such as methanol, can be used. The Black Mesa pipeline, which transports pulverized coal from northern Arizona to an electric-generating station, is probably the best-known slurry pipeline currently in operation; other slurry pipelines in current operation transport phosphate, limestone, copper concentrate, and iron concentrate.

Although pipelines tend to have limited capabilities with respect to the products that can be transported, pipelines are capable of transporting very large product volumes. For example, the
48-inch Trans-Alaska pipeline, which is 789 miles long, has a discharge capacity of two million barrels of oil per day. Moreover, pipelines are quite costly to construct and thus have high fixed costs; however, because these fixed costs can be spread over rather large capacities, pipelines offer their users a relatively low cost per unit.

**Railroads**

Although more than 550 freight railroads operate in the United States, over 90 percent of the rail industry’s revenues and ton-miles are accounted for by the seven Class I (2015 revenues of approximately $450 million) freight railroads. Moreover, the U.S. railroad industry is dominated by four freight carriers, the Burlington Northern (BN), CSX, Norfolk Southern (NS), and Union Pacific (UP); the BN and UP dominate rail freight transportation west of the Mississippi River, whereas CSX and NS have a similar position east of the Mississippi River.

This level of market concentration and domination is not found in the other modes, and from a practical perspective it can create limited service and pricing options for potential customers. One possible manifestation of limited service options might be seen in the railroads’ rather uneven reliability in recent years, some of which can be linked to adverse weather conditions. In recent years, major U.S. railroads have dealt with blizzards, record-setting cold temperatures, severe flooding, and tornadoes that have damaged many miles of rail track and caused significant transit time delays.

U.S. freight railroads present an intriguing paradox in the sense that they are not either the “best” or “worst” on any of the six attributes (capability, capacity, cost, flexibility, reliability, speed) that we’re using as a basis of comparison for the five transport modes. For example, although freight railroads have the potential to transport many different kinds of products (capability), they tend to transport lower-value, high-volume shipments of bulk-type commodities such as coal, chemicals, farm products, and nonmetallic minerals. Having said this, the growth of intermodal transportation (which will be more fully discussed later in the chapter) has given railroads access to manufactured and packaged products, which tend to be higher value. Overall, railroads are superior to air, motor, and pipeline, but inferior to water, in terms of their ability to transport different kinds of products.

Similarly, rails possess less flexibility (ability to deliver the product to the customer) than motor carriers, unless the customer is located on a rail line or has a rail siding (a track that runs from a main line to a particular facility). However, rails generally have greater flexibility than air, water, and pipeline. In terms of the volume that can be carried at any one time (capacity), rail is superior to air and motor, but not as good as pipeline or water. Boxcars (used to carry general freight), hopper cars (used to carry products like coal and minerals), and tank cars (used for liquid or liquefiable products) have usable carrying capacities of approximately 110 tons. Although this dwarfs the 25-ton capacity of a typical truck trailer, consider that the carrying capacity of one dry bulk barge (flatboard boat used to transport heavy products) is about 1,750 tons.

Freight railroads are also right in the middle of the five modes when it comes to cost (price that a carrier charges to transport a shipment) and speed (elapsed transit time from pickup to delivery) considerations. Although railroads are less expensive than air and motor, they are more expensive than pipeline and water. Alternatively, railroads are faster than both pipeline and water, but slower than air and truck.

**Water**

Freight moves by water on the Great Lakes, using vessels called lake freighters (lakers), as well as on inland waterways, using barges. Waterborne commerce also moves via oceangoing vessels between the mainland states (Lower 48) and Alaska, Hawaii, and Puerto Rico. Our discussion will focus on the

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6[www.aar.org](http://www.aar.org)

7Center for Ports and Waterways, *A Modal Comparison of Domestic Freight Transportation Effects on the General Public* (College Station, TX: Texas Transportation Institute, 2009).
inland waterways, primarily rivers, which are dredged to a depth of nine feet—the minimum depth required for most barges. Although minimum dredging depths might appear to be a rather mundane topic, it is actually quite important in the sense that inland water transportation is somewhat unreliable due to weather-related conditions such as drought and icing.

Drought creates problems because when water levels drop below acceptable levels, barges are forced to reduce their loads, or barge traffic might be halted altogether, situations that require alternate means of transportation. During 2012, for example, drought conditions closed an 11-mile stretch of the Mississippi, costing barge operators approximately $1 million per day. Flooding is another weather-related consideration that can affect the reliability of inland water transportation. For example, severe flooding caused parts of the Mississippi River to be closed to barge transportation in late 2015 and early 2016. Icing is a problem in northern states such as Minnesota and Wisconsin; the ice closes the rivers and prevents year-round operation. Because of this, customers can stockpile inventories in the fall to last through winter months or can use alternate methods of transportation.

However, not all of the unreliability associated with U.S. inland water transportation is weather related. More specifically, the waterways’ lock system (a lock raises or lowers barges so they can meet the river’s level as they move upstream or downstream) also contributes to transport unreliability. Many locks on the U.S. inland waterway system are quite old, with some locks dating to the 1930s, and their maintenance needs tend to increase as a function of age. With preventive maintenance of locks currently the exception rather than the rule, when a lock malfunctions the related repairs can take months to complete—a situation with potentially adverse consequences for shippers and barge operators.

Inland water transportation in the United States is also characterized by slow average speeds of approximately six miles per hour. It should be noted that transit times will be affected by the direction of travel; upstream movements that go against the prevailing current will be slower than downstream movements. In addition, inland waterways can be circuitous in nature, which can add to transit time. And, as previously pointed out, transit times may be extended because of lock-related maintenance considerations.

In terms of positive attributes, inland water transportation is relatively inexpensive to users. At one time, inland water transportation was considered to be the least expensive form of transportation, but fuel taxes that were imposed on inland water transportation in the 1980s permitted pipelines to become the least expensive mode. Nevertheless, inland water transportation is quite inexpensive when compared to rail and motor carrier transportation. As a general guideline, on a ton-mile basis, rail costs are approximately two to three times as high as inland water carriers, whereas truck costs are approximately 20 to 30 times higher than inland water carriers.

Although inland water carriers tend to focus on lower-value bulk commodities that can be handled by mechanical means such as pumps, scoops, and conveyors, many different kinds of products can be carried. The predominant commodity moved by barge is petroleum and petroleum-related products, followed by coal. Other products that move extensively in the inland waterway system include food and farm products, industrial chemicals, and minerals and stone. And, as pointed out in the previous section, inland water carriers can carry much greater volumes than can rail and truck.

**INTERMODAL TRANSPORTATION**

We have discussed each mode as if each acts in isolation from the others, but in an increasingly global economy, multiple modes are used to transport a shipment from its origin to its destination. For our purposes, **intermodal transportation** refers to transportation when using a container or other equipment that can be transferred from the vehicle of one mode to the vehicle of another.

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8Josh Sanburn, “As Barges Sit Idle along the Mississippi, the Economic Costs Grow,” business.time.com, August 22, 2012.
mode without the contents being reloaded or disturbed. With intermodal transportation, two or more modes work closely together in an attempt to utilize the advantages of each mode while at the same time minimizing their disadvantages. For example, a company might use piggyback transportation, that is, either truck trailer-on-flatcar or container-on-flatcar, to take advantage of rail’s low transportation costs on the line-haul along with truck’s ability to provide door-to-door service.

As evident in our definition, the container is an important type of equipment in intermodal transportation. Containers are moved by mechanical devices such as container cranes, and companies need only handle a container and not the freight inside it—thus providing a dramatic reduction in freight handling costs. Because the container is interchangeable among rail, truck, and water carriers, containers can be used in intermodal applications and provide the advantages offered by each of several modes. Both ocean carriers and railroads have developed methods of handling multiple containers at one time, thereby reducing the number of individual lifting and storage moves.

Containers are generally 8 feet wide, 8 feet high, and between 10 and 53 feet long. Most containers are dry-cargo boxes, although some are insulated and come with temperature-controlling devices. Specialized intermodal containers are also available that carry tanks for holding liquids or gases as well as containers that hold insulated or refrigerated cargo. Figure 12.1 shows several different types of containers.

Air freight containers, often referred to as unit load devices (ULDs), are constructed of lightweight metals and come in different sizes. Unlike the containers in Figure 12.1, air freight ULDs have somewhat irregular shapes, dictated by the contours of the fuselage into which they must fit.

Although intermodal containers can range between 10 and 53 feet in length, a commonly used metric is twenty-foot equivalent unit (TEU), which stands for 20-foot equivalent unit. Volumes of intermodal traffic are commonly expressed as so many TEUs, meaning they would fill that many

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20-foot containers. Water ports, for example, are often ranked in terms of the number of TEUs that are handled in a particular period of time. Likewise, containerships are measured by the number of TEUs that can be carried, and containership capacity continues to increase over time. Consider that in the year 2000—a time when many of today’s college undergraduates were younger than five years of age—the largest capacity containership was approximately 8,000 TEUs. By contrast, Mediterranean Shipping Company, a major ocean transportation company, began operating three 19,224 TEU vessels during 2015.

Not only did the container revolutionize freight handling, it also spurred cooperation between various modes to develop more effective and efficient transport offerings, such as land bridge services. Rather than all water service between two ports, land bridge services involve the use of surface transportation—usually rail transportation—between the origin and destination port. Consider, for example, a shipment of pineapples from Hawaii to Europe. Rather than the shipment going by water from Hawaii through the Panama Canal and then on to Europe, under land bridge service, the pineapples would move by containership from Hawaii to a U.S. West Coast port. From this port, the containers of pineapple would be placed on railcars and shipped across the United States to an East Coast port, where the containers would be loaded onto a vessel for continuation of the shipment to Europe. Although the land bridge adds to total transportation costs, the primary advantage to land bridge service is the reduction in total transit time from the origin to destination port.

**TRANSPORTATION SPECIALISTS**

In addition to the five basic modes and intermodal transportation, a number of different transportation specialists can provide value-added services to prospective customers. We will discuss several transportation specialists in the paragraphs that follow: Freight forwarders are not modes, but from the shipper’s viewpoint, they are analogous to other carriers. There are two types of domestic freight forwarders—surface and air—and they can best be thought of as consolidators of freight.

Surface carriers give volume discounts to customers shipping large quantities of freight at one time. For example, the LTL rate from city A to city B might be $5 per 100 pounds for shipments less than 20,000 pounds, whereas the TL rate might be $2 per 100 pounds when shipments of 20,000 pounds or more are tendered. Truckload rates are lower than LTL rates for three reasons: (1) the shipper loads the goods, and the consignee unloads the trailer; (2) the load goes directly from shipper to consignee without passing through terminals; and (3) paperwork, billing, and other administrative costs are little more for a 25,000-pound shipment than they would be for a 250-pound shipment.

The freight forwarder exists by offering a service to shippers that use LTL rates because they do not generate enough volume to use TL rates. Without the freight forwarder, the shipper has to use the $5 LTL rate. The freight forwarder, however, offers the same transportation service for a rate between the LTL and TL rate—say, $4 per 100 pounds. This is possible because the freight forwarder consolidates enough small shipments to reach a volume of at least 20,000 pounds and thus qualifies for the $2 per 100 pound TL rate. The freight forwarder typically offers pickup and delivery service but does not perform the line-haul service, which is done by motor carriers or railroads (in terms of intermodal service).

The air forwarding industry works with the air carriers and air forwarders to consolidate shipments and tend them in containers that are ready for aircraft loading. This results in significant ground-handling savings for the airlines. Therefore, airlines encourage forwarder traffic because it results in an agreeable division of labor: The forwarders provide the retailing function and deal with each individual shipper and consignee, and the airline concentrates on wholesaling, moving the forwarders’ loaded containers among major cities.

Some forwarders specialize in certain cargoes. A common example is in the garment industry, in which many small garment firms send large numbers of a few garments each to retail shops in most large cities. The garment forwarders use special containers in which the garments are on hangers and thus ready for display on arrival. Some forwarders specialize in animals, and their services
include arranging for transportation, customs clearance, documentation, quarantine facilities, lab services, and custom-made animal containers, among others.

Shippers’ associations perform basically the same function as surface and air freight forwarders, except that they do not operate as profit-making organizations. Shippers’ associations are membership cooperatives where membership can be based on different considerations, such as shipping a particular commodity or commodities, belonging to a particular industry, or being located in a particular area. Although shippers’ associations tend to be thought of as providing a large number of transportation-related services for their members (full-service associations), some shippers’ associations are primarily focused on achieving the lowest rates for their members (“rate negotiator” associations). One example of a shippers’ association is NASA (North American Shippers Association), which specializes in the transportation of beverages across the globe.11 NASA, like many other shippers’ associations, focuses on transportation cost savings for its members.

Brokers are another type of transportation specialist; they are companies that look to match a shipper’s freight with a carrier to transport it. Brokers look to secure the best transportation rate and service package available for shippers, while attempting to ensure that carriers operate as close as possible to maximum capacity. Brokers can handle both LTL and TL shipments; those handling LTL shipments consolidate them and then turn them over to motor carriers, freight forwarders, or shippers’ associations. With respect to TL shipments, brokers will retain a particular carrier and receive a portion of the transportation charges as compensation.

In some cases, third-party logistics (3PL) companies are involved in arranging transportation services. They try to find clients with complementary transportation needs so that equipment utilization can be increased, which should reduce transportation costs to the respective clients. As an example, one prominent 3PL was able to persuade Chrysler and Ford to share space on trucks that were delivering repair parts to both Chrysler and Ford dealerships in a particular geographic area. The 3PL was able to show both Chrysler and Ford that dedicated equipment (that is, equipment carrying only Chrysler or only Ford parts) led to additional equipment, additional shipments, and excess capacity for each party—thus increasing the costs of distributing the repair parts.

Much of the discussion up to this point has assumed that we are dealing with shipments that weigh at least several hundred pounds. We’ll conclude our discussion of transportation specialists by looking at parcel carriers, companies that specialize in transporting parcels, which are often referred to as packages that weigh up to 150 pounds. Parcel shippers have a variety of potential options available to them, one of which is Retail Ground, a service of the U.S. Postal Service. Retail Ground has size (130 inches in combined length and girth) and weight (70 pounds) limitations, with transportation charges based on weight, distance, and shape.12 In most cases, a parcel must be transported to the post office by the shipper, but it will be delivered to the receiver’s actual mailing address.

Another option for parcel shippers is United Parcel Service (UPS), which financially dwarfs any other transportation company in the United States (2015 revenues of approximately $49 billion from package operations). UPS was able to attract customers in its early years because it offered certain services, such as automatic daily pickups, multiple delivery attempts, and the return of undeliverable packages, that were not available from competitors such as the U.S. Postal Service—and UPS was able to offer this service at rates that were competitive with the U.S. Postal Service. Unlike the U.S. Postal Service, UPS rates include both pickup and delivery, and today UPS offers a range of parcel services via several modes of transport, to include truck, rail, and air.

Whereas UPS started as a package delivery company that emphasized line-haul movement by truck and in the 1980s expanded into air transportation, Federal Express (now FedEx Express) started as a package delivery company that emphasized service by air transportation and later expanded into line-haul movement by truck. Both UPS and FedEx now offer package shippers service options that include same-day service involving air transportation, next-day service involving air

11www.nasaships.com
12http://www.usps.com/ship/mail-shopping-services.htm
or truck, and second-day service involving air or truck, among others. The size and weight limitations for packages shipped by UPS and FedEx are similar, with both carriers limiting package sizes to a maximum of 108 inches in length and 165 inches in girth. And while the maximum package weight for UPS and FedEx is 150 pounds, both carriers mandate special guidelines and procedures when shipping packages that weigh more than 70 pounds (UPS) or 75 pounds (FedEx).

Package services are also available from Greyhound Lines (called Greyhound Package Express), which is the primary intercity bus company in the United States. As is the case with UPS and FedEx, several service options are available for package delivery, such as direct drive (which uses dedicated vehicles) and standard service (where the packages travel in special compartments on the bus). Packages that are sent via Greyhound Package Express are limited to a maximum weight of 100 pounds.13

TRANSPORTATION REGULATION

The five modes of transportation have been influenced, and continue to be influenced, by various types of regulation by federal, state, and local governments. You may not be aware, for example, that until 2007 commercial airline pilots in the United States faced mandatory retirement upon reaching 60 years of age (65 is now the mandatory retirement age for commercial pilots). Likewise, you might not be aware that there are very specific guidelines for the placement of lighting on truck trailers. The existence of these and other regulations has implications not only for transportation companies, but also for users of transportation companies because regulations can affect the effectiveness and efficiency of a user’s logistics system. Indeed, regulation costs money—regulations need to be codified, and government agencies (regulatory bodies) exist to enforce the regulations.

Our discussion in this section will focus on federal regulation of transportation in the United States. We will look at environmental, safety, and economic regulation. However, before proceeding with this discussion, readers should recognize that the level and degree of transportation regulation varies from country to country. For example, many of the world’s more industrialized economies have instituted fairly stringent regulations with respect to vehicle emissions (air pollution) from transportation equipment. In lesser economically developed countries, emissions regulations are much less stringent—if they exist at all. We are not here to judge the appropriateness or inappropriateness of transportation regulation in individual countries; rather, logisticians need to understand the relevant transportation regulations of the countries in which they conduct business as well as the cost and service implications of these regulations.

Environmental Regulation

The Environmental Protection Agency (EPA), a U.S. federal regulatory agency that was established to protect human health and the environment, influences transportation in a number of different ways. A major transportation-related concern of the EPA involves various types of pollution such as noise and air pollution. With respect to noise, the EPA is responsible for enforcing noise emissions from transportation equipment such as rail locomotives and truck tractors. In terms of air pollution, the EPA has mandated that rail locomotives and truck tractors must meet stringent emissions standards. With respect to locomotives, for example, EPA Tier 4 emission standards, which went into effect in 2015, required new locomotive engines to lower nitrous oxides emissions by approximately 75% compared to locomotive engines that went into service in 2005.14

The EPA is also quite concerned with resource conservation, and this is particularly germane in that transportation accounts for approximately two-thirds of the petroleum consumption in the United States. As such, improved fuel efficiency and reduced consumption of petroleum have

13 http://www.shipgreyhound.com/e/Pages/Faq.aspx#Ship_Q14
become important issues for many transportation companies. For example, United Airlines has improved its aircraft fuel efficiency by over 33% since 1994 and in 2016 began a three-year trial of sustainable aviation biofuel at Los Angeles International Airport.15

**Safety Regulation**

The **Department of Transportation (DOT)** is the U.S. federal government body with primary responsibility for transportation safety regulation. Although the DOT's safety responsibilities encompass all five modes of transportation, safety regulation of inland water carriers is primarily the responsibility of the U.S. Coast Guard, which is now part of the U.S. Department of Homeland Security. The key federal government safety agency for each mode, along with an example of its roles or responsibilities, will be discussed in the following paragraphs.

The Federal Aviation Administration (FAA) has primary responsibility for air transportation safety and strives to improve the safety and efficiency of aviation. One of the FAA’s primary roles involves airspace and air traffic management and to this end the FAA operates airport towers and air traffic control centers.16 The Federal Motor Carrier Safety Administration (FMCSA), a relatively new government agency, started operations in January 2000. It is focused on reducing crashes, injuries, and fatalities involving large trucks and buses. As such, the FMCSA focuses on strong enforcement of safety regulations; targeting high-risk carriers and commercial motor vehicle drivers; and improving safety information systems and commercial motor vehicle technologies.17

The Office of Pipeline Safety (OPS), which is part of the Pipeline and Hazardous Materials Safety Administration, is responsible for safety considerations for natural gas and liquid pipelines. The OPS has responsibility for establishing and enforcing regulations with respect to pipeline design, construction, and operation.18 Among its myriad responsibilities, the Federal Railroad Administration (FRA) also has primary responsibility for safety in the U.S. railroad industry. The FRA employs approximately 400 safety inspectors who investigate five distinct disciplines, namely, hazardous materials; motive power and equipment; operating practices, including drug and alcohol issue; track structures; and signal and train control issues.19 Finally, the U.S. Coast Guard (USCG) has three broad roles associated with marine (water) transportation, namely, safety, security, and stewardship. Prominent USCG safety roles include promoting safe boating practices, accident investigation, and licensing mariners.20

**Economic Regulation**

Economic regulation in transportation refers to control over business practices and activities such as entry and exit, pricing, service, accounting and financial issues, and mergers and acquisitions. Federal economic regulation of transportation in the United States, which began in the 1870s, was justified because of transportation's economic and social importance as well as a belief that transportation companies would not act in the public’s best interest without government regulation.21 Economic regulation resulted in the creation of two key economic regulatory bodies, the Interstate Commerce Commission (ICC), with authority over rail, motor, inland water, and oil pipelines, and the Civil Aeronautics Board (CAB), with authority over air transportation.

Although a comprehensive discussion of the economic regulation of transportation is beyond the scope of this book, one of the authors worked for an LTL company while the LTL industry was

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16http://www.faa.gov/about/safety_efficiency/
17http://www.fmcsa.dot.gov/mission/about-us
18http://www.phmsa.dot.gov/pipeline/about
19http://www.fra.dot.gov/us/content/3
economically regulated, and his experiences offer insight into the challenges presented by economic regulation. For example, under economic regulation, price competition among LTL carriers was limited and carriers could set their prices through collective ratemaking (i.e., sharing cost and price information with one another) without fear of legal prosecution. This meant that all LTL carriers charged the exact same prices for transporting shipments between any two points and when companies can’t compete on price, they must compete on service. As such, one reason that the author’s employer chose the name “AAA Trucking Corporation” was because it would be the first listing in a telephone book.

Beginning in the late 1970s, various sectors of the transportation industry experienced a reduction in economic regulation (also referred to as deregulation), and in 1985 the CAB went out of existence. The Interstate Commerce Commission was legislated out of existence in 1995, and its remaining economic regulatory functions were transferred to a new agency, the Surface Transportation Board (STB), which is affiliated with the Department of Transportation. Although the STB has primary responsibility for resolving railroad rate and service disputes and reviewing potential rail mergers, it continues to have some jurisdiction over motor carriers, domestic water transportation, and the rates and services of pipelines that are not regulated by the Federal Energy Regulatory Commission.22

From a logistics perspective, the economic deregulation of transportation is important because it has allowed transportation companies much greater freedom with respect to pricing and service options—two attributes that are at the heart of the tailored logistics concept that was presented in Chapter 1. In addition, the economic deregulation that occurred in the United States spurred economic deregulation (sometimes called “liberalization”) in many other countries. This movement has been particularly noticeable with respect to air transportation.

LEGAL CLASSIFICATION OF CARRIERS

Although there has been a dramatic reduction in U.S. economic regulation since the late 1970s, the legal classification of carriers continues to be relevant. More specifically, transportation carriers are classified as either for hire or private, and for-hire carriers can be further subdivided into common, contract, and exempt carriers. The legal classification of carriers is important because of the varying levels of economic regulation that are applicable to the different carriers (for example, common carriers have more extensive economic regulation than contract carriers). However, all carriers, regardless of their legal classification, must comply with the relevant environmental and safety regulations.

The key factor that separates a common carrier from other forms of transportation is that the common carrier has agreed to serve the general public. To ensure that the general public is adequately serviced, common carriers assumed four specific obligations: to serve, to deliver, to charge reasonable rates, and to avoid discrimination in pricing and service. The service obligation means that common carriers are supposed to serve all customers who request service, so long as the commodity and origin/destination are within a carrier’s scope of service. For example, a motor carrier that specializes in dry van, general freight service would not be expected to transport a shipment of liquid chemicals. Even though a company might not want to carry certain types of freight, its undesirability is not a legitimate reason to avoid the obligation to serve. To this end, in recent years the major U.S. freight railroads have tried to convince the Surface Transportation Board to waive their common carrier obligations associated with the transportation of hazardous chemicals such as chlorine.23

The obligation to deliver requires that a carrier provide timely pickup and delivery as well as ensuring that the delivered shipment is in the same condition as the picked-up shipment (i.e., the avoidance of lost or damaged freight). The obligation to charge reasonable rates has long been viewed as offering protection for both carriers and users; the idea of reasonable rates guards against

22http://www.stb.dot.gov/stb/about/overview.html
rates so low that carriers are unable or unwilling to carry freight, and it guards against rates so high
that users are unwilling or unable to tender freight to carriers. The obligation to avoid discrimination
in pricing and service suggests that similarly situated customers (e.g., customers that ship the same
product, customers that ship to the same origin and destination point) should receive identical treat-
ment. One of the key provisions of the ICC Termination Act of 1995 was the elimination of the
reasonable rate obligation (hence, also, the obligation to avoid discrimination in pricing and service)
for many types of motor carriers.

A **contract carrier** offers a specialized service to customers on a contractual basis. The contract
specifies the compensation to be received, the services to be provided, and the type of equipment
to be used, among other details. Unlike the common carrier, the contract carrier is under no
obligation to render services to the general public and only has to serve customers with whom it has
contracts. Moreover, the contract carrier is under no obligation to treat its customers on an equal
basis. Because each contract can be tailored to the specifications of individual customers, contract
 carriage is viewed as offering many of the advantages of private transportation (such as control over
service) while avoiding many of the disadvantages of private transportation (e.g., the hiring of drivers,
owners equipment).

**Exempt carriers** are for-hire carriers that have been exempted from economic regulation
through provisions in various pieces of legislation; the appropriate rates and services must be
negotiated directly between the carrier and user. For example, the Transportation Act of 1940,
which brought domestic water carriers under economic regulation, exempted liquid-bulk com-
modities from economic regulation, as well as dry-bulk commodities, as long as no more than
three dry-bulk commodities were moved in a particular tow.24 In a similar fashion, the Motor
Carrier Act of 1935, which brought motor carriers under economic regulation, exempted unpro-
cessed agricultural commodities from economic regulation; the Motor Carrier Act of 1980, which
lessened economic regulation for motor carriers, exempted agricultural seeds and plants from
regulation.25

**Private carriers**, which are exempt from any economic regulation, are companies whose pri-
mary business is other than transportation. They provide their own transportation service by operat-
ing trucks, railcars, barges, ships, or airplanes. Private transportation is most prevalent in the trucking
industry, accounting for over 50 percent of the U.S. highway mileage for trucks.26 Prominent private
truckers in the United States include Coca-Cola Company, Sysco Corporation, US Foods, and
Walmart, among others.

One advantage to private transportation is that the equipment can serve as a rolling billboard
that allows an organization to promote itself. Operational control is another advantage to private
transportation, in part because shipments can move at a time convenient for the company, as
opposed to a time that might be convenient for a for-hire carrier. Private transportation can also
provide important competitive advantages to an organization. For example, private truck fleets
allow organizations to better serve key customers relative to the performance of for-hire carriers.27

Although private transportation can be a cost-effective form of transportation, a key disad-
vantage is that it can be quite costly, in part because of the capital expenditures that are necessary to
own or lease the relevant vehicles as well as regular expenditures to maintain the vehicles. Moreover,
managerial costs are often ignored or underestimated; many private fleets require at least one full-
time employee to manage the various responsibilities such as vehicle selection, vehicle maintenance,
staffing, labor relations, regulatory compliance, and so on.

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25 Ibid.
Summary

Transportation, the actual, physical movement of goods and people between two points, is pivotal to the success of any logistics or supply chain operation. The chapter began by comparing transportation infrastructures in several different countries and found distinct infrastructural differences across the countries.

The chapter then discussed the five modes of transportation in terms of each mode’s capability, capacity, cost, flexibility, reliability, and speed. This mode-by-mode discussion was followed by a look at intermodal transportation, with a particular focus on containerization. The roles that can be played by transportation specialists such as freight forwarders and brokers were also examined.

The chapter discussed environmental regulation, safety regulation, and economic regulation as they apply to transportation. We learned that a number of U.S. federal agencies are responsible for transportation and also that the levels and types of regulation may not be consistent across modes. The chapter concluded with a look at the four legal classifications of carriers—common, contract, exempt, and private.

Key Terms

<table>
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<tr>
<th>Accessorial service</th>
<th>Intermodal transportation</th>
<th>Shippers’ associations</th>
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<td>Barge</td>
<td>Land bridge services</td>
<td>Slurry systems</td>
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<td>Brokers</td>
<td>Less-than-truckload (LTL)</td>
<td>Surface Transportation Board</td>
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<td>Common carrier</td>
<td>Line-haul</td>
<td>Twenty-foot equivalent unit (TEU)</td>
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<td>Consignees</td>
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<td>Contract carrier</td>
<td>Parcel carriers</td>
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<td>Department of Transportation (DOT)</td>
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<td>Exempt carriers</td>
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<td>Truckload (TL)</td>
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<td>Freight forwarders</td>
<td>Rail gauge</td>
<td>Unit load devices (ULDs)</td>
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Questions for Discussion and Review

12.1 Why is transportation important to a firm’s supply chain operations?
12.2 Which attributes are considered while selecting transportation modes?
12.3 Discuss the speed of airfreight transportation in terms of the line-haul and accessorial service.
12.4 Why is the reliability of airfreight transportation somewhat problematic?
12.5 How do truckload operations differ from less-than-truckload operations?
12.6 Explain why the rates for truckload are relatively lower than for less-than-truckload.
12.7 What are the different types of pipelines used in the industry?
12.8 What are pipeline slurry systems? How do they function?
12.9 Discuss the drawbacks to rail transportation.
12.10 How do weather conditions influence the reliability of inland water carriers?
12.11 What are the positive and negative attributes of inland water transportation?
12.12 How do containers help facilitate intermodal transportation?
12.13 What are freight forwarders? How do they function? What services do they perform?
12.14 Discuss the role of brokers in transportation with examples from your country.
12.15 Discuss the various options that are available to parcel shippers in your country.
12.16 List several environmental regulations existing in your country and describe their impact on transportation.
12.17 Pick three modes of transportation, name the government agency in your country responsible for safety regulations for each of the modes that you have picked, and provide a safety-related role or responsibility for each mode.
12.18 Define what is meant by economic regulation. Why is transportation economic deregulation important?
12.19 How does a common carrier differ from a contract carrier?
12.20 Discuss advantages and disadvantages to private transportation.
Suggested Readings


CASE

CASE 12.1 HDT TRUCK COMPANY

HDT Truck Company has been located in Crown Point, Indiana, since 1910. Its only products—large trucks—are built to individual customer specifications. The firm once produced automobiles but dropped out of the auto business in 1924. The firm nearly went out of business in 1924. The firm nearly went out of business in 1970, HDT had manufactured only large off-road vehicles, including airport snowplows, airport crash trucks, oil-field drilling equipment, and the like. HDT purchased all components from small manufacturers that were still clustered in the Milwaukee–Detroit–Toledo–Cleveland area. Essentially, all HDT did was assemble components into specialized vehicles containing the combinations of frame, transmission, axles, cab, and other equipment necessary to do the job. The assembly line was relatively slow. After wheels were attached to the frame and axles, the night shift labor force would push the chassis along to its next station on the line so it would be in place for the next day’s shift. By using one shift, two trucks could be assembled each day. If large orders for identical trucks were involved, it was possible to assemble three trucks per day. Quality declined whenever the pace quickened.

HDT officials had decided they could not grow and became satisfied with their niche in the very-heavy-truck market. With only two exceptions, since 1970, HDT had always had at least a four-month backlog of orders. In the 1960s, its best market had been airports, but since 1980 its best market had been for oil-field equipment, first for the North Slope in Alaska and then for the Middle East. The U.S. military was also a regular customer.

In late 2002, HDT received an order for 50 heavy trucks to be used in the oil fields of Saudi Arabia. The terms of sale were delivery on or before July 1, 2003, at the Port of Doha, Saudi Arabia. Specifically, HDT would receive $172,000 per truck in U.S. funds FAS (free alongside ship) at the discharging vessel in Doha, which meant that HDT was responsible for all transportation costs up until the time and point the trucks were discharged from the ship’s tackle at Doha. Once each truck was unloaded, HDT would be paid for it.

Chris Reynolds, production manager at HDT, estimated that production could start approximately April 1, 2003, and the order would take 18 working days to
complete. Because weekends were involved, all 50 trucks would be completed by April 20 to 25. Reynolds thought that May 1, 2003, was a more realistic completion date because he had always found it difficult to restrict the assembly line to constructing trucks for only one account. The reason for this was that Vic Guillou, HDT’s sales manager, liked to have trucks being built for as many accounts as possible on the assembly line at any one time. Prospective buyers frequently visited the plant and were always more impressed when they could see a diverse collection of models being built for a wide range of uses.

Norman Pon, HDT’s treasurer, wanted to give priority to building trucks that were being sold on an FOB plant basis because that would improve his cash flow position. At the time the $172,000 price had been set on the truck sale to Saudi Arabia, Pon had argued (unsuccessfully) that the price was too low. Guillou, on the other hand, argued that the sale was necessary because the Middle East represented a growth market by anyone’s definition, and he wanted HDT trucks there. HDT’s president, Gordon Robertson, had sided with Guillou. Robertson thought that Pon was a good treasurer but too much of a worrier when it came to making important decisions. Pon, in turn, thought that Robertson had yet to shed the image he had acquired in the 1980s when his late father was president of HDT. Pon had lost count of the number of times the elder Robertson had needed cash to buy his son’s way out of some embarrassing situation. Guillou was young Robertson’s fraternity roommate in college, and Pon thought the two of them shared a similar love of life in the fast lane.

At the time the order was signed in 2002, Guillou argued that the FAS destination port represented the best terms of sale because ocean charter rates were declining as a result of an oversupply of tonnage. Guillou predicted that by mid-2003 charter rates would be so low that the cheapest method of transport would be to load all 50 trucks on one vessel. Pon countered that HDT should try to make a profit only from the manufacture of trucks because nobody in the firm knew much about ocean shipping. Robertson, who was a gambler at heart, disagreed.

In March 2003, Reynolds had the 50-truck order scheduled to be on the line from April 2 to 29, which represented 2.5 trucks per working day. Other work was scheduled for the assembly line at the same time, so the production schedule was considered firm. Component parts for the oil-field trucks and for the other trucks were already arriving. Orders were backlogged for over seven months, the highest figure since 1989. This was due, almost in total, to Guillou’s additional sales of oil-field equipment to Middle Eastern producers. Three separate orders, totaling 115 trucks, were involved.

Robertson and Guillou left Crown Point for an industry convention in San Diego. Robertson phoned from San Diego that he and Guillou had decided to vacation in Mexico for a while before returning to Crown Point. Robertson knew that HDT could function in his absence and knew that with Pon overseeing operations, the company’s assets would be safe. Several days later, a Mexican postcard postmarked in Tijuana arrived, saying that both were enjoying Mexico and would stay longer than initially planned.

Pon was relieved to learn that Guillou and Robertson would be gone for a longer time and immediately began wondering what types of bills they were accumulating in Mexico and for which ones they would want company reimbursement. Both had several credit cards belonging to the company. Based on experience, Pon also expected Robertson to phone on his cell phone for a cash advance or transfer about once a week. (Robertson did not want charge records generated for some of his expenses.)

As usual, Pon started wondering how paying for the Robertson and Guillou vacation venture would affect HDT’s cash flow. Pon looked at his cash flow projections, which were always made up for six weeks in advance, in this case through the first of April, when some of the bills for components of the oil-field trucks would come due. In fact, if Reynolds’s schedule were adhered to, all the components would be on hand by April 10 and, if HDT were to receive the customary discounts, all of the components would have to be paid for in the period between April 8 and April 20 (HDT received a 1 percent discount for goods paid for within 10 days of actual or requested receipt, whichever came later). For a moment, Pon thought that the worst might happen: The component bills would be due at the same time as Robertson’s and Guillou’s request for a hefty cash advance. He called the Crown Point Bank and Trust Company, where HDT had a line of credit, and learned that the current rate was 8 percent per annum. He then asked Bob Vanderpool, who was HDT’s traffic manager, when the oil-field trucks would arrive in Saudi Arabia.

“I don’t know,” was Vanderpool’s reply. “I assumed that Guillou had arranged for transportation at the time you decided to charge $172,000 per truck, but I’ll check further.” He did and phoned back to tell Pon that Guillou’s secretary could find nothing in the files to indicate that Guillou had checked out charter rates. “That figures,” muttered Pon. “Would you mind doing some checking?” Vanderpool said he would mind doing some checking. Pon then suggested to him that there were several other newer

(continued)
orders also destined for the Middle Eastern countries so Vanderpool should start thinking about widening his area of expertise. Vanderpool reluctantly agreed, and Pon heard nothing until Vanderpool passed him in the hall a few days later and said the assignment was much more time-consuming than he had imagined. One week later, Vanderpool said he had done as much as he could and would turn the figures over to Pon. Vanderpool also said that he did not have the authority to charter a ship and suggested that Pon determine who could do so in Robertson's absence. Later that day, Vanderpool came to Pon's office with a thick file.

"It looks like you've been doing a lot of figuring," said Pon.

"No, not me," said Vanderpool, "but two outsiders. One is Bob Guider, an international freight forwarder in Chicago whom we use for our export parts shipments. And he put me in touch with Eddie Quan, a New York ship broker who is on top of the charter market. We have two alternatives."

"What are they?" asked Pon.

"Well," answered Vanderpool, "the St. Lawrence Seaway will open in mid-April, so we could use it. The problem is that the Seaway route is circuitous, especially to reach the Middle East. Also, there aren't many scheduled Seaway sailings to that area, and because the Seaway will just be opening again, cargo space is hard to come by. Therefore, if we're not going to charter a ship, the best bet is to use Baltimore."

"What about chartering a ship?" asked Pon. "Why not use Baltimore for that?"

"In theory, we could," answered Vanderpool. "But Quan says the size of ship we want is rather small and not likely to be sailing into Baltimore. We could arrange to share a ship with another party, but many bulk cargoes are pretty dusty and might not be compatible with our vehicles. Quan says there is one foreign vessel entering the Great Lakes in April that is still looking for an outbound charter. Seaway vessels, you know, are smaller because of the lock size restrictions. If we want to charter that vessel, we'll have to move quickly, because if somebody else charters her, she's gone."

"What kind of vessel is it?" asked Pon.

"The vessel's name is the Nola Pino, the same name as a French movie actress of the 1960s. You may recall that some Greek shipping magnate named the vessel after her, but his wife made him give up both Nola Pino the actress and Nola Pino the ship. At present, it's scheduled to be in Chicago the last week in April with a load of cocoa beans and ready for outbound loading May 1. Quan thinks we could charter it for $2,400 per day for 30 days, which would be enough time for it to load, transit the Seaway, reach Doha, and discharge the trucks by May 29 or 30."

"Tell me about the alternative," said Pon.

"Baltimore has fairly frequent sailings to the area we want to reach," said Vanderpool. "We could load two trucks per day on railcars here and send them to Baltimore. Two ships a week are scheduled from Baltimore to Doha. It would take the trucks an average of 4 days to reach Baltimore, where they would wait an average of 3 days to be loaded aboard ship. The figure should be 3.5 days, but the railroad will hustle if it knows we're trying to connect with an outgoing sailing. Sailing time to Doha averages 15 days—a little more, a little less, depending on the amount of cargo to be handled at ports in between."

"That averages 22 days per truck," stated Pon, who had been putting the figures in his calculator. "What are the charges?"

Vanderpool answered, "It costs $120 to load and block two trucks on a flatcar, which is, of course, $60 apiece as long as they move in pairs. Sticking to pairs, the rail rate for two on a flatcar totals $1,792 to Baltimore. Handling at Baltimore is $200 per truck, and ocean freight rate from Baltimore to Doha is $1,440 per truck. We also have to buy insurance, which is about $150 per truck."

"That totals $2,790," said Pon, after consulting his calculator. "What are the costs if we charter the Nola Pino? You said it could be $72,000 for the vessel. What else is involved?"

"There are two ways of getting the trucks to port," said Vanderpool. "The loading and blocking would be only $40 per truck because we'd be doing all 50 at one time. The rail rate per truck would average out to $180 each, and it would take 1 day for them to reach Chicago and another day to be loaded. We'd be tying up a wharf for 1 day, and the wharfage charge runs $2 per foot, and the Nola Pino is 535 feet long. We'd be responsible for loading and stowing the cargo, and this would cost $4,000 for all 50 trucks. The Seaway tolls are $1.80 cents per ton or, in our case, $54 per truck. At Doha, the unloading costs will be $4,200 for the entire vessel. Marine insurance will be $210 per truck."

"Are there any other alternatives?" asked Pon.

"The only other one that comes close is to drive the trucks from here to Chicago," answered Vanderpool. "We would need temporary licenses and a convoy permit and pay to have the fuel tank on each truck drained before it is loaded. The problem is that the convoy would cross state lines, and we would need temporary licenses and permits in Illinois as well. We'd also need 50 drivers and have to pay for their time and for their trips back home."
“Do me one favor,” said Pon. “Please call Frank Wood, our outside counsel, and ask him what steps we have to go through to charter a ship. Tell him I’m especially concerned about the liability. Give him Quan’s phone number. I want to make sure there are no more costs involved. If Robertson’s fooling around is on schedule, he’ll be wanting me to wire him some cash. I’d really appreciate it if you would summarize what you’ve told me in two columns, with the charter costs on the left and the overland Baltimore cost column on the right. Then when Robertson calls, I can ask him to decide.”

“One question,” asked Vanderpool.
“Shoot,” responded Pon.
“Why should the charter figures be on the left?”

“Because on a map (see Exhibit 12.A), Chicago is to the left of Baltimore and that’s the only way I’ll keep them straight when I’m talking on the phone.”

QUESTIONS

1. Assume you are Vanderpool. Draft the comparison Pon just requested.

2. Which of the two routing alternatives would you recommend? Why?

3. Assume that the buyer in Saudi Arabia has made other large purchases in the United States and is considering consolidating all its purchases and loading them onto one large ship, which the buyer will charter. The buyer contacts HDT and, although acknowledging its commitment to buy FAS Doha, asks how much HDT would subtract from the $172,000 per truck price if the selling terms were changed to FOB HDT’s Crown Point plant. How much of a cost reduction do you think HDT should offer the buyer? Under what terms and conditions?

4. Answer question 3 with regard to changing the terms of sale to delivery at port in Baltimore. The buyer would unload the trucks from the railcars.

5. Is there an interest rate that would make HDT change from one routing to another? If so, what is it?

6. Assume that the cost to HDT of borrowing money is 12 percent per year. Because the buyer will pay for trucks as they are delivered, would it be advantageous for HDT to pay overtime to speed up production, ship the trucks as they are finished via the Port of Baltimore, and collect its payment earlier? Why or why not?
The transportation manager’s job is much different today than when the first edition of this text was published in the 1970s, in part because of globalization, changes in regulation, and advances in technology. With respect to globalization, consider that in the 1970s, the People’s Republic of China (China) was in the midst of the Cultural Revolution, a movement that severely restricted the country’s economic development as well as trade with other countries. Today, by contrast, China has the second-largest economy in the world (based on gross domestic product) and is a key source of manufactured products for many countries. The transportation requirements associated with a shipment of, say, toys, from Shanghai, China, to Des Moines, Iowa, are noticeably different than those for a shipment of toys from Cleveland, Ohio, to Des Moines.

As for changes in regulation, Chapter 12 pointed out that a reduction of economic regulation in the United States began in the late 1970s, and with it came greater options in terms of both pricing and service. These pricing and service options meant that transportation managers have morphed from a reactive to a proactive focus; rather than simply accepting the available pricing and service packages that were established by economic regulation (reactive), today’s transportation manager can play an active role (proactive) in blending the appropriate pricing and service packages for an organization.

Advances in technology, and their impact on logistics management, have been a recurring theme throughout the text. Rate determination (to be more fully discussed in the next section) provides one example of how advances in technology have impacted transportation management. As recently as the 1980s, all rates were published in tariffs (a phonebook-like manual that contained rate information), and it was not uncommon for a transportation manager to refer to multiple tariffs to determine the applicable rate—a process that led to numerous incorrect rate determinations. Today, by contrast, many carriers provide rating information online and a transportation manager may need to enter little more than origin and destination zip codes and the relevant shipment weight to receive an estimated rate.

For our purposes, transportation management will refer to the buying and controlling of transportation services by either a shipper or consignee. Today more than ever before, organizations are concerned about transportation management because transportation represents a major expense item. In general terms, freight transportation accounts for approximately 6 percent of U.S. gross

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domestic product. Moreover, as we have emphasized throughout, transportation is the most costly logistics activity for many organizations, and as pointed out in Chapter 12, transportation is pivotal to the successful operation of any supply chain.

Similar to Chapter 12, the discussion in this chapter will be approached from the perspective of the transportation manager in the United States. Keep in mind that a particular country’s transportation system, the degree of government involvement in transportation, and a country’s technological development will influence the nature of transportation management in that country. For example, in some countries there may be only one government-run transportation company in a particular mode; thus, the transportation manager would not need to be concerned with carrier selection considerations for that particular mode.

Although the majority of this chapter will focus on several of the transportation manager’s key responsibilities, it should be pointed out that transportation managers are also involved with many other operations of the firm. They can assist marketing by quoting freight rates for salespeople, suggesting quantity discounts that can be based on transportation savings, and selecting carriers and routes for reliable delivery of products. Transportation managers can help manufacturing by advising on packaging and materials handling and making certain that an adequate supply of transportation is available when it is needed. Transportation managers can aid the outbound shipping process by providing simplified shipping or routing guides, drawing up transportation documents, and encouraging shipment consolidations. Finally, they can help purchasing by advising about methods to control the costs and quality of inbound deliveries and by tracing and expediting lost or delayed shipments of important inputs.

The remainder of this chapter will focus on some of a transportation manager’s primary responsibilities. We first analyze rate (pricing) considerations, with a particular emphasis on rate determination. Next, we discuss modal and carrier selection, followed by a discussion of documentation considerations. We also look at making and receiving shipments. The chapter concludes with an examination of transportation service quality.

**RATE (PRICING) CONSIDERATIONS**

**Rate Determination**

As we have seen throughout this text, logistics has discipline-specific terminology. To this end, one key responsibility of transportation managers involves rate considerations, with rate being the logistics term that signifies the price charged for freight transportation (“fare” refers to the prices charged for passenger transportation). Rate determination is essential to calculating the appropriate transportation cost, according to the following formula:

\[
\text{Weight} \times \text{rate} = \text{transportation charge.}
\]

Moreover, transportation rates are based on three primary factors—product, weight, and distance—which will be discussed next:

- Relationships between different products in terms of their handling characteristics, for example, the difference between carrying 2,000 pounds of ballpoint pens and 2,000 pounds of live chickens
- Relationships between shipments of different weights, for example, shipments of 10 pounds each versus shipments of 1,000 pounds each versus shipments of 10,000 pounds each
- Relationships between different distances the products are carried, for example, from Boston, Massachusetts, to Albany, New York, versus from Atlanta, Georgia, to Spokane, Washington

Rate determination has to define all three relations in numeric form and then has to devise methods of tying those numbers into a rate for a specific shipment. The three relationships just mentioned are of continual importance to the transportation manager because if they are altered, the total transportation charges will be altered.
One approach to rate making is to determine one specific rate for every possible combination of product, weight, and distance—in other words, a commodity rate. Although a commodity rate is very good for dealing with demand-specific situations, the number of commodity rates quickly becomes overwhelming (and potentially counterproductive) when you consider how many different products, weights, and distances exist. For example, because there are over 30,000 “important” shipping and receiving points in the United States, in the commodity rate system there would need to be separate rates for all possible combinations of shipping and receiving points—a number that is in the trillions of trillions!\(^2\)

When you consider that the transportation rate structure dates to the time of economic regulation in the late 1800s—a time when “office automation” might have meant a manual typewriter—it becomes clear that the transportation community needed a way to simplify rate determination. This was accomplished through the class rate system, which simplified each of the three primary rate factors—product, weight, and distance. One widely used system for simplifying the number of products is the National Motor Freight Classification (NMFC), which has 18 separate ratings, or classes, from 50 to 500;\(^3\) the higher the rating, the greater the relative charge for transporting the commodity. Classification numbers are very important because they are code words that describe cargo in a manner that carriers and shippers understand, and classification descriptions also specify the packaging that must be used and that carriers require. Figure 13.1 shows a page of the National Motor Freight Classification; note the detail. NOI stands for “not otherwise indexed by number” (i.e., one cannot find a definition that fits more closely). Packages are referred to by number; they are described in great detail in the classification document.

Four factors are used to determine a product’s freight classification, namely, density, stowability, ease of handling, and liability to damage and theft. Density, which refers to how heavy a product is in relation to its size, is viewed as the primary factor for setting a product’s classification, in part because of the opportunity costs associated with it. That is, a product with low density (i.e., low weight per cubic foot), such as foam rubber, can easily fill a vehicle’s usable capacity (cubing out) before reaching the maximum weight (weighing out). As a result, low-density products are assigned a higher classification; for example, products with densities of less than one pound per cubic foot are assigned to Class 400, while densities of one pound but less than two pounds per cubic foot are assigned to Class 300.\(^4\)

Stowability refers to how easy the commodity is to pack into a load, and possible considerations involve the commodity’s ability to be loaded with hazardous materials and ability to load freight on top of the commodity. Ease or difficulty of handling refers to challenges to handling that might be presented by a commodity’s size, weight, and so on. Finally, the liability for loss and damage considers, among others, a commodity’s propensity to damage other freight, its perishability, and its value.

Just as the freight classification is used to simplify the number of commodities, shipment weight is simplified through weight groups (e.g., less than 500 pounds; 500–999 pounds; 1,000–1,999 pounds, etc.). The rate for shipments weighing less than 500 pounds will be higher than that for shipments between 500–999 pounds, and so on. Distances are simplified in a similar fashion and, historically, distances were classified according to a rate basis number; the higher the rate basis number, the greater the distance between origin and destination. Increasingly, rate basis numbers are being replaced by the zip codes of a particular shipment’s origin and destination.

An example of transportation charges using the class rate system is presented in Table 13.1. Shipment 1 in Table 13.1 will serve as our reference point for looking at transportation charges based on commodity classification, weight, and distance. As shown in Table 13.1, the commodity classification is the only difference between Shipment 1 (class 100) and Shipment 2 (class 200). Because a higher class rating takes a higher rate, Shipment 2’s transportation charges ($1,245.87) are noticeably higher than Shipment 1’s transportation charges ($666.52).

\(^2\)Ibid.

\(^3\)http://www.nmfta.org/Pages/Nmfc.aspx

\(^4\)www.freightquote.com/howtoship/nmfc-freight-density.aspx
With respect to the class rate system and weight, Shipment 1 weighs 500 pounds versus 1,500 pounds for Shipment 3. Table 13.1 indicates that Shipment 3 is more expensive ($1,533.26) than Shipment 1 ($666.52), but not three times more expensive (as might be expected by a linear relationship between weight differences and freight charges). Finally, Shipment 1 and 4 differ in terms of the destination zip code and Shipment 4 is traveling much further (approximately 2,100 miles) than
Shipment 1 (approximately 1,000 miles). Not surprisingly, Table 13.1 indicates that Shipment 4 is more expensive ($829.96) than Shipment 1 ($666.52).

The transportation charges in Table 13.1 point out some important considerations with respect to class rates. First, a commodity’s classification (e.g., Class 100 versus Class 200) can noticeably impact transportation expenses and one can see why shippers should be cognizant of a particular commodity’s classification. Second, heavier shipments of a particular commodity generate higher transportation expenses than do lighter shipments. Having said this, shippers can reduce their transportation expenses by utilizing fewer, heavier shipments (e.g., transportation expense for Shipment 3 at 1,500 pounds is $1,533.26) rather than multiple, lighter shipments (e.g., transportation expense for three 500-pound shipments is $1,999.56 [$666.52 times 3]).

Third, while longer distance shipments (Shipment 4) are more expensive than shorter distance shipments (Shipment 1), the difference in cost—Shipment 4 is approximately 1.25 more expensive than Shipment 1—is not proportional to the increase in distance—Shipment 4 travels more than twice the distance of Shipment 1. As such, transportation managers should try to avoid purchasing transportation in short distance movements.

A commodity’s freight classification is developed and maintained by the Commodity Classification Standards Board, which consists of at least three, but no more than seven, full-time employees of the National Motor Freight Traffic Association. There is often a natural tension between shippers and carriers with respect to a product’s classification; shippers tend to prefer a lower classification number (which translates into a lower rate), whereas carriers tend to prefer a higher classification number. Transportation managers can appeal a commodity’s classification, and Figure 13.2 shows a proposal for a reclassification of magnesium rakes.

Referring to Figure 13.2, the proposal begins with the present classification provisions, followed by the proposed classification provisions. Figure 13.2 indicates that the proposal seeks to lower the classification of magnesium rakes according to the length of the handling unit. The majority of the content presented in Figure 13.2 provides the proponent’s rationale for the proposed classification. Note that the “Transportation Characteristics” section in Figure 13.2 focuses on the four-product attributes—density, stowability, handling, and liability—that were discussed earlier in this chapter.

**Rate and Service Negotiations**

As pointed out earlier in this chapter, the contemporary transportation manager is much less constrained by rate and service regulations and thus has the opportunity to assume a proactive role in rate and service negotiations. Today’s transportation manager can craft rate and service packages that best meet an organization’s logistical needs, and these rate and service packages can conceivably vary from product to product, location to location, or customer to customer.

This rate and service flexibility allows transportation managers to take advantage of trade-offs between price and service, and these price and service trade-offs are limited only by the transportation manager’s creativity and ingenuity. Consider the following two examples from the railroad
SUBJECT 3

Re: Rakes or Lutes, magnesium

CCSB Contact: George M. Beck, Telephone — (703) 838-1813, beck@nmfta.org
Allison L. Austin, Telephone — (703) 838-8864, austin@nmfta.org

PropONENT: Surfa Slick, LLC, Riverside, California

Present Classification Provisions

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rakes</td>
<td>Magnesium, in boxes</td>
<td>100</td>
</tr>
</tbody>
</table>

Proposed Classification Provisions

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rakes</td>
<td>Magnesium, etc.</td>
<td>100</td>
</tr>
<tr>
<td>NEW</td>
<td>Rakes or Lutes, hand, consisting of magnesium heads with detached handles of same or other material; or Handles or Parts thereof, NO!; in boxes:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exceeding 96 inches in length</td>
<td>92.5</td>
</tr>
<tr>
<td>Sub 1</td>
<td>Not exceeding 96 inches in length</td>
<td>70</td>
</tr>
</tbody>
</table>

Analysis

This proposal was submitted by Surfa Slick, LLC to add a new item under the Tools, or Parts Named generic heading for magnesium rakes or lutes, or handles or parts thereof. The proponent’s rakes or lutes are currently classified under the provisions of item 185653, naming “Rakes, hand, having tines constructed of magnesium.” The proponent states, however, that these particular commodities exhibit transportation characteristics not reflected in the current class 100. The proposal seeks to establish provisions for magnesium rakes or lutes, based on the length of the handling unit.

History of Provisions

Provisions for magnesium rakes were established as a result of action taken on Docket 932, Subject 18 (March 1993). That proposal sought to establish classes for rakes based on the material construction of the tines. Information on that record showed a density of 9.47 pcf for magnesium rakes. When shipped in boxes, no unusual or significant handling, stowability or liability problems were indicated. The proposal was approved as modified, and the provisions first appeared in Supplement 2 to NMF 100-T, effective July 10, 1993. The provisions have remained substantially unchanged to the present.
SUBJECT 3

About Magnesium Rakes or Lutes

Magnesium rakes or lutes are tools primarily used in the spreading and leveling of asphalt or concrete. They may also be used to level dirt, rock, gravel or snow. The proponent’s products consist of a fiberglass or magnesium handle, metal connector bracket and a magnesium rake or lute head. Some handles will exceed eight feet in length. Examples of the involved parts and assembled product are shown in the photos below.

Transportation Characteristics

Density—the proponent submitted a total of 89 density observations, including data on all of its models of magnesium rakes or lutes and the individual parts. The densities range from 9.41 to 28.46 pcf, with an average density of 18.73 pcf. A frequency distribution is shown below.

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Figure 13.2 (Continued)
SUBJECT 3

When the data is evaluated based on the handling unit’s length, the following density ranges and averages emerge.

<table>
<thead>
<tr>
<th>Handling Unit Length</th>
<th>Density Range (pcf)</th>
<th>Average Density (pcf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exceeding 96 inches</td>
<td>9.41 – 16.57</td>
<td>13.39</td>
</tr>
<tr>
<td>Not exceeding 96 inches</td>
<td>11.63 – 28.46</td>
<td>20.38</td>
</tr>
</tbody>
</table>

**Handling**—As shown in the photo on the right, the proponent’s magnesium rakes or lutes are shipped in fiberboard boxes secured on lift truck skids or pallets. Individual components (i.e. handles, connector brackets or heads) of magnesium rakes or lutes may be shipped in boxes on the same handling unit. Data furnished by the proponent indicates that handling units can exceed 96 inches in length. Generally, freight that exceeds 96 inches in length will require extra care and attention during handling.

**Stowability**—The proponent states that the involved products are stackable. However, depending on the shipment configuration, its magnesium rakes or lutes may or may not provide a regular load-bearing surface for top freight. In addition, handling units that exceed 96 inches in length may complicate the carrier’s ability to structure a load and maximize vehicle utilization.

**Liability**—The involved articles are not perishable, hazardous in nature, unusually susceptible to theft, unusually liable to damage and would not appear likely to damage other freight. The proponent provided the list prices for various models of its magnesium rakes or lutes. The list price ranges from $12.58 to $13.48 per pound, with an average price per pound of $13.16. The individual parts range in list price from $12.00 to $19.43 per pound, with an average price per pound of $14.33. The proponent states that no claims have been filed for a one-year period.

**Relationship to CCSB Policies and Guidelines**

CCSB policy calls for classification provisions to reflect a commodity’s known transportation characteristics. The proponent asserts that the provisions of item 185653 for “Rakes, hand, having tines constructed of magnesium” are not reflective of the transportation characteristics of its products. Information provided by the proponent includes 89 density observations ranging from 9.41 to 28.46 pcf, with an average density of 18.73 pcf. An average density of 18.73 pcf is generally associated with a class 70, which under CCSB guidelines calls for a minimum average density of 15 pcf. However, CCSB policies further state that unusual or significant negative handling, stowability or liability characteristics may be contributing factors in the assignment of classes. In this regard, it is noted that some of the involved magnesium rakes or lutes exceed 96 inches in length, which present additional handling and stowability considerations. In such situations, classification precedent has been to assign a class higher than that called for under the CCSB density guidelines. Surf Slick has proposed classes accordingly, as outlined in the table on the following page.
This proposal would cancel item 185653 with reference to a new item for “Rakes or Lutes, hand, consisting of magnesium heads with detached handles of same or other material; or Handles or Parts thereof, NOI,” at class 70 when the length does not exceed 96 inches, consistent with the respective density guideline. Handling units exceeding 96 inches in length would be assigned a class 92.5, one class higher than that called for by the respective density guideline.

This proposal is in keeping with CCSB policies and precedent.
industry. In one case, the shipping organization agreed to pay the railroad a premium for each railcar that was delivered on a precise, previously agreed-upon schedule. In the second case, an organization agreed to ship six million pounds of intermodal freight each year between Houston and Chicago. The shipper agreed to pay the railroad an additional $75 per trailer when at least 90 percent of the trailers completed the rail movement within 96 hours. Although these two examples illustrate situations where monetary premiums were paid for meeting predetermined service standards, the rate and service negotiations can also include monetary penalties for failure to achieve predetermined service standards.

It is not possible to present a comprehensive list of all possible rate and service items that might be negotiated by shippers and carriers. However, Table 13.2 contains a representative list of items that might be used in the negotiation process.

**TABLE 13.2** Representative Rate and Service Items in the Carrier—Shipper Negotiation Process

<table>
<thead>
<tr>
<th>Adjustment to Rates</th>
<th>Arbitration</th>
<th>Articles and Commodities Covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audit rights</td>
<td>Basis for charges</td>
<td>Billing procedures</td>
</tr>
<tr>
<td>Carrier equipment and drivers</td>
<td>Carrier insurance</td>
<td>Carrier notification requirements</td>
</tr>
<tr>
<td>Detention time</td>
<td>Duration of agreement</td>
<td>Estimated transportation volume</td>
</tr>
<tr>
<td>How loss and damage claims are handled</td>
<td>Lead times</td>
<td>Pallet loading</td>
</tr>
<tr>
<td>Proof of delivery</td>
<td>Renegotiation and reopening of contract</td>
<td>Schedule of rates and charges</td>
</tr>
<tr>
<td>Termination of agreement</td>
<td>Transportaion service level</td>
<td>Waiver of terms</td>
</tr>
</tbody>
</table>

DOMESTIC TERMS OF SALE One consideration in rate and service negotiations involves the terms of sale, or when the freight charges are paid for a particular domestic shipment (we will discuss international terms of sale in Chapter 14). FOB (free on board) is followed by either “origin” or “destination” and this location specifies the point at which the title and control of a shipment passes from buyer to seller. With **FOB origin**, the buyer assumes title and control of a shipment at the point of pickup, while with **FOB destination** the seller retains title and control of a shipment until it is delivered.

In addition to establishing the point at which title for a shipment passes from buyer to seller, the FOB location term also establishes which party is responsible for arranging transportation for a shipment as well as which party is responsible for filing freight claims (a topic that will be discussed later in this chapter). FOB origin and FOB destination are typically qualified by modifying terms, the most common of which are **freight collect**, **freight prepaid**, and **freight prepaid and charged back**. This results in six possible domestic terms of sale, which are described next.5

- **FOB origin, freight collect**: The buyer pays freight charges, owns the goods in transit, and files loss and damage (L&D) claims, if needed.
- **FOB origin, freight prepaid**: The seller pays the freight charges; the buyer owns the goods in transit and files L&D claims, if needed.
- **FOB origin, freight prepaid and charged back**: The seller pays the freight charges in advance but bills the buyer for them; the buyer owns the goods in transit and files L&D claims, if needed.
- **FOB destination, freight collect**: The buyer pays the freight charges; the seller owns the goods in transit and files L&D claims, if needed.

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- **FOB destination, freight prepaid:** The seller pays the freight charges, owns the goods in transit, and files L&D claims, if needed.

- **FOB destination, freight prepaid and charged back:** The seller pays the freight charges in advance but bills the buyer for them; the seller owns the goods in transit and files L&D claims, if needed.

The transportation responsibilities associated with FOB origin and FOB destination have important implications for transportation management. For example, an advantage of FOB destination from the seller’s perspective is that the seller controls transportation and can assure a more uniform transportation outcome for each buyer. Alternatively, a disadvantage of FOB destination from a seller’s perspective is that the seller’s organization must have a thorough knowledge of transportation management (e.g., rate and service negotiations, modal and carrier selection, and so on) and this knowledge is not learned in a short period of time.

**TRANSPORTATION COST ANALYSIS** Another consideration in rate and service negotiation involves transportation cost analysis, which can be especially valuable in the shipment consolidation decision. Because transportation costs tend to be lower per unit of weight for larger shipments, there is a natural motivation to consolidate smaller shipments into larger ones. Having said this, shipment consolidation decisions affect other logistical activities such as warehousing and inventory management.

Transportation cost analysis continues to be facilitated by advances in information technology. Some trucking companies, for example, can examine inbound or outbound deliveries for a representative period of time using data gathered from a customer’s paid freight bills. This can allow both the carrier and the customer to determine whether individual shipments or shipment patterns can be improved. Moreover, it is also possible to conduct sensitivity analysis to determine the transportation costs for varying levels of transportation service. Although sensitivity analysis can provide insights about potential transportation cost savings if shifting from one service level to another, the sensitivity analysis does not estimate other relevant costs (e.g., unhappy customers because of slower transportation service).

**MODAL AND CARRIER SELECTION**

Transportation managers have long been responsible for both modal and carrier selection. Conceptually, modal and carrier selection is a two-step process in which the transportation manager first determines the appropriate mode, or modes, to use and then selects a particular carrier, or carriers, within the chosen mode(s). At a minimum, an understanding of the modal characteristics presented in Chapter 12 would be helpful in the modal selection process.

Unfortunately, the carrier selection procedure is more challenging than that for modal selection, in part because there can be tens, hundreds, or even thousands of carriers from which to choose in a particular mode. It might not be realistic to expect a transportation manager to be aware of every possible carrier in a particular mode or to know about each carrier’s service and operating characteristics.

Carrier selection is also less straightforward due to a lack of agreement on the number of relevant factors that might be used in carrier selection. For example, the number of carrier selection factors evaluated in academic research studies has ranged from less than 10 to over 150. As was the case with rate and service negotiation, it is not possible to provide a comprehensive list of all possible factors that might be used in the carrier selection decision. Representative carrier selection factors include total transit time, transit time reliability, competitive rates, and loss and damage performance, among others.

Modal and carrier selection has become even murkier in recent years with the rise in what we will call the **amodal shipper.** An amodal shipper refers to a transportation manager who purchases a prespecified level of transportation service (e.g., two-day delivery for a particular price) and is
indifferent to the mode(s) and/or carrier(s) used to provide the actual transportation service. Indeed, research indicates that shippers are exhibiting more interest in transportation metrics such as transit time and transit time dependability than in transportation modes. One reason for the growth of amodalism is that non-asset-based third-party logistics companies have the ability to develop multimodal solutions to a client’s transportation problems. Amodalism is also aided by companies such as UPS and FedEx that own companies that provide different types of transportation services (e.g., air, expedited, LTL, parcel).

**DOCUMENTATION**

The definition of logistics presented in Chapter 1 refers to the management of information and the documents associated with transportation shipments, or documentation, are one important source of logistics information. Transportation documentation serves both a practical function (e.g., what, where, and how much is being transported) as well as potentially providing legal recourse if something goes awry with a particular shipment. Our discussion here will focus on the documents associated with domestic shipments; the documentation for international shipments is presented in Chapter 14.

The transportation department is responsible for completing all the documents needed to transport the firm’s products. Today, many carriers provide software or secure websites that enable the shipper to generate all the commonly used documents. Some shippers also have their own order-processing software that is capable of generating transportation documents.

**Bill of Lading**

The most important single transportation document is the bill of lading, which is the basic operating document in the industry. The bill of lading functions as a delivery receipt when products are tendered to carriers. On receipt of the freight, the carrier signs the bill of lading and gives the original to the shipper. The signed original of the bill of lading is the shipper’s legal proof that the carrier received the freight. The bill of lading is a binding contract, specifying the duties and obligations of both carrier and shipper. The bill of lading contract for surface carriers is basically standardized by law and greatly simplifies the transportation manager’s job because it specifies exactly the duties of the shipper and carrier.

There are two types of bills of lading: the straight bill of lading and the order bill of lading. On a straight bill of lading, which is printed on white paper, the name of the consignee is stated in the appropriate place, and the carrier is under a strict legal obligation to deliver the freight to the named consignee and to no one else. Ownership of the goods is neither stated nor implied. On the order bill of lading, which is printed on yellow paper, the name of the consignee is not specified. For example, assume that a lumber company in Washington State has loaded a boxcar of plywood that it has not yet sold. It would use an order bill and tender the shipment to the Burlington Northern Railroad, which would start the car moving toward Chicago. Once a buyer for the plywood is found, the shipper would send the original copy of the order bill by mail to a bank near the buyer and would also tell the buyer which bank had possession of the order bill. The buyer would go to the bank and pay for the plywood, and the bank would give the original copy to the buyer. The buyer would take it to the railroad, and the railroad would deliver the carload of plywood. Order bills can also be used when faced with slow-paying customers because the order bill guarantees that the customer must pay for the products prior to receipt.

An additional classification for bills of lading is the specific form: long, short, or preprinted. The long-form bill of lading, which may be either an order or straight bill, contains the standard information on the face of the bill (see Figure 13.3), and on the reverse side it contains the entire contract between carrier and shipper. The reverse side is printed in extremely small print. Because of the

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difficulty of reading the long-form contract and the printing costs of including the contract on all bills, in 1949 the railroads and motor carriers adopted the short-form bill of lading. The short form has the following statement on its face: “Every service to be performed hereunder shall be subject to all the terms and conditions of the Uniform Domestic Straight Bill of Lading.”

Another kind of bill of lading—which may be long, short, order, or straight—is preprinted. In theory, the bill of lading is prepared and issued by the carrier. In fact, however, most shippers buy their bills of lading and then have them preprinted with a list of the products they regularly ship. Shippers go to the expense of buying and printing their own bills because, in practice, they frequently prepare them prior to calling the carrier. The preprinted bill can be prepared more rapidly

![Figure 13.3 A Long-Form Bill of Lading](image-url)
and with less chance of error; for example, the shipper can insert the correct classification rather than letting the carrier determine it.

A few shippers are adopting their own bills of lading, which carriers may be reluctant to accept because the carriers may be subject to new liabilities specified in the documents. Carriers are advised to supply drivers with stickers to place on the bills of lading indicating that their signature means only that they have picked up the freight.

**Freight Bill**

Another basic document that the transportation manager must be familiar with is the freight bill, which is an invoice submitted by the carrier requesting to be paid. Often, the transportation manager must approve each freight bill before it is paid, and carriers must be paid within a specific number of working days. In an attempt to meet these time limits, many transportation managers now participate in automated freight bill-paying services. Once the transportation manager initiates the program with the payment service, the carriers submit their freight bills directly to the service. The payment service treats the freight bills as checks drawn on the shipper’s freight account and then pays the carriers. CT Logistics, Cass Information Services, and Data2Logistics are examples of well-known U.S.-based freight payment companies.

One continuing issue with freight bills involves companies being charged too much (overcharges) for transportation services. To detect current errors that result in overcharges and to correct these errors in the future, shippers conduct internal audits (work is performed by employees of the company) of their freight bills. Some shippers also conduct external audits (work is performed by an independent third party) of their freight bills.

**Freight Claims**

Another key documentation issue involves freight claims, which refers to a document that notifies a carrier of wrong or defective deliveries, delays, or other delivery shortcomings. Filing claims against carriers is a routine matter, and many carriers post filing information and sample claim forms on their websites. The following are representative of freight claims information that might be found on a carrier website: “Who can file an LTL freight claim? What is the time limit for filing a claim? How do I file an LTL freight claim? What documents do I need to file an LTL freight claim? What should I expect to happen after the freight claim has been filed?” You should be aware that there are time limitations—nine months from the date of the bill of lading—within which a freight claim must be filed.

One of the most difficult and challenging aspects of claim work is the determination of the exact dollar amount of the damage. The law states that the common carrier is responsible for the full actual loss sustained by the shipper or consignee. The amount of the “full actual loss” is often determined according to the following common rule of thumb: The basic thought underlying the federal statutes that define the liability and prescribe the measure of damages in cases of this kind is that the owner shall be made whole by receiving the proper money equivalent for what has actually [been] lost; or, in other words to restore [the owner] to the position he or she would have occupied, had the carrier performed its contract.8

A key factor in determining the value of the full actual loss is the word earned. Assume that a retailer owned the products shipped via a common carrier and that they were damaged beyond repair. The question arises, “Should the retailer recover the wholesale price or the retail price?” If the products destroyed were going into a general inventory replacement stock, the retailer would recover the wholesale price plus freight costs (if they had been paid) because the retail price has not been earned. Assume, instead, that a product is ordered especially for a customer. When the product

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7 http://works.pittohio.com/mypittohio/ltl/freight-claims.asp

8 *Atlantic Coast Line Ry. Co. v. Roe*, 118 So. 155.
arrives, it is damaged, and the retailer’s customer states that he or she will wait no longer and cancels the order. In this situation, the retailer is entitled to the retail price because the profit would have been earned if the carrier had properly performed its service.

Another difficult area for shippers and carriers alike involves **concealed loss or damage**, which refers to a situation where loss or damage is not apparent until after a shipment has been unpacked and inspected. Carriers may be reluctant to pay concealed loss and damage claims for two reasons. First, if the shipment came through the transportation process with no exterior damage, then there is a strong possibility that the product was improperly protected on the inside. If this is the case, the carrier is exempted from liability because improper packaging is the fault of the shipper. Second, the possibility exists that the consignee’s employees damaged or stole the products in question. The potential delicateness of concealed loss or damage claims is the balancing act between a carrier (1) not wanting to pay claims caused by shipper or consignee errors and (2) upsetting a shipper or consignee by seemingly implicating them in the loss or damage.

Transportation experts suggest that receivers/consignees follow five tips for managing concealed loss and damage: (1) inspect the freight as soon as possible; (2) break down the shipment as soon as possible; (3) note issues that look out of the ordinary in the proof of delivery (e.g., broken pallets, punctured packaging); (4) document, document, document; (5) have the shipper take photos when the freight is being shipped out and the receiver take photos when the freight is received.9

Since transportation deregulation, the volume of claims activity has dropped because, during the negotiation process, the shipper may agree to hold the carrier less liable for claims in return for lower transportation charges. In addition, the transportation deregulation acts have reduced carrier liability. The Staggers Act of 1980, which lessened railroad economic regulation, and the Motor Carrier Act of 1980, which pertained to trucks, permitted railroads and motor carriers, respectively, to establish released value rates (wherein the shipper agrees that a commodity is worth no more than so many dollars per hundred pounds in case a claim is filed, in return for a lower rate).

**MAKING AND RECEIVING SHIPMENTS**

Another key area of decision making in transportation management involves making and receiving shipments, which refers to tactical planning and control of shipments along with supervision of freight loading and unloading.10 A number of activities are associated with making and receiving shipments. We will discuss some of them in the paragraphs that follow.

**Consolidating Small Shipments**

Small shipments, often defined as those that weigh more than 150 pounds and less than 500 pounds, represent one of the most challenging situations faced by the transportation manager. As mentioned in Chapter 12, the nature of transportation costs is that it costs less on a per-pound basis to ship a larger quantity because certain costs (fixed, administrative, or terminal) are the same per shipment. When the shipment is larger, such costs can be allocated over a larger weight. The transportation manager faces the decision of whether and when to consolidate large numbers of small shipments into small numbers of large shipments. Some shipment consolidation activities are shown in Figure 13.4.

Smaller shipments are problematic for several reasons. From a carrier perspective, there may be reluctance to accept small shipments because they tend to require a high degree of manual labor, thus increasing labor costs. In addition, there is a belief by some carriers that they lose money on small shipments because the revenues from them do not sufficiently reflect cost considerations. From a transportation manager’s perspective, a large number of small shipments means that there needs to be an information system capable of keeping track of each shipment’s status; as a general

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9 cerasis.com/2015/04/28/concealed-damage-claims/
Figure 13.4 The Transportation Manager Consolidates Shipments Whenever Possible

- Truckload shipments of a single product directly from supplier to customer, bypassing warehouse.
- A truckload made up of products from suppliers and plants goes from warehouse to customer.
- Truckload of single product from plant to customer.
rule, it is easier to keep track of, say, one shipment of 10 units than to keep track of 10 shipments of one unit apiece. However, it could take some time to accumulate 10 units, and the increased time could result in poorer service to the final customer. Moreover, although a 10-unit shipment might yield transportation cost savings, there would be inventory carrying cost considerations in the sense that it is more costly to hold 10 units of product than to hold 1 unit of product.

Potential solutions for consolidating small shipments involve consolidation across time or place. Continuing with the 10-unit example from the previous paragraph, and supposing that 2 units are available for shipment each day, consolidation across time could be accomplished through volume guidelines (e.g., minimum shipment of 8 units, which would mean a shipment on the fourth day) or time guidelines (e.g., ship every third day, in which case the shipment volume would be 6 units). In consolidation across place, the transportation manager looks to build volume with shipments going to a similar destination or similar destinations, and this often involves looking outside one’s firm. Transportation specialists such as freight forwarders, shippers’ associations, and transportation brokers (all of which were discussed in Chapter 12) can be helpful in achieving consolidation across place.

**Demurrage and Detention**

Demurrage is a penalty payment made by the shipper or consignee to a railroad for keeping a railcar beyond the time when it should be released back to the carrier. Demurrage is also collected by inland water carriers if their barges are kept by the shipper or consignee for a longer period than allowed. Pipelines are involved with demurrage if oil stored in tanks at destination is not removed within specified time limits. Detention is basically the same concept as demurrage, except that it usually refers to the trucking industry. Users of containers owned by the airlines are subject to similar charges. With both demurrage and detention, carriers are concerned that their equipment is idle and unproductive—a less-than-optimal situation for a revenue-generating asset. From the shipper or consignee perspective, idle transportation vehicles such as a rail car or truck trailer can act as temporary (and potentially inexpensive) warehousing.

Both demurrage and detention operate on a “free-time” principle; that is, shippers or consignees are permitted a specified amount of time to load or unload freight before monetary penalties are levied. For example, as of mid-2016, CSX Transportation’s penalties for demurrage violations were $105 per day per car, with several exceptions. More specifically, CSX also assesses demurrage charges of $175 per day per hazardous materials cars, $200 per day per car for refrigerated units, and $1,500 per day per car for rail security-sensitive materials such as PIH (poisonous by inhalation) materials and radioactive materials.

Many carriers currently offer averaging agreements, where an accounting system of debits and credits is established, for demurrage and detention. A credit is received every time the shipper or consignee releases a piece of equipment early, and a debit is recorded each time a piece of equipment is surrendered to a carrier late. These averaging agreements are typically one month in duration, and at the end of a month, credits and debits are totaled, and the particular demurrage account is settled. If the total demurrage days exceed the total credit days, then demurrage charges are equal to: (total demurrage days minus total credit days) times the applicable demurrage rate. Alternatively, if the total credit days exceed the total demurrage days, then no demurrage charges are paid. As a general rule, credits are not allowed to be carried over from one month to another.

**Routing**

Routing can be defined as the “process of determining how a shipment will be moved between origin and destination.” One example of routing is a routing guide, which is a document that can provide a variety of shipment-related information such as shipment preparation, freight invoicing, a

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11 Ibid.
12 Information derived from CSX Transportation’s Publication CSXT 8100, Terms and Conditions of Service and Prices for Accessorial Services, effective July 1, 2016.
list of preferred carriers, and a list of which carrier or carriers to use for shipments moving between two points. As an example, Nordstrom’s (a high-end retail department store) routing guide contains information that lists which distribution center is to supply a particular retail location. To this end, the Nordstrom’s in Spokane, Washington is supplied from the Nordstrom’s distribution center in Portland, Oregon. In addition, Nordstrom’s routing guide also indicates which carriers are to be used to transport shipments to Nordstrom’s distribution centers.

Routing guides are intended to standardize various aspects associated with transporting shipments and can simplify modal/carrier selection (e.g., modes and/or carriers may be explicitly identified), reduce transportation costs (e.g., via volume discounts), and improve supply chain performance (e.g., reduced cycle times). However, the reality is that routing guides aren’t always followed, which can lead to higher transportation costs and potentially dissatisfied customers. Suggestions for maximizing the effectiveness of routing guides include making them readily available to the relevant personnel as well as monitoring and enforcing compliance with them.  

**Tracking and Expediting**

Tracking refers to determining a shipment’s location during the course of its move, and the ability to track shipments directly affects expediting, which involves the need to rapidly move a shipment to its final destination. Today, many transportation carriers have information systems that provide real-time information about shipment status, and this information is widely available to customers through the Internet and smart phones, thus making it fast and easy to trace shipments. Air transportation and motor carriers are the two most prominent modes involved in expediting, and both modes played key roles in alleviating supply chain problems, such as congestion and delays, that arose with U.S. West Coast water port labor issues in late 2014 and early 2015.

**TRANSPORTATION SERVICE QUALITY**

We will conclude this chapter with a look at transportation service quality. Chapter 7 pointed out that macroenvironmental changes, such as globalization and advances in technology, have caused organizations to demand higher levels of service quality, and this is particularly true for transportation services. For example, when one of the authors worked in the trucking industry in the late 1970s and early 1980s, shipment tracking was a laborious manual process that might take multiple days before information was provided to a transportation manager about a particular shipment. Today, by contrast, the combination of real-time information systems and global positioning systems allows for virtually instantaneous tracking of a shipment, and this tracking information is increasingly provided to the transportation manager on mobile devices such as a laptop, tablet, and/or smart phone.

Recall from Chapter 12 that economic deregulation allowed for both price and service competition among carriers, and this resulted in the need for organizations to measure their carriers’ performance. To this end, a number of organizations utilize transportation performance scorecards that contain a list of relevant attributes (perhaps the same attributes used to select carriers) and an evaluation of each carrier on every attribute.

Table 13.3 illustrates how a carrier performance scorecard might work; in this example, the transportation manager has selected five performance attributes that will be used to evaluate individual carriers. The transportation manager assigns each attribute an importance rating, such as 30% for “improved cost performance.” The transportation manager also evaluates each attribute with respect to a particular carrier’s performance on that attribute; 4 is the evaluation for “improved cost performance.” “Net weighted score” is calculated by multiplying each attribute’s importance rating by its evaluation; for example, the 1.2 for “improved cost performance” comes from its 30% importance multiplied by its evaluation of 4. The net weighted scores for all five attributes are summed (4.1375 in Table 13.3) and divided by the maximum possible gross score (5.00) to yield the “performance score” (82.75%).

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TABLE 13.3 Example of a Carrier Performance Scorecard

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Importance (%)</th>
<th>Evaluation (1–5)</th>
<th>Weighted Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved cost performance</td>
<td>30</td>
<td>4</td>
<td>1.2</td>
</tr>
<tr>
<td>On-time delivery performance</td>
<td>25</td>
<td>4.5</td>
<td>1.125</td>
</tr>
<tr>
<td>Customer complaints</td>
<td>20</td>
<td>4.25</td>
<td>.85</td>
</tr>
<tr>
<td>Loss and damage performance</td>
<td>15</td>
<td>4.75</td>
<td>.7125</td>
</tr>
<tr>
<td>Social media presence</td>
<td>10</td>
<td>2.5</td>
<td>.25</td>
</tr>
<tr>
<td>Sum</td>
<td></td>
<td></td>
<td>4.1375</td>
</tr>
<tr>
<td>Performance score</td>
<td></td>
<td></td>
<td>82.75%</td>
</tr>
</tbody>
</table>

The data are hypothetical and for illustrative purposes only.

The performance scorecard can be used as a diagnostic tool; if an individual carrier’s performance is rated as lower than, say, 70, then the carrier might be put on probation for a certain time period. Moreover, if performance does not exhibit satisfactory improvement during the probationary period, then the carrier might be fired.

There are also more “positive” manifestations of transportation service quality. A number of organizations now officially recognize (e.g., a press release, an awards recognition dinner, a plaque) transportation carriers that provide superior service. In addition, several logistics trade publications annually recognize transportation service excellence. For example, Logistics Management annually conducts its “Quest for Quality,” in which users of transportation services are asked to rate transportation companies on five dimensions: on-time performance, value, customer service, information technology, and equipment and operations. Individual carriers receive a “Quest for Quality” award when their overall rating on the five dimensions exceeds their industry average, and many of these carriers prominently feature this award on their websites.

Summary

This chapter covered transportation management, which refers to the buying or selling of transportation services by a shipper or consignee. This chapter analyzes several of a transportation manager’s primary responsibilities. Rate considerations are one prominent responsibility, particularly in terms of rate determination. A transportation manager is also responsible for modal and carrier selection, and an emerging selection trend involves a focus on transportation metrics as opposed to transportation mode.

Documentation is another responsibility of a transportation manager, and the chapter discussed key documents such as the bill of lading, freight bill, and freight claims. Another key area of decision making in transportation management is making and receiving shipments, which includes activities such as shipment consolidation, demurrage, and detention, among others. The chapter concluded by looking at transportation service quality.

Key Terms

- Amodal shipper
- Bill of lading
- Class rate system
- Commodity rate
- Concealed loss or damage
- Demurrage
- Density
- Detention
- Documentation
- Expediting
- FOB destination
- FOB origin
- Freight bill
- Freight claims
- Rate
- Routing
- Routing guide
- Stowability
- Tracking
- Transportation management
Questions for Discussion and Review

13.1 What is transportation management and why is it important?
13.2 How have advances in technology changed the rate determination process?
13.3 Discuss how transportation managers could be involved with other operations of the firm.
13.4 What are the three primary factors that determine transportation rates?
13.5 Distinguish between a commodity rate and a class rate.
13.6 Discuss the four factors used in determining a product’s freight classification.
13.7 Identify the commodity classification and rate system prevailing in your country in domestic logistics.
13.8 Discuss how a transportation manager might take advantage of the trade-offs between price and service.
13.9 What are the important rate and service items in the transportation negotiation process between carrier and shipper?
13.10 Why is the carrier selection process less straightforward than the modal selection process?
13.11 Define what is meant by an amodal shipper, and discuss the factors that have contributed to its growth.
13.12 Why is documentation a very important component in transportation?
13.13 Distinguish between the straight bill of lading and the order bill of lading.
13.14 What are freight claims? What is the time limit for filing these claims?
13.15 Discuss the basic issues, conflicts, and problems involved in concealed loss and damage claims.
13.16 Explain why smaller shipments are challenging to transportation managers.
13.17 Discuss the basic idea of demurrage and detention and how averaging agreements can be helpful in this area.
13.18 Explain how a routing guide might be used by a transportation manager.
13.19 Distinguish between tracking and expediting.
13.20 What is a carrier performance scorecard? How might it be used by transportation managers?

Suggested Readings


CASE
CASE 13.1 CHIPPY POTATO CHIP COMPANY

Located in Reno, Nevada, since 1947, the Chippy Potato Chip Company manufactured potato chips and distributed them within a 100-mile radius of Reno. It used its own trucks for delivery in the Reno, Carson City, and Lake Tahoe areas and common carrier trucking for all other outgoing shipments. All of its motor carrier shipments were on an LTL basis. The applicable motor carrier freight rating, or classification, for LTL potato chips was 200. This classification was high, although potato chips are often given as textbook examples of bulky freight that will cause a truck to cube out. Even after much of the motor carrier industry was deregulated, Chippy had difficulty finding contract truckers interested in negotiating specific contract rates. This was because potato chips—as a result of their bulk—were not a desirable cargo from the truckers’ point of view.

The potato chips were packed in 8-ounce bags. Twenty-four 8-ounce bags were packed in cartons that were 12 inches by 12 inches by 36 inches. The packed carton weighed 14 pounds. The 8-ounce bags of chips wholesaled FOB plant for 40 cents each and retailed for 59 cents.

Recently, the Chippy firm acquired rights to produce a new type of chip, made from powdered potatoes, yielding chips of identical shape that could be packed in tubular containers. A 5-ounce paper tube of chips would wholesale (FOB plant) for 40 cents and retail for 59 cents. The new chips were much less bulky: Twenty-four 5-ounce containers could be packed in a carton measuring one cubic foot. The filled carton weighed 10 pounds. (The difference between the weight of chips and that of cartons is due to packaging materials. The carrier is paid on the basis of carton weight.)

Chippy management believed that because the new chips were less bulky, the LTL classification of 200 was too high. Management decided to ask the motor carrier classification bureau for a new, lower classification. (Motor carrier rates for a movement are the classification multiplied by a distance factor. If the classification were lowered, the rate would be lowered proportionally for all shipments.)

QUESTIONS

1. If you worked for Chippy, what new classification would you ask for? Give your reasons.

2. Classifications are based on both cost and value of service. From the carrier’s standpoint, how has cost of service changed?

3. Given the existing LTL classification of 200, how has value of service to the customer changed?

4. The new tubular containers are much sturdier. If you worked for Chippy, how—if at all—would you argue that this factor influences classification?

5. You work for the motor carrier classification bureau and notice that the relationship between the weight of potato chips and the weight of packaging has changed. How, if at all, should this influence changes in the product’s classification?

6. One of Chippy’s own trucks, used for local deliveries, has two axles and an enclosed body measuring (inside) 7 feet by 8 feet by 20 feet and is limited by law to carrying a load of no more than 8,000 pounds. Because the truck is not supposed to be overloaded, what combinations, expressed in terms of cartons of both new- and old-style chips can it legally carry? (Hint: Use a piece of graph paper.)
An understanding of international logistics is vital due to the tremendous increase in global trade during the twenty-first century. Indeed, the value of world merchandise exports has tripled since the start of the twenty-first century, growing from approximately $6.2 trillion in 2000 to approximately $19 trillion in 2014—despite the worldwide economic slowdown in 2008 and 2009.\footnote{World Trade Organization, \textit{International Trade Statistics}, 2001 and 2015.} From a relative perspective, the ratio of merchandise exports to \textit{gross world product} (i.e., the sum of the gross domestic product of all countries) has doubled from approximately 12% in 2000 to approximately 24% in 2014.\footnote{Calculated from data in the World Trade Organization, \textit{International Trade Statistics}, 2001 and 2014 as well as data from the World Bank, 2014.}

**International logistics**—logistics activities associated with goods that are sold across national boundaries—occurs in the following situations:

1. A firm exports a portion of a product made or grown—for example, paper-making machinery to Sweden, wheat to Russia, or coal to Japan.
2. A firm imports raw materials—such as pulpwood from Canada—or manufactured products—such as motorcycles from Italy or Japan.
3. Goods are partially assembled in one country and then shipped to another, where they are further assembled or processed. For example, a firm stamps electronic components in the United States. It ships them to a free trade zone in the Far East, where low-cost labor assembles them, and then the assembled components are returned to the United States to become part of the finished product.
4. The firm is \textit{global} in outlook and sees almost all nations as being markets, sources of supply, or sites for markets or for assembly operations.
5. Because of geography, a nation’s domestic commerce crosses foreign borders, often in bond. For example, goods moving by truck between Detroit and Buffalo or between the Lower 48 states and Alaska, through Canada, travel in bond, which means that the carrier handling them has a special legal obligation to keep them sealed and to make certain that they are not released for sale or use within the country through which they are traveling. Products shipped in bond are not subject to normal duties of the country through which they are passing.
This chapter begins with a discussion of macroenvironmental influences on international logistics, and this is followed by a look at three key transaction-related considerations in international logistics, namely, documentation, terms of sale, and methods of payment. Next is a discussion of key international trade specialists, including international freight forwarders and export packers. The chapter then looks at transportation considerations in international logistics, followed by a discussion of international trade inventories. The chapter concludes by discussing an emerging international logistics concept, the Logistics Performance Index.

MACROENVIRONMENTAL INFLUENCES ON INTERNATIONAL LOGISTICS

Macroenvironmental influences refer to the uncontrollable forces and conditions facing an organization and include cultural, demographic, economic, natural, political, and technological factors. Although these macroenvironmental factors provide various challenges in an organization’s domestic market, they provide even greater challenges when doing business outside of one's home market. For example, many countries have regulations and laws pertaining to air pollution; however, the nature of these regulations and laws as well as the degree of enforcement of them is not uniform from country to country.

A comprehensive discussion of the influences of all six environmental factors on international logistics is beyond the scope of this text. However, to give you a sense as to how macroenvironmental factors can impact international logistics, we'll look at three such influences, namely, political, economic, and cultural factors.

Political Factors

Political restrictions on international trade can take a variety of forms. Many nations ban certain types of shipments that might jeopardize their national security; for example, the United States does not ship military equipment or strategic materials to certain nations, such as Iran and North Korea. Likewise, individual nations may band together to pressure another country not to be an active supplier of materials that could be used to build nuclear weapons. Some nations restrict the outflow of currency because a nation’s economy will suffer if it imports more than it exports over a long term. These regulations are not concerned with specific commodities; rather, they are concerned with restricting the outflow of money. All imports require advance approval, and goods that arrive without prior approval are not allowed to enter.

A relatively common political restriction on trade involves tariffs, or taxes that governments place on the importation of certain items. Tariffs are often established to protect local manufacturers, producers, or growers, and once tariff barriers are built, they are not easily torn down. Sometimes, the tariff the importing nation charges differs according to the nation from which the good is coming and from an international sourcing standpoint, this could influence the choice of a production site.

Another group of political restrictions on trade can be classified as nontariff barriers, which refer to restrictions other than tariffs that are placed on imported products. One type of nontariff barrier is an import quota, which limits the amount or product (either in units or by value) that may be imported from any one country during a period of time. The health and safety of a country’s population often provides “convenient” reasons for applying nontariff barriers. Many nations are concerned with stopping the spread of plant and animal diseases and therefore inspect various commodities or products to make certain that they do not contain these problems. If material is found to

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be infested, it cannot enter the country until it is cleaned. Entry of other products may be prohibited because they do not meet safety standards. For example, because of the danger of earthquakes in Japan, upright refrigerators must be built so that they will remain upright, even when tilted as much as 10 degrees.

**Embargoes**, or the prohibition of trade between particular countries, are another political restriction on trade and generally result from political tensions. For example, U.S. trade with Cuba has been banned since the late 1950s (corresponding to Fidel Castro’s rise to Cuban prime minister and installation of a communistic government). Although the U.S. and Cuba restored diplomatic relations in 2015, the trade embargo is not likely to be lifted in the short term because of strong political opposition in the United States.  

In a similar fashion, because of long-standing political tensions, Israel and a number of Arab nations do not trade with each other, and this embargo has been extended to include nations that are sympathetic, or provide support, to Israel.

Yet another political consideration that influences international logistics is the degree of federal government involvement in cross-border trade. Businesses involved in foreign trade may often find that a federal government’s role is more significant than in domestic transactions, and as a result the buying and selling parties are not always free to contract the terms to suit their needs. In part, this is because most firms are first developed in domestic markets and take all existing governmental controls as a given factor. As a firm expands beyond its domestic markets, it finds requirements that differ for each nation with which the firm wishes to trade.

Businesses that engage in international logistics also learn that federal governments are often more involved in international transportation than they are in domestic transportation. One reason for this is that ocean carriers and international airlines can operate as extensions of a nation’s economy, and most of the revenues they receive flow into that nation’s economy. To that nation, international carriage functions as an export with favorable effects on the nation’s balance of payments (system of accounts that records a country’s international financial transactions). However, to the nation on the other end of the shipment, the effect is opposite because it must import the transport service, and this has an adverse impact on its balance-of-payments position. Some nations with very weak balance-of-payments positions issue an import license, or permit, on the condition that the goods move on a vessel or plane flying that nation’s flag, which means it is importing only the goods, not the transportation service required to carry them. Situations such as this dictate carrier choice.

Another aspect of federal government involvement in cross-border trade is that many nations provide subsidies, train their own merchant marine officers, absorb portions of the costs of building commercial vessels, and engage in other activities to promote their own merchant fleets. Governments also support their own carriers through cargo preference rules, which require a certain percentage of traffic to move on a nation’s flag vessels.

Historically, many international airlines were owned and operated by their national government; examples include Air India, Air China, and Alitalia (owned by the Italian government). However, over the past 30 years some government-owned international carriers have moved to the private sector, a process called privatization. For example, British Airways (formerly British Overseas Airways Corporation, or BOAC) was privatized by the British government in the late 1980s, Kenya Airlines was privatized by the Kenyan government in the mid-1990s, and SriLankan Airlines was privatized in the late 1990s.

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6Cateora, Gilly, and Graham, International Marketing, 15th ed.

7As used here, flying a nation’s flag is synonymous with being owned by private or public entities in that nation.
Economic Factors

A number of different economic factors—currency fluctuations, market size, income, infrastructure, and economic integration, among others—impact international trade, and in turn, international logistics. Consider currency fluctuations, or changes in the relative value of currencies. When one country’s currency is weak relative to other currencies, it becomes more costly to import products, but exports often surge; when one country’s currency is strong relative to other currencies, the reverse occurs.

Population is one proxy for market size, and you might recall from Chapter 9 that China and India are the world’s two most populous countries. Indeed, China and India each have populations in excess of 1.2 billion people and the two countries combined account for about one-third of the world’s population. From a population perspective, China and India might be potentially attractive markets because of their absolute and relative size.

Although both China’s and India’s gross domestic product (GDP) have been rapidly expanding over the past 15 years, China’s GDP per capita is approximately $14,300 and India’s GDP per capita is approximately $6,300. GDP per capita figures have potential implications in terms of the products that are available in particular countries. One strategy for marketing in countries with relatively low GDP per capita, such as India, involves single-use packets of products, called sachets, because people may not be able to afford to buy products in larger quantities. From a logistical perspective, single-use packets require different packaging and are easier to lose and more prone to theft than products sold in larger quantities.

A country’s logistics infrastructure is another economic factor that can impact international logistics. We learned in Chapter 12 that the transportation infrastructures in Brazil, China, Germany, Nigeria, and the United States are quite different and these differences have important implications for cross-border commerce. A lack of 10,000-foot airport runways, for example, could limit a country’s ability to participate in long-haul international movements of higher-value products. Warehousing, another key logistics infrastructure component, also varies tremendously across countries. For example, warehousing in China and India tends to be more labor intensive than in many western countries. In a similar fashion, the majority of warehouses in China and India lack warehouse management systems, and automatic data collection tools such as barcodes and scanners tend to be limited.

Economic integration is the final economic factor that we’ll discuss in terms of international logistics. Varying degrees of economic integration exist, ranging from a free trade area (such as the North American Free Trade Agreement) which focuses on removing trade barriers among participant countries, to an economic union (such as the European Union) which integrates economic policies among member nations and allows the free movement of goods, services, and factors of production among member nations.

While a comprehensive discussion of economic integration is beyond the scope of this text, many countries continue to explore the different types of economic integration. For example, at the time of publication, Albania, Macedonia, Montenegro, Serbia, and Turkey are currently candidates for admission to the European Union (EU). Currently 28 countries have been admitted to the EU, with Croatia being the most recent in 2013. In mid-2016, the United Kingdom voted to leave the EU and the logistical implications of this choice will play out in coming years.

Potential logistical implications of economic integration include reduced documentation requirements, reduced tariffs, and the redesign of distribution networks. For example, you might recall from Chapter 9 that Poland and the Czech Republic have become favorite distribution sites with the eastward expansion of the European Union.

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8 The CIA World Factbook, 2016.
Cultural Factors

Cultural considerations will be the final macroenvironmental influence on international logistics to be discussed and cultural influences include religion, values, rituals, beliefs, and language. We’ll look at three cultural factors—language, national holidays, and time orientation—and their potential implications for international logistics.

With respect to language, cargo handlers may not be able to read and understand the language of the exporting country, and it would not be unusual for cargo handlers in some countries to be illiterate. Hence, cautionary symbols, rather than writing, must be used (see Figure 14.1). Cargo moving aboard ocean vessels has distinct markings that identify the shipper, consignee, destination point, and piece number (in multipiece shipments). Some cartons and crates moving internationally are marked with what looks like a cattle brand, which is a shipper’s mark, and a drawing of the mark also appears on the documentation. The shipper’s mark is for use in areas in which dockworkers cannot read but need a method to keep documents and shipments together.

As with domestic cargo, care must be taken so that pilferable items are not identified. This may include changing the symbols every few months. Figure 14.2 shows a package with the various markings required for movement in cross-border commerce. The bill of lading, packing list, letter of credit, and other documents pertaining to a shipment must contain similar markings. Note that

Figure 14.1 Some of the Symbols Used for Packing Export Shipments  
Source: Fotolia.
markings on the box are in both inches and meters. Both weight and dimensions are given because density is a factor in determining international transportation charges.

National holidays are another cultural aspect that can affect the effectiveness and efficiency of international logistics. Consider, for example, the Chinese New Year that, unlike the New Year that many of you are familiar with, does not take place on January 1. Rather, because the Chinese New Year is based on the lunar calendar, it has a different starting date each year (see Table 14.1). Moreover, the Chinese New Year is characterized by a 15-day celebration period when many businesses shut down—a situation that affects shipments within, into, and out of China during that time period.

With respect to time orientation, a number of cultures view time as linear and as a resource that can be managed, allocated, used, and wasted. Under this time orientation, punctuality is a key attribute and can be operationalized in logistical metrics such as on-time service as well as through the implementation of just-in-time systems. Other countries, however, have very different time orientations. Some countries, for example, view time as circular, rather than linear, and under this perspective, today isn’t much different from yesterday; similarly, tomorrow isn’t much different from today. From an operational perspective, a circular time orientation means that what doesn’t get accomplished today can be accomplished tomorrow and thus “time schedules” (e.g., production schedules, pickup and delivery schedules) are often viewed as guidelines, rather than as absolutes.

**TABLE 14.1** Beginning Dates for the Chinese New Year 2018–2023

<table>
<thead>
<tr>
<th>Year</th>
<th>Beginning Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>February 16</td>
</tr>
<tr>
<td>2019</td>
<td>February 5</td>
</tr>
<tr>
<td>2020</td>
<td>January 25</td>
</tr>
<tr>
<td>2021</td>
<td>February 12</td>
</tr>
<tr>
<td>2022</td>
<td>February 1</td>
</tr>
<tr>
<td>2023</td>
<td>January 22</td>
</tr>
</tbody>
</table>

INTERNATIONAL DOCUMENTATION

International logistics involves a system in which documentation flows are as much a part of the main logistical flow as the flow of the product. Companies that export products from their home country for sale in other countries soon find that preparing the requisite documentation, assembling the documentation, and ensuring that the documentation arrives where and when it is needed is quite a challenge. Although domestic shipments might only require several pieces of documentation, export shipments typically require approximately 10 documents, and for some cross-border trades, more than 100 separate documents can be required!

Documentation can act as a nontariff barrier in the sense that all the necessary documents are required at the point of importation. Failure to do this can cause delays or, in some cases, result in the shipment being seized by the customs authority of the importing country. Moreover, simply having all required documentation is often just a starting point; the exporting organization may be given specific instructions, such as the relevant languages as well as appropriate font types and sizes, for completing the documentation.

Given the vast array of documents that can be used for international shipments, it’s only possible to discuss several of the most commonly used, and we’ll look at commercial invoices, certificates of origin, the shipper’s export declaration, and the shipper’s letter of instruction. A **commercial invoice** is similar in nature to a domestic bill of lading in the sense that a commercial invoice summarizes the entire transaction and contains (should contain) key information to include a description of the goods, the terms of sale and methods of payment (to be discussed in the next section), the shipment quantity, the method of shipment, and so on. The commercial invoice is often the most important document for customs agencies. A **certificate of origin** specifies the country(ies) in which a product is manufactured and can be required by governments for control purposes or by an exporter to verify the location of manufacture.

A **shipper’s export declaration (SED)** contains relevant export transaction data such as the transportation mode(s), transaction participants, and description of what is being exported. SEDs often serve as the basis for a country’s official export statistics. A **shipper’s letter of instruction (SLI)** often accompanies an SED and provides explicit shipment instructions. For example, an SLI might indicate which parties should receive which documents, the method or route of shipment, what types of insurance to purchase, and which insurance company(ies) to use.

Before concluding our discussion of the documentation requirements associated with international shipments, mention should be made about free trade agreements. Although some free trade agreements have led to a decrease in documentation requirements, others actually result in an increase in documentation, which could defeat the primary purpose of these agreements, namely, facilitating trade between participating countries.

Consider, for example, the U.S. and Central America Free Trade Agreement (CAFTA), which went into effect in 2005. To receive the favorable tariffs specified in this agreement, organizations provide extensive documentation, beginning with a detailed certificate of origin that is supported by sworn affidavits from various supply chain participants such as suppliers and producers. By contrast, there is much less documentation required for products imported from China.

**Terms of Sale**

Choosing the **terms of sale** involves parties working within the negotiations channel, looking at the possible logistics channels, and determining when and where to transfer the following between buyer and seller:

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1. The physical goods (the logistics channel)
2. Payment for the goods, freight charges, and insurance for the in-transit goods (the financing channel)
3. Legal title to the goods (the ownership channel)
4. Required documentation (the documentation channel)
5. Responsibility for controlling or caring for the goods in transit, say, in the case of livestock (the logistics channel).

Transfer can be specified in terms of calendar time, geographic location, or completion of some task. One must think in terms of both time and location.

In the 1930s, the International Chamber of Commerce developed, and then has periodically revised, terms of sale for international shipments. In the recent past, these terms of sale, commonly referred to as Incoterms, were implemented at the beginning of a new decade, such as Incoterms 1990 and Incoterms 2000. The most recent revision, Incoterms 2010, became effective on January 1, 2011 and it reflects the rapid expansion of global trade with a particular focus on improved cargo security and new trends in cross-border transportation.\(^\text{13}\)

Two key changes with Incoterms 2010 involve (1) organizing the terms by modes of transport and (2) using the terms in both international and domestic transportation. With respect to the former, Incoterms are now characterized as Group 1 (apply to any mode of transport) and Group 2 (apply to sea and inland waterway transport only). These two groups, and their respective Incoterms, will be listed and described in the following paragraphs.\(^\text{14}\)

**Group 1: Terms That Apply to Any Mode of Transport**

**EXW (ExWorks)**

The seller fulfills his obligation by having the goods available for the buyer to pick up at his premises or another named place (i.e., factory, warehouse, etc.). The buyer bears all risk and costs starting when he picks up the products at the seller’s location until the products are delivered to his location.

**FCA (Free Carrier)**

The seller delivers the goods export cleared to the carrier stipulated by the buyer or another party authorized to pick up goods at the seller’s premises or another named place. The buyer assumes all risks and costs with delivery of goods to final destination including transportation after delivery to carrier and any customs fees to import the product into a foreign country.

**CPT (Carriage Paid To)**

The seller clears the goods for export and delivers them to the carrier or another person stipulated by the seller at a named place of shipment. The seller is responsible for the transportation costs associated with delivering goods to the named place of destination but is not responsible for purchasing insurance.

**CIP (Carriage and Insurance Paid To)**

The seller clears the goods for export and delivers them to the carrier or another person stipulated by the seller at a named place of shipment. The seller is responsible for the transportation costs associated with delivering goods and purchasing minimum insurance coverage to the named place of destination.

**DAT (Delivered at Terminal)**

The seller clears the goods for export and bears all risks and costs associated with delivering the goods and unloading them at the terminal at the named port or place of destination. The buyer is responsible for all costs and risks from this point forward including clearing the goods for import at the named country of destination.

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\(^\text{13}\)Export.gov—Incoterms 2010.

\(^\text{14}\)This information comes from Export.gov—Incoterms 2010.
DAP (Delivered at Place)

The seller clears the goods for export and bears all risks and costs associated with delivering the goods to the named place of destination not unloaded. The buyer is responsible for all costs and risks associated with unloading the goods and clearing customs to import the goods into the named country of destination.

DDP (Delivered Duty Paid)

The seller bears all risks and costs associated with delivering the goods to the named place of destination ready for unloading and clearing for import.

Group 2: Terms That Apply to Sea and Inland Waterway Transport Only

FAS (Free Alongside Ship)

The seller clears the goods for export and delivers them when they are placed alongside the vessel at the named port of shipment. The buyer assumes all risks and costs for goods from this point forward.

FOB (Free on Board)

The seller clears the goods for export and delivers them when they are onboard the vessel at the named port of shipment. The buyer assumes all risks and costs for goods from this moment forward.

CFR (Cost and Freight)

The seller clears the goods for export and delivers them when they are onboard the vessel at the port of shipment. The seller bears the cost of freight to the named port of destination. The buyer assumes all risks for goods from the time goods have been delivered onboard the vessel at the port of shipment.

CIF (Cost, Insurance, and Freight)

The seller clears the goods for export and delivers them when they are onboard the vessel at the port of shipment. The seller bears the cost of freight and insurance to the named port of destination. The buyer's insurance requirement is only for minimum coverage. The buyer is responsible for all costs associated with unloading the goods at the named port of destination and clearing goods for import. The risk passes from seller to buyer once the goods are onboard the vessel at the port of shipment.

Although Incoterms use is not mandatory, they are generally accepted by legal authorities as well as buyers and sellers worldwide. In addition, it is acceptable to use previous versions of Incoterms, but both parties should clearly indicate which version is being used (e.g., Incoterms 2010, Incoterms 2000, Incoterms 1990, etc.).

Methods of Payment\textsuperscript{15}

With respect to international transactions, methods of payment refer to the manner by which a seller will be paid by a buyer and methods of payment are much more challenging in international logistics than in domestic logistics. The goals of international buyers and sellers are pretty much the same as those for domestic buyers and sellers—buyers want to receive the product that was paid for, and sellers want to get paid. However, the vagaries of international trade, such as delayed transportation and the economic and political riskiness of particular countries, impact the likelihood of successfully achieving these goals. Moreover, incorrect documentation for international shipments as well as documentation with incorrect information can cause sellers not to be paid by buyers.

Four distinct international methods of payment exist—cash in advance, letters of credit, bills of exchange, and the open account—and similar to terms of sale, the different payment methods offer varying amounts of risk to the involved parties. For example, although cash in advance is of

\textsuperscript{15}The material in this section is largely drawn from Jim Sherlock and Jonathan Reuvid, editors, The Handbook of International Trade (Edinburgh, UK: GMB Publishing, 2005), Part 8.
minimal risk to the seller, it is extremely risky to the buyer—what if the paid-for product is never received? Alternatively, an open account, where a seller sends the goods and all documents directly to the buyer and trusts the buyer to pay by a certain date, involves tremendous potential risk for the seller and minimal risk for the buyer.

The continuing worldwide economic uncertainty has resulted in a pronounced reduction in credit availability for open account financing and generated renewed usage of letters of credit as an international payment method. A letter of credit is issued by a bank and guarantees payment to a seller provided that the seller has complied with the applicable terms and conditions of the particular transaction. A sample letter of credit appears in Figure 14.3.

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The method of payment for international shipments should be established at the time that a shipment price is decided upon and the payment method can be influenced by key factors such as the country the product is to be sold in and the seller’s assessment of buyer risk. For example, with respect to the country the product is to be sold in, buyers located in countries characterized by political and/or economic instability would likely need to pay via cash in advance. The seller’s assessment of buyer risk can be based on previous experience with the buyer, references from other companies that trade with the buyer, and the buyer’s credit rating, if available.

INTERNATIONAL TRADE SPECIALISTS

Few companies involved in international logistics rely solely on in-house personnel to manage all shipping operations. Specialist firms have developed, and most companies involved in international trade eventually use one or more services that these specialists provide. Several international trade specialists will be discussed in this section.

International Freight Forwarders

International freight forwarders specialize in handling either vessel shipments or air shipments, yet their functions are generally the same. Some of their principal functions are discussed in the following paragraphs.

ADVISING ON ACCEPTANCE OF LETTERS OF CREDIT When a client receives a letter of credit, the document contains many conditions that the seller must meet. The forwarder determines whether the client can meet these conditions and, if it cannot, will advise the client that the letter of credit must be amended. The buyer and buyer’s bank must be notified before the order can be processed further.

BOOKING SPACE ON CARRIERS Space is frequently more difficult to obtain on international carriers than on domestic carriers for several reasons. Vessel or aircraft departures are less frequent, and the capacities of planes or ships are strictly limited. Connections with other carriers are more difficult to arrange, and the relative bargaining strength of any one shipper with an international carrier is usually weaker than it is with respect to domestic carriers. Forwarders are experienced at keeping tabs on available carrier space, and because they represent more business to the carrier than an individual shipper does, they have more success when finding space is difficult.

PREPARING AN EXPORT DECLARATION An export declaration is required by the U.S. government for statistical and control purposes and must be prepared and filed for nearly every shipment.

PREPARING AN AIR WAYBILL OR BILL OF LADING The international air waybill is a fairly standardized document; the ocean bill of lading is not. The latter may differ between ocean lines, coastal areas through which the shipments are moving, and for a variety of other circumstances. Ocean bills of lading are frequently negotiable, which means that whoever legally holds the document may take delivery of the shipment. Because nearly every ocean vessel line has its own bill of lading, a forwarder’s expertise is necessary to fill it out accurately.

OBTAINING CONSULAR DOCUMENTS Consular documents involve obtaining permission from the importing country for the goods to enter. Documents are prepared that the importing country uses to determine duties to be levied on the shipment as it passes through customs.

ARRANGING FOR INSURANCE Unlike domestic shipments, international shipments must be insured. Either the individual shipment must be insured or the shipper (or forwarder) must have a
blanket policy covering all shipments. International airlines offer insurance at nominal rates. Rates on vessel shipments are higher, and the entire process is complex because of certain practices that are acceptable at sea. For example, if the vessel is in peril of sinking, the captain may have some cargo jetisoned (thrown overboard) to keep the vessel afloat. The owners of the surviving cargo and the vessel owner must then share the costs of reimbursing the shippers whose cargo was thrown overboard.

**PREPARING AND SENDING SHIPPING NOTICES AND DOCUMENTS**  The financial transaction involving the sale of goods is carefully coordinated with their physical movement, and rather elaborate customs and procedures have evolved to ensure that the seller is paid when the goods are delivered. The international freight forwarder handles the shipper's role in the document preparation and exchange stages, and it is necessary to have certain documents available as the shipment crosses international boundaries.

**SERVING AS GENERAL CONSULTANT ON EXPORT MATTERS**  Questions continually arise when dealing with new products, terms of sale, new markets, or new regulations and a good international freight forwarder knows the answers or how to find them. A conscientious forwarder also advises a shipper as to when certain procedures, such as similar shipments to the same market, become so repetitive that the shipper can handle the procedures in its own export department at a cost lower than the fees charged by the forwarder.

International freight forwarders’ income comes from three sources. Similar to domestic forwarders, they buy space wholesale and sell it retail. By consolidating shipments, they benefit from a lower rate per pound. In addition, most carriers allow the forwarders a commission on shipping revenues they generate for the carriers. Also, forwarders charge fees for preparing documents, performing research, and the like.

**Nonvessel-Operating Common Carriers**

Another international logistics intermediary, the *nonvessel-operating common carrier (NVOCC)*, is often confused with the international freight forwarder, because both intermediaries consolidate freight from different shippers and leverage this volume to negotiate favorable transportation rates from ocean carriers. Adding to the confusion, the legal responsibilities of NVOCCs and international freight forwarders often differ across countries. The United States, for example, requires both NVOCCs and international freight forwarders to be licensed as ocean transportation intermediaries by the Federal Maritime Commission. According to the Federal Maritime Commission, NVOCCs are common carriers and thus have common carrier obligations to serve and deliver, among other responsibilities. From the shipper’s perspective, an NVOCC is a carrier; from an ocean carrier’s perspective, an NVOCC is a shipper.

In the United States, although a company can simultaneously hold both NVOCC and international freight forwarder licenses, it cannot act as an NVOCC and international freight forwarder on the same shipment. Currently, three key factors differentiate NVOCCs from international freight forwarders: (1) NVOCCs can issue their own bills of lading; (2) NVOCCs can set their own rates for ocean and intermodal shipments; and (3) NVOCCs can enter into service contracts with ocean carriers to purchase transportation services.17

**Export Management Companies**

Sometimes the manufacturer seeking to export retains the services of an *export management company (EMC)*, a firm that acts as the export sales department for a manufacturer. EMCs can provide a variety of value-added activities to include marketing research in prospective countries, developing appropriate distribution channels, handling sales correspondence in foreign languages, and ensuring that foreign labeling requirements are met, among others. When handling the overseas

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sales for a U.S. firm, the export management firm either buys and sells on its own account or provides credit information regarding each potential buyer to the U.S. manufacturer, which can judge whether to take the risk.

Export management companies often specialize by product (products) or by country (regions). For example, Five Star NDT exports, markets, and sells U.S. manufactured products to grocery chains and retail stores in Mexico. To this end, Five Star represents U.S. manufacturers like Mrs. Fields Cookies and Marie Callenders whose products are sold in Mexican retailers such as Benavides, Calimax, and Walmart de Mexico.18

**Export Packers**

Export packers custom pack shipments when the exporter lacks the equipment or the expertise to do so itself. Export packaging involves packaging for two distinct purposes, in addition to the sales function of some packaging. The first is to allow goods to move easily through customs. For a country assessing duties on the weight of both the item and its container, this means selecting lightweight packing materials. For items moving through the mail, it might mean construction of an envelope with an additional small flap that a customs inspector could open and look inside without having to open the entire envelope. For crated machinery, this might involve using open slats rather than completely closed construction (the customs inspectors would likely satisfy their curiosity by peering and probing through the openings between the slats).

The second purpose of export packing is to protect products in what almost always is a more difficult journey than they would experience if they were destined for domestic consignees. For many firms, the traditional ocean packaging method is to take the product in its domestic pack and enclose it in a wooden container. Ocean shipments are subject to more moisture damage and more extreme temperature variations than are domestic shipments. For example, because canned goods moving through hot areas sweat, causing the cans to rust and the labels to become unglued, Campbell's Soup adds desiccants to its cartons of soup, otherwise specks of rust will appear on the cans during their sea voyage.19

**TRANSPORTATION AND INVENTORY CONSIDERATIONS IN INTERNATIONAL LOGISTICS**

In many cases the distances associated with international shipments are often much greater than those associated with domestic shipments. Because these increased distances often mean that the buyer or seller must choose water or air transportation, we’ll take a somewhat detailed look at ocean shipping and international air transportation in this section. This will be followed by a discussion of surface transportation in international logistics.

Before beginning our discussion of ocean shipping and international air transportation, you should recognize the transit time/cost trade-offs between them. For example, a shipment from Shanghai to Los Angeles might take one or two days by air transportation and between 15 and 20 days by water transportation. On the other hand, the cost of air transportation for this shipment can be two to five times more expensive than sending it by water.

Moreover, international transportation can’t be effective or efficient without fairly identical handling equipment being in place at each end of the trip. Thus, containerization isn’t feasible unless both the origin and destination ports are equipped with the appropriate container handling equipment. Having said this, there continue to be countries where certain products are still stowed or unloaded by stevedores carrying individual bags on their shoulders (or heads) and walking up and down gangplanks. Although this manual loading and unloading is inefficient because of increasing loading or unloading times, the nations in which this practice occurs are often very poor, and manual cargo handling can be a means for providing jobs (and thus income) to many people.

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18http://www.soldinmexico.com

Ocean Shipping

If you don’t live near a seaport, you might not have an appreciation for the importance of water transportation in international trade; a frequently cited statistic is that approximately 60 percent of cross-border shipments move by water transportation. Another example of the importance of water transportation in international trade can be seen in Table 14-2 which provides data on the world’s 10 busiest container ports in 2015, as measured by TEU (twenty-foot equivalent units) throughput. As pointed out in Table 14-2, Shanghai, the world’s busiest container port, handled over 36 million TEUs in 2015; moreover, nine of the ten busiest container ports are located in Asia, with seven of the ports located in China. Note that no European ports, and no U.S. ports, rank among the ten busiest container ports.

In addition, you might not be aware of the variety of ship types available for transporting international shipments by water. For example, dry-bulk cargoes, such as grain, ores, sulfur, sugar, scrap iron, coal, lumber, and logs, usually move in complete vessel-load lots on chartered vessels and a bulk carrier is shown in Figure 14.4. There are also specialized cargo ships that are often owned by shippers. For example, Dole Food Company owns and operates approximately 20 refrigerated vessels to transport the different fruits, such as bananas and pineapples, produced by the company. Liquid bulk cargoes, such as petroleum, are transported by tankers that are either owned by oil companies or leased (chartered) by them from individuals who invest in ships.

Another type of vessel that combines aspects of several vessel types is the parcel tanker, which has over 50 different tanks, ranging from 350 to 2,200 cubic meters. Each can carry a different liquid and is loaded and unloaded through a separate piping system. The tanks have different types of coating; some are temperature controlled. Some of the vessels go on round-the-world voyages and carry palm oil, coconut oil, chemicals, and refined petroleum products.

Finally, containerships dominate the traffic between Europe and the United States, Europe and Asia, and the United States and Asia. Shippers or forwarders tender full containers, and if a shipper tenders a less-than-container lot, the vessel operator must load all the less-than-container lots into containers so that the cargo can be loaded aboard the containership. In large containerships, some of the containers are carried above the level of the deck which increases the vessel’s cubic carrying capacity.
We pointed out in an earlier chapter that the carrying capacity of containerships continues to increase, and this increased vessel size is one contributor to the growth of load centers, or major ports where thousands of containers arrive and depart each week. As vessel sizes increase, it becomes more costly to stop (call) at multiple ports in a geographic area, and as a result operators of larger containerships prefer to call at only one port in a geographic area. Load centers might affect the dynamics of international transportation in the sense that some ports will be relegated to providing feeder service to the load centers. In addition, load centers might affect supplemental transportation providers, such as truck and rail, particularly if the existing road and rail infrastructure is insufficient to accommodate the higher volumes that will be associated with the megaports.

**Shipping Conferences and Alliances**

Beginning in the mid-1860s, ocean rates were determined by shipping conferences, or cartels of all ocean vessel operators operating between certain trade areas such as Asia and Europe. Historically, shipping conferences provided both rate stability as well as guaranteed space availability due in large part to the ability of member carriers to collectively set rates and service levels without fear of antitrust prosecution.

The relationship between buyers (shippers) and sellers (carriers) and groups of sellers (conferences or alliances) has changed dramatically over the last 20 years and these relationships are currently very fluid. In certain regions, this commercial relationship has moved from a tightly regulated environment to a largely unregulated environment wherein shippers and carriers are free to work out whatever commercial relationship best suits them in confidential contractual agreements.

In particular, the influence of shipping conferences has been on the wane in the United States and Europe since the late 1990s. For example, although the U.S. Ocean Shipping Reform Act (OSRA) of 1998 did not explicitly prohibit shipping conferences, OSRA allowed ocean shippers and carriers to negotiate confidential contracts—which severely undermined conferences’ power and lessened their appeal. Moreover, in late 2008 the European Union removed the shipping conferences’ antitrust immunity for collective ratemaking for ocean shipments between EU countries.

In the mid-1990s, ocean carrier alliances, in which carriers retain their individual identities but cooperate in the area of operations, began forming in the container trades. These alliances provide two primary benefits to participating members, namely, the sharing of vessel space and the ability to offer shippers a broader service network (i.e., ports of call). Although alliances are not conferences, their size allows the alliances to exercise considerable clout in their dealings with shippers, port terminal operators, and connecting land carriers.

Due to acquisitions, mergers, and bankruptcies in recent years, there has been a great deal of flux in terms of the composition of the major ocean carrier alliances. As of mid-2016, three major ocean

**TABLE 14.2** World’s Busiest Container Ports (2015)

<table>
<thead>
<tr>
<th>Port</th>
<th>Country</th>
<th>TEU Throughput</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shanghai</td>
<td>China</td>
<td>36,540,000</td>
</tr>
<tr>
<td>Singapore</td>
<td>Singapore</td>
<td>30,920,000</td>
</tr>
<tr>
<td>Shenzen</td>
<td>China</td>
<td>24,200,000</td>
</tr>
<tr>
<td>Ningbo</td>
<td>China</td>
<td>20,630,000</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>China</td>
<td>20,070,000</td>
</tr>
<tr>
<td>Busan</td>
<td>South Korea</td>
<td>19,450,000</td>
</tr>
<tr>
<td>Qingdao</td>
<td>China</td>
<td>17,470,000</td>
</tr>
<tr>
<td>Guangzhou</td>
<td>China</td>
<td>17,220,000</td>
</tr>
<tr>
<td>Jebel Ali Dubai</td>
<td>United Arab Emirates</td>
<td>15,600,000</td>
</tr>
<tr>
<td>Tianjin</td>
<td>China</td>
<td>14,110,000</td>
</tr>
</tbody>
</table>


**International Airfreight**

Three types of international airfreight operations exist: chartered aircraft, integrated air carriers that specialize in carrying parcels, and scheduled air carriers. Chartering an entire aircraft is, of course, expensive, but sometimes the expense can be justified. For example, chartered aircraft can be used in the transport of livestock and pedigreed animals and one particular shipment involved carrying 2,400 cattle from the United States to the Voronezh region of southern Russia. Six back-to-back flights, using a Boeing 747 freighter, transported approximately 400 cattle per trip.  

A second type of international airfreight focuses on parcel services offered by well-known carriers such as UPS, FedEx, and DHL International. These companies provide land pickup and delivery services for documents and small parcels and are called **integrated carriers** because they own all their vehicles and the facilities that fall in between. These parcel services are of special significance to international logistics because they often provide the fastest service between many major points. They are also often employed to carry the documentation that is generated by—and is very much a part of—the international movement of materials, although many international trade documents can now be transferred electronically. The integrated carriers also handle documentation services for their clients.

The principal function of scheduled airlines is to carry passengers; freight tends to be a secondary consideration and is often carried in the bellies of passenger aircraft. Having said this, some scheduled airlines use all-freight aircraft (called **freighters**) in certain markets. For example, Lufthansa, a German airline, flies non-stop freighters between Frankfurt, Germany and Shanghai, China as well as between Frankfurt and Delhi, India, among other city pairs.

Historically, the routes of scheduled international air carriers were established by negotiations between nations and these negotiations generally involved two countries (called **bilateral agreements**). The types of issues that could be negotiated in these bilateral agreements included the number of flights between the two nations, the types of aircraft to be used, the total number of seats to be offered, the regions or cities to be served, and the carriers that were to serve particular regions or city pairs, among others.

While the traditional bilateral air agreements provided an important stimulus to international air transportation, these agreements tended to be quite restrictive in nature as illustrated in the previous paragraph. To this end, **open skies agreements**, which liberalize international aviation opportunities and limit federal government involvement, have become increasingly popular in the twenty-first century. One of the most prominent open skies treaties is the Open Aviation Area agreement between the United States and 27 EU member states that went into effect in March 2008. A key provision of this agreement is that any EU airline as well as any U.S. airline can fly between any point in the European Union and any point in the United States.  

**Surface Transport Considerations**

While ocean shipping and air transportation play a key role in international trade, particularly among shipments that move long distances, an understanding of surface transportation considerations is also important. For example, highway freight transportation is accomplished by trucks (motor carriers) in certain countries; alternatively, highway freight transportation can be provided by bicycles or some type of animal and cart combination in certain countries.

Surface transportation considerations in international logistics include an understanding of both a country’s infrastructure and its modal operating characteristics. As an example of infrastructure characteristics, the United States ranks first in the world in terms of highway mileage (approximately 6.5 million

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kilometers), followed by India (approximately 4.7 million kilometers) and China (approximately 4.1 million kilometers). However, only 2,000 kilometers of Indian highways are classified as expressways, compared to 75,000 for the United States and 65,000 kilometers for China. These highway mileages tell only part of the story, however. For example, a truck trip between the Indian cities of Delhi and Mumbai which is approximately 1,400 kilometers, can take up to 60 hours to complete. By contrast, several U.S. motor carriers promise transit times of approximately 30 hours for a 1,400 kilometer trip.

In addition to infrastructure characteristics, it’s also important to understand a country’s modal operating characteristics for surface transportation. For example, a motor carrier shipment from Cleveland, Ohio to Orlando, Florida experiences virtually no delays when moving across state borders (e.g., from Ohio into West Virginia; from West Virginia into Virginia; and so on). Alternatively, multi-state motor carrier shipments in other countries can be subject to lengthy delays when moving across state borders. Delays may happen in certain countries because a motor carrier’s operations may be limited to within a particular state’s borders; as a result, multi-state shipments must be transferred from one company’s vehicle to another company’s vehicle whenever crossing into another state. Another source of delay in certain countries is the inspection of trucks as they move from one state to another. This can include physical counting and inspection of all shipments, inspection of documentation, vehicle inspection, as well as driver inspection. Keep in mind that delays, whatever their source, result in slower transit times and increased costs.

Service performance is another important modal operational characteristic associated with surface transportation in other countries. For example, freight is given lower priority than passengers in rail transportation in China. Railroad transportation in China is also plagued by poor handling techniques, resulting in higher damage than if shipments moved by truck. In addition, the theft of rail freight is quite common in China and in some cases shippers provide their own security guards on trains to protect their goods from theft.

An alternative to surface transport in some nations is short-sea shipping (SSS), which refers to waterborne transportation that utilizes inland and coastal waterways to move shipments from domestic ports to their destination. SSS is more widely accepted and practiced in Europe (see Figure 14.5), and the European Union has championed a Motorways of the Sea concept that specifies four well-defined short-sea shipping lanes involving EU member nations. Potential benefits to SSS include reduced rail and truck congestion, reduced highway damage, a reduction in truck-related noise and air pollution, and improved waterways utilization.

Although the short-sea concept has received some attention in North America, a short-sea service that linked Halifax, Nova Scotia to several Northeast U.S. ports ceased operations in early 2012 after only nine months in operation. The fact that this service failed—and failed in such a short period of time—makes it highly unlikely that SSS will be a viable North American transportation option in the coming years.

International Trade Inventories

Even under the best conditions, the movement of products in an international supply chain is never as smooth as a comparable domestic movement. Because greater uncertainties, misunderstandings, and delays often arise in international movements, safety stocks must be larger. In addition, inventory valuation is difficult because of continually changing exchange rates. If goods are valued in the currency of where they are produced, that value can fluctuate with respect to the currency value of where the product is being stored. When a nation’s (or the world’s) currency is unstable, investments in inventories may increase because they are believed to be less risky than holding cash or securities.

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22Highway data taken from The CIA World Factbook, 2016.
Firms involved in international trade must give careful thought to their inventory policies, in part because inventory available for sale in one nation may not necessarily serve the needs of markets in nearby nations. Consider, for example, that electrical voltages, electrical plugs, and electrical sockets differ across countries. As a result, a 120-volt electrical product designed for use in the United States would need both a voltage converter and a plug adapter in order to be used in Europe.

Product return (reverse logistics) policies are another concern with respect to international inventory management. One issue is that, unlike the United States where products can be returned for virtually any reason, some countries don’t allow returns unless the product is defective in some respect. A second challenge with international returns is that it may be unreasonable or impractical to tell buyers to return a defective item to the country where it was produced.

Warehousing is another inventory-related consideration associated with international logistics. Whereas warehousing facilities in economically developed countries have been developed to meet the requirements of contemporary logistics systems, warehousing facilities in other countries can be more problematic. For example, a 2015 report indicated that approximately 10% of China’s warehouses can be classified as meeting global standards (e.g., high ceilings, sufficient lighting).  

LOGISTICS PERFORMANCE INDEX

We’ll conclude this chapter with a look at an emerging international logistics concept, the Logistics Performance Index (LPI) that was first introduced in 2007 and updated several times since, including in 2016. The LPI was created in recognition of the importance of logistics in global trade and

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28 The material in this section is based on Logistics Performance Index, http://lpi.worldbank.org/international/global
measures a country’s performance across six logistical dimensions (seven logistical dimensions were evaluated in 2007):

- Efficiency of the clearance process (i.e., speed, simplicity, and predictability of formalities) by border control agencies, including customs;
- Quality of trade and transport related infrastructure (e.g., ports, railroads, roads, information technology);
- Ease of arranging competitively priced shipments;
- Competence and quality of logistics services (e.g., transport operators, customs brokers);
- Ability to track and trace consignments;
- Timeliness of shipments in reaching destination within the scheduled or expected delivery time.

The LPI incorporates data for approximately 160 countries and uses a scale of 1 (lowest possible score) to 5 (highest possible score) to rate each of the six dimensions. Germany (LPI score = 4.23) and Luxembourg (LPI score = 4.22) were the two top-ranked countries in the 2016 LPI, while the Syrian Arab Republic (LPI score = 1.60) and Haiti (LPI score = 1.72) were the two lowest-rated countries.

The LPI is a potentially valuable international logistics tool because the data can be analyzed from several different perspectives. First, the LPI can be analyzed for all countries according to the overall LPI score as well as according to scores on each of the six dimensions. For example, while Luxembourg ranks second in terms of the overall 2016 LPI score, it ranks first in terms of the “timeliness” dimension.

Second, the LPI can be analyzed in terms of an individual country’s performance (1) over time, (2) relative to its geographic region, and (3) relative to its income group. For example, one can compare Argentina’s overall and dimension-specific LPI scores (1) in 2007, 2010, 2012, 2014, and 2016, (2) to Latin American and Caribbean countries, and (3) to upper-middle-income countries. The 2016 LPI also allows for comparisons to the top performing country in an income group; for example, South Africa was the top performing upper-middle-income country.

**Summary**

This chapter covered various aspects of international logistics, which differs from domestic logistics in many respects, such as by having a requirement for numerous documents as well as by greater distances between origin and destination points. Macroeconomic influences can provide significant challenges for international logistics and the chapter discussed three specific macroeconomic factors—political, economic, and cultural.

From a political perspective, we learned that international trade can be influenced through tariff and nontariff barriers and that federal governments are actively involved in cross-border trade. The chapter also mentioned that different economic factors, such as currency fluctuations and economic integration, can impact international logistics. In terms of culture, a country’s time orientation can influence the use of schedules as well as the emphasis placed on on-time performance.

The chapter also looked at three key operational issues—documentation, terms of sale, and methods of payment—in international logistics. Several key pieces of international documentation, including the certificate of origin and shipper’s export declaration, were examined and international terms of sale—Incoterm—were discussed. And because international logistics is complex, many firms rely on specialists, such as international freight forwarders and export packers, to help with export and import transactions.

The chapter also examined transportation and inventory considerations in international distribution. We looked at ocean shipping, international air freight, and surface transportation, and we learned that the greater uncertainties associated with international shipments necessitate higher inventory levels. The chapter concluded with a discussion of the Logistics Performance Index, which measures an individual country’s performance across six logistical dimensions.
Part III • Elements of Logistics Systems

Key Terms

- Balance of payments
- Cargo preference
- Certificate of origin
- Commercial invoice
- Embargoes
- Export management company (EMC)
- Export packers
- Gross world product
- Import quota
- Incoterms
- International freight forwarders
- International logistics
- Letter of credit
- Load centers
- Logistics Performance Index (LPI)
- Methods of payment
- Non-tariff barriers
- Non-vessel-operating common carrier (NVOCC)
- Ocean carrier alliances
- Open account
- Open skies agreements
- Shipper’s export declaration (SED)
- Shipper’s letter of instruction (SLI)
- Shipping conferences
- Short-sea shipping (SSS)
- Tariffs
- Terms of sale

Questions for Discussion and Review

14.1 Discuss some of the key political restrictions on cross-border trade.
14.2 How might a particular country’s government be involved in international trade?
14.3 Discuss how a nation’s market size might impact international trade and, in turn, international logistics.
14.4 How might economic integration impact international logistics?
14.5 How can language considerations impact the packaging and labeling of international shipments?
14.6 What is a certificate of origin, a commercial invoice, and a shipper’s export declaration?
14.7 Discuss international terms of sale and Incoterms.
14.8 Name the four methods of payment for international shipments. Which method is riskiest for the buyer? For the seller?
14.9 Discuss four possible functions that might be performed by international freight forwarders.
14.10 What is an NVOCC?
14.11 What are the two primary purposes of export packing?
14.12 Discuss the importance of water transportation for international trade.
14.13 Explain the load center concept. How might load centers affect the dynamics of international transportation?
14.14 Discuss the role of ocean carrier alliances in international logistics.
14.15 How do integrated air carriers impact the effectiveness and efficiency of international logistics?
14.16 How do open-skies agreements differ from bilateral agreements?
14.17 Discuss the potential sources of delays in certain countries with respect to motor carrier shipments that move across state borders.
14.18 Define what is meant by short-sea shipping (SSS), and discuss some advantages of SSS.
14.19 What are some challenges associated with inventory management in cross-border trade?
14.20 What is the Logistics Performance Index? How can it be used?

Suggested Readings


**CASE**

**CASE 14.1 NÜRNBERG AUGSBURG MASCHINENWERKE (N.A.M.)**

The Nürnberg Augsburg Maschinenwerke, one of Germany’s most successful manufacturing companies, enjoys a long tradition. It dates from 1748, when the St. Antony Iron Mill opened in Oberhausen (located in the heart of the Ruhrgebiet industrial region) during the beginning years of German industrialization. The owners soon founded additional iron and coal mills, then established the firm as Gute Hoffnungshuette (GHH). Shortly following, in Augsburg and Nürnberg, several companies joined together to form Nürnberg Augsburg Maschinenwerke (N.A.M.). These two firms, GHH and N.A.M., would ultimately merge in the early twentieth century.

In the interim, N.A.M. had distinguished itself through the work of Rudolf Diesel, who invented his famous engine and then brought it to N.A.M. late in the nineteenth century. The diesel engine competed with the internal combustion engine in early automotive design and today powers heavy trucks, turbines, railroad engines, and ships. Based on this success, N.A.M. swiftly expanded manufacturing operations and distribution across the globe, only to have its foreign operations compromised by international politics on two occasions. First, N.A.M. lost most of its foreign property in the wake of World War I, a setback that, among other adjustments, encouraged its merger with GHH in 1920. Second, N.A.M. lost all of its foreign property again after World War II and had to rebuild and restructure much of its domestic operation as well. In 1955, the company opened a truck unit in Munich, which would later become the new company headquarters.

By 2003 the company had reclaimed its preeminence as a global player in heavy truck and bus design, engineering, and manufacturing, as well as in print technology, rocket, and energy science. It had reestablished both its plants and sales offices across the globe, and is one of the largest diesel engine makers in the world. Karl Huber was the N.A.M. regional vice president of sales for South America, and he supervised a team of local sales representatives in the countries of that continent, plus a small group of people in the Munich headquarters.

On August 15, Huber received an e-mail from Leopold Escabar in Caracas, who had just returned from an important meeting with local authorities in charge of redesigning the local public transportation systems for the Brazilian cities of São Paulo and Rio de Janeiro. Escabar had attended the meeting along with salespeople from competing truck and bus companies. Escabar gave Huber some good news and some bad news. Escabar had been told N.A.M. was favored to receive an order for 224 N.A.M. class #4-G two-section articulated buses (or “accordion” buses, as Escabar liked to call them), with the possibility of securing a contract for an additional 568 buses. To win the business, however, N.A.M. would have to meet cost and timing guarantees.

The customers first required that N.A.M. must match or beat the total price per unit, including shipping, that N.A.M. had received for a shipment of 233 buses to the transit district of Buenos Aires, 6 months earlier. That price was 124,500 € per bus. Huber had built in a small extra profit margin on the Buenos Aires deal, so he felt confident that to meet their pricing demand he could shave profit a little, if necessary, in this case.

The second guarantee, however, was more worrisome: The Brazilian authorities were feeling political heat because they were badly behind schedule in implementing their transportation plan and needed proof to show the public that their new programs were underway. So they had made this offer to N.A.M. on the strict condition that the company could ensure delivery of the first 25 buses (continued)
to Santos, the port that serves São Paulo, by November 15 (only 3 months away). If N.A.M. delivered this initial 90-day order on time, the company would receive a contract for the remaining 199 vehicles to be delivered in full within the following 15 months. The follow-on order for 568 more vehicles was, essentially, contingent on meeting terms of the initial contract to the letter, with regard to the 224 buses. All buses were to be delivered to the Port of Santos.

Huber whistled softly to himself as he read Escabar’s e-mail. This would be a major order. In a single stroke, it could move him ahead of his regional sales targets for several quarters to come. Huber immediately sent back an e-mail, instructing Escabar to tentatively accept the offer, assuring the local authorities that they’d have their 25 buses in 90 days and the rest within 18 months. N.A.M. would formally accept the proposal within 5 working days. Then he scratched his head and tried to figure out how. Huber had 4 days before the next managing director’s meeting, at which time he would present the project and, with the vice president for production, propose a plan to accomplish it. Huber lunged for the phone and, scarcely glancing at the number pad, his fingers automatically dialed 4823.

Dieter Berndsen, the production V.P., listened as his old friend Huber described the opportunity, jotting down notes as he went. He explained to Huber that the factory in Munich was already producing to its limits, and the two other German facilities were also facing a backlog of orders through the fourth quarter. So Berndsen offered two immediate possibilities. First, he considered wait listing a 40-bus order from the Thai military at the Munich plant. He said he was reluctant to do this, however, because the Thais had ordered several product modifications, and the Munich line had already been set up to handle them. Second, Berndsen suggested sending the new Brazil order to N.A.M.’s Prague facility. Prague was the smallest of all the European plants and had the oldest, slowest assembly lines, but they were just finishing up manufacture of an order of #4-G’s and, due to a recent order cancellation, would now be working at only 70 percent capacity through year-end. Within 8 weeks, figured Berndsen, Prague could easily handle the order for Brazil’s first 25 buses.

Huber eagerly agreed, as Berndsen decided to recommend Prague for this assignment. The problem was that this facility could not produce fast enough to fulfill more than 20 percent of the rest of the contract (for the 224 buses), which meant that he would have to coordinate production and delivery on the rest of this order from other plants. Sighing audibly over the phone line, Berndsen said, “Thanks a lot for the new headache, Hubie. Let me mull this one over for a bit before I call you back. But don’t worry, we’ll make your deadline—and you will make your bonus. Just remember to cut me in for a piece.”

Huber chuckled, thanked him, and hung up.

Berndsen decided to split the full order (224 buses) among the factories in Prague and the much larger plant in Munich. To finalize both scheduling and pricing, he now needed to estimate the time it would take to fulfill the order, as well as the cost of transportation. He was inclined to use the Deutsche Bundesbahn to transport the buses by train to the North Sea port of Bremerhaven, but he wasn’t sure that this was the best solution for each of the plants involved.

Berndsen’s immediate problem was the first shipment of buses, which would be ready to leave Prague on October 15. Berndsen asked Marcus Weiss, his supply-chain analyst, to create a worksheet that would show all costs and times required to get the buses from the Prague factory to the port of Bremerhaven, and he also asked Weiss to identify viable alternatives. (Europe possesses an extensive network of rivers and channels that connect together its network of commercial waterways. In fact, the European Union champions a Motorways of the Seas concept that specifies four short-sea shipping lanes that involve its member nations.) Consequently, the Prague plant sometimes transported buses on barges via the Elbe, north to Hamburg. The German plants occasionally shipped north to Bremerhaven or Hamburg, via a network of industrial waterways, or westward, over the River Rhein, to the port of Rotterdam in the Netherlands. (See Exhibit 14.A.)

Following is some of the information Weiss assembled for Berndsen:

- By train, the geographic distances between plants and ports were as follows: Prague to Hamburg 490 kilometers, Prague to Rotterdam 640 kilometers.
- N.A.M. would need 3 days to get the buses from the factories in Prague to the Port of Bremerhaven or Hamburg by train and 4 or 5 days to reach Rotterdam. The advantage of Rotterdam comes, however, in the shipping time from there to Santos, which saves a day versus Bremerhaven or Hamburg, and ocean shipping charges are 5 percent less.
- The Czech railway could transport the load to the border with Germany, where the Deutsche Bundesbahn would take over the flatcars, which carry two buses each. The Bundesbahn quotes a price of €1,643 per flatcar from Prague to Hamburg, which includes the service by its Czech partner. If rail were used from Prague to Rotterdam, the cost
per flatcar would be €1,943. In either port, it costs another €45 per bus to have it unloaded and driven to alongside the vessel. The vessel line can load and pack 20 buses per day, charging €25 per bus and up to 30 buses with overtime charges. The overtime charges would amount to an additional €15 per bus (for buses 21, 22, and so on). All charges per bus included detaching the two halves.

- Using the waterways instead of trains to reach the Hamburg port from Prague would decrease the transportation cost by €48 per bus. Waterway transportation would increase the transport time necessary by 3 days to Hamburg.

- For transoceanic shipping on any of these routes, N.A.M. works with Hapag-Lloyd AG. Hapag-Lloyd is able to offer a cheap and flexible commodity cost, through its alliance with other ship lines for the ocean transport of the buses. One vessel could carry up to 125 buses as deck cargo, but they would have to be disassembled at their accordion junctions and then reassembled again at their destination.

- The cost per bus (in shipments of 20 buses or more) from Bremerhaven or Hamburg to Santos is quoted at €6,000, and the trip requires 18 days. Hapag-Lloyd indicates that deck space is available for the initial shipment of 25 buses on vessels departing Hamburg on October 24, October 27, October 31, and November 3. Hapag-Lloyd also has space on vessels leaving from Rotterdam to Santos on October 23, October 28, and November 2.

- Handling (unloading) in Santos is estimated to cost another €94 per bus, and this includes reattaching the two halves.

- The interest for N.A.M.’s line of credit is 10 percent.

QUESTIONS

1. Assume that you are Weiss. How many viable alternatives do you have to consider regarding the initial shipment of 25 buses?

2. Which of the routing alternatives would you recommend to meet the initial 90-day deadline for the 25-bus shipment? Train or waterway? To which port(s)? What would it cost?

3. What additional information would be helpful for answering question 2?

4. How important, in fact, are the transport costs for the initial shipment of 25 buses?

5. What kinds of customer service support must be provided for this initial shipment of 25 buses? Who is responsible?

6. The Brazilian buyer wants the buses delivered at Santos. Weiss looks up the International Chamber of Commerce’s Incoterms and finds three categories of “delivered” terms:

   - **DAT (Delivered at Terminal)**. In this type of transaction, the seller clears the goods for export and bears all risks and costs associated with delivering the goods and unloading them at the terminal at the named port or place of destination. The buyer is responsible for all costs and risks.

   (continued)
from this point forward including clearing the goods for import at the named country of destination.

- **DAP (Delivered at Place).** The seller clears the goods for export and bears all risks and costs associated with delivering the goods to the named place of destination not unloaded. The buyer is responsible for all costs and risks associated with unloading the goods and clearing customs to import goods into the named country of destination.
- **DDP (Delivered Duty Paid).** The seller bears all risks and costs associated with delivering the goods to the named place of destination ready for unloading and clearing for import.

7. How should he choose? Why?

8. Would you make the same routing recommendation for the second, larger (199 buses) component of the order, after the initial 90-day deadline is met? Why or why not?

9. How important, if at all, is it for N.A.M. to ship via water to show its support of the European Union’s Motorways of the Seas concept?
APICS (www.apics.org)

APICS “is the premier professional association for supply chain and operations management.”\(^1\) In 2014, APICS merged with the Supply Chain Council and APICS merged with the American Society of Transportation and Logistics in 2015. These mergers now allow APICS to offer multiple certification programs: APICS Certified in Production and Inventory Management (CPIM), APICS Certified Supply Chain Professional (CSCP), APICS Supply Chain Operations Professional (SCOR-P), and APICS Certified in Logistics, Transportation, and Distribution (CLTD).

COUNCIL OF SUPPLY CHAIN MANAGEMENT PROFESSIONALS (CSCMP) (www.cscmp.org)

The Council of Supply Chain Management Professionals’ mission is “to lead the Supply Chain profession by connecting, developing, and educating the world’s Logistics and Supply Chain Management Professionals throughout their careers.”\(^2\) CSCMP offers the SCPro™ certification program, “a three-tiered certification program that assesses progressive knowledge, skills, and abilities across supply chain activities.”

INTERNATIONAL SOCIETY OF LOGISTICS (SOLE) (www.sole.org)

The International Society of Logistics is a “non-profit international professional society composed of individuals organized to enhance the art and science of logistics technology, education and management.”\(^3\) SOLE has a presence in over 50 countries and offers three certification programs: the Demonstrated Logistician Program (DL Program), the Certified Professional Logistician Program (CPL), and the Certified Master Logistician Program (CML).

THE CHARTERED INSTITUTE OF LOGISTICS AND TRANSPORT (CILT) (www.ciltinternational.org)

CILT “is the leading international professional body for anyone who works in supply chain, logistics and transport.”\(^4\) CILT has a presence in approximately 30 countries and it offers the Chartered Membership designation, which reflects educational achievement as well as significant practical experience.

WAREHOUSING EDUCATION AND RESEARCH COUNCIL (WERC) (www.werc.org)

WERC is “the only professional organization focused on logistics management and its role in the supply chain.”\(^5\) It emphasizes education and learning, research into industry issues, and networking opportunities.

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\(^{3}\)From The International Society of Logistics, © 2016 SOLE  
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\(^{5}\)From Warehousing Education and Research Council © 2016, WERC
Activity-based costing (ABC) is focused on better understanding the cost of a product by identifying what activities drive particular costs. Unlike traditional accounting techniques, activity-based costing attempts to trace an expense category to a particular cost object. With activity-based costing, cost objects consume activities, and activities consume resources.\(^1\)

Activity-based costing consists of five steps:

- Identify activities
- Determine cost for each activity
- Determine cost drivers
- Collect activity data
- Calculate product cost\(^2\)

This five-step activity-based costing process will be illustrated by the following hypothetical example. Suppose that a company is interested in applying the activity-based costing process to its order cycle process for two products that it sells. So, we’ve identified the relevant activities (step 1); next comes a determination of cost for each activity, as shown in Table 7A-1. Step 3 requires us to determine cost drivers, and in this example they are order transmittal → number of orders; order processing → number of processing activities; order picking and assembly → number of boxes; order delivery → number of delivery locations.

The two remaining steps, activity data and product cost calculation, appear in Table 7A-2. With respect to order transmittal, three orders were received for Product 1 and seven orders for Product 2, for a total of 10 orders. Because Product 1 accounts for 30 percent of the total orders (3/10), the relevant transmittal cost is $300, which represents 30 percent of the $1,000 total order transmittal cost. Likewise, because Product 2 accounts for 70 percent (7/10) of the total orders, its relevant transmittal costs are $700. The product costs for the three other activities are calculated in a similar fashion. Note that the data in Table 7A-2 indicate that the total order cycle cost is $22,000; according to the activity-based costing process, Product 1 is responsible for $12,600 in costs, and Product 2 is responsible for $9,400.

<table>
<thead>
<tr>
<th>TABLE 7A-1</th>
<th>Cost for Each Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activity</strong></td>
<td><strong>Cost</strong></td>
</tr>
<tr>
<td>Order transmittal</td>
<td>$ 1,000</td>
</tr>
<tr>
<td>Order processing</td>
<td>$ 3,000</td>
</tr>
<tr>
<td>Order picking and assembly</td>
<td>$12,000</td>
</tr>
<tr>
<td>Order delivery</td>
<td>$ 6,000</td>
</tr>
</tbody>
</table>

\(^1\) www.pitt.edu/~roztocki
\(^2\) Ibid.
Before concluding this brief discussion of activity-based costing, it’s important to recognize that the cost drivers can vary from organization to organization and should be driven by company-specific considerations such as organizational structure, operational structure, and products.3

For example, in our hypothetical example the number of delivery locations was the cost driver associated with order delivery. Another potential cost driver for order delivery could be the number of customers receiving deliveries.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Cost</th>
<th>Product 1 data</th>
<th>Product 1 cost</th>
<th>Product 2 data</th>
<th>Product 2 cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order transmittal</td>
<td>$1,000</td>
<td>3 orders</td>
<td>$300</td>
<td>7 orders</td>
<td>$700</td>
</tr>
<tr>
<td>Order processing</td>
<td>$3,000</td>
<td>4 activities</td>
<td>$1,200</td>
<td>6 activities</td>
<td>$1,800</td>
</tr>
<tr>
<td>Order picking and assembly</td>
<td>$12,000</td>
<td>110 boxes</td>
<td>$6,600</td>
<td>90 boxes</td>
<td>$5,400</td>
</tr>
<tr>
<td>Order delivery</td>
<td>$6,000</td>
<td>30 locations</td>
<td>$4,500</td>
<td>10 locations</td>
<td>$1,500</td>
</tr>
<tr>
<td>Total</td>
<td>$22,000</td>
<td></td>
<td>$12,600</td>
<td></td>
<td>$9,400</td>
</tr>
</tbody>
</table>

Before concluding this brief discussion of activity-based costing, it’s important to recognize that the cost drivers can vary from organization to organization and should be driven by company-specific considerations such as organizational structure, operational structure, and products.3

For example, in our hypothetical example the number of delivery locations was the cost driver associated with order delivery. Another potential cost driver for order delivery could be the number of customers receiving deliveries.

GLOSSARY

3D printing A process of making three-dimensional solid objects from a digitized file.

ABC analysis of inventory Concept that recognizes that because inventories are not of equal value to a firm, they should not be managed in the same way.

Accessorial service Transportation service that is supplemental to line-haul transportation.

Accumulating (bulk-making) Bringing together inventory from different sources.

Activity-based costing (ABC) A technique that seeks to better understand the cost of a product by identifying what activities drive particular costs.

Agglomeration (industry cluster) Refers to the net advantage which can be gained by a sharing of common locations by various enterprises.

Agile supply chain Focuses on an organization’s ability to respond to changes in demand with respect to volume and variety.

Allocating (bulk-breaking) Breaking larger quantities into smaller quantities.

Amodal shipper A transportation manager who purchases a prespecified level of transportation service and is indifferent to the mode(s) or carrier(s) used to provide the actual transportation service.

Application-specific software Refers to software that has been developed for managers to deal with specific logistics functions or activities (e.g., transportation management systems).

Assets Are what a company owns and include current assets and long-term assets.

Asset turnover In the Strategic Profit Model, asset turnover measures the efficiency of capital employed to generate sales.

Assorting Building up a variety of different products for resale to a particular customer.

Back order Placing an order for an item that is out of stock.

Balance of payments Systems of accounts that records a country’s international financial transactions.

Balanced Scorecard (BSC) A strategic planning and performance management system that evaluates a business from four distinct perspectives: customers, internal business processes, learning and growth, and financial.

Balance sheet Reflects an organization’s assets, liabilities, and owners’ equity at a given point in time.

Barge Flatboard boat used to transport heavy products.

Benchmarking Using measures of another organization’s performance to judge one’s own performance.

Big-box retailer A store with large amounts of both floor space and products for sale.

Big data The collection of large amounts of near real-time data collected through a variety of sources, such as sensors, smartphones, RF tags and business-to-business data exchanges.

Bill of lading The most important single transportation document that is the basic operating document in the industry.

Bribes Money paid before an exchange.

Broker A company that helps both shipper and carrier achieve lower freight rates and more efficient utilization of carrier equipment. Brokers also help match carriers to loads.

Brownfields Locations that contain chemicals or other types of industrial wastes.

Building-blocks concept Combining smaller packages into larger units that can be more efficiently handled at one time.

Bullwhip effect Characterized by variability in demand orders among supply chain participants.

“C-level” position Refers to corporate officers such as a chief executive officer (CEO), chief operating officer (COO), or chief financial officer (CFO).

Cargo preference Requires a certain percentage of traffic to move on a nation’s flag vessels.

Cause and effect (associative) forecasting Assumes that one or more factors are related to demand, and the relationship between cause and effect can be used to estimate future demand.

Center-of-gravity approach An approach for locating a single facility that minimizes the distance to existing facilities.

Centralized logistics organization An organization maintains a single logistics department that administers the related activities for the entire company from the home office.

Certificate of origin Specifies the country(ies) in which a product is manufactured.

Class rate system A system that simplifies each of the three primary rate factors—product, weight, and distance.

Closed-loop systems Refers to systems that consider the return flow of products, their reuse, and the marketing and distribution of recovered products.

Cloud computing See on-demand software.

Co-branding Refers to an alliance that allows customers to purchase products from two or more name-brand retailers at one store location.

Collaborative planning, forecasting, and replenishment (CPFR) Retail industry initiative where trading partners share planning and forecasting data to better match supply and demand.

Commercial invoice A document used in cross-border trade that summarizes the entire transaction and contains key information such as a description of the goods, the terms of sale and payment, and so on.

Commodity rate A specific rate for every possible combination of product, weight, and distance.

Common carrier Transportation carrier that has agreed to serve the general public and assumes four legal obligations: service, delivery, reasonable rates, and avoidance of discrimination.
Complementary products Inventories that are used or distributed together (e.g., razor blades and razors).

Concealed loss or damage Loss or damage that is not apparent until after a shipment has been unpacked and inspected.

Consignee The receiver of a shipment.

Container A uniform sealed reusable metal “box” in which goods are shipped.

Container Security Initiative (CSI) An agreement in which the world’s ports agree to allow U.S. customs agents to identify and inspect high-risk containers bound for the United States before they are loaded onto ships.

Contract carrier A contract carrier provides specialized service to each customer based on a contractual arrangement.

Contract logistics See third-party logistics.

Contract (third-party) warehousing A type of contract logistics that focuses on providing unique and specially tailored warehousing services to particular clients.

Cost leadership strategy Requires an organization to pursue activities that will enable it to become the low cost producer in an industry for a given level of quality.

Cost trade-offs Changes to one logistics activity cause some costs to increase and others to decrease.

Cross-docking A process of receiving product and shipping it out the same day or overnight without putting it in storage.

Cube out Occurs when a cargo takes up a vehicle’s or a container’s cubic capacity before reaching its weight capacity.

Current ratio A financial ratio that measures how well an organization can pay its current liabilities by using only current assets.

Customer profitability analysis (CPA) Refers to the allocation of revenues and costs to customer segments or individual customers to calculate the profitability of the segments or customers.

Customer service The ability of logistics management to satisfy users in terms of time, dependability, communication, and convenience.

Customs Trade Partnership Against Terrorism (C-TPAT) A program in which public and private organizations work together to prevent terrorism against the United States through imports and transportation.

Cycle (base) stock Inventory needed to satisfy demand during an order cycle.

Data Facts or recorded measures of certain phenomena.

Data mining Utilizes sophisticated quantitative techniques to find hidden patterns in large volumes of data.

Data warehouse A central repository for all relevant data collected by an organization.

Dead inventory (dead stock) Product for which there is no demand.

Decentralized logistics organization Logistics-related decisions are made separately at the divisional or product group level and often in different geographic regions.

Demand management The creation across the supply chain and its markets of a coordinated flow of demand.

Demurrage A charge assessed by rail carriers to users that fail to unload and return vehicles or containers promptly.

Density A measure of how heavy a product is in relation to its size.

Detention A payment from a shipper or consignee to a truck carrier for having kept the carrier’s equipment too long.

Department of Transportation (DOT) U.S. federal government body with primary responsibility for transportation safety regulation.

Differentiation strategy Entails an organization developing a product and/or service that offers unique attributes that are valued by customers and that the customers perceive to be distinct from competitor offerings.

Dimensional weight (dim weight) Considers a shipment’s density (the amount of space occupied relative to weight) to determine a shipment’s billable weight.

Disintermediation The removal of levels (layers) from a channel of distribution.

Distribution center A warehouse with an emphasis on quick throughput, such as is needed in supporting marketing efforts.

Documentation The documents associated with transportation shipments.

Dunnage Material that is used to block and brace products inside carrier equipment to prevent the shipment from shifting in transit and becoming damaged.

Economic order quantity (EOQ) An order size that minimizes the sum of carrying and ordering costs.

Economic utility Refers to the value or usefulness of a product in fulfilling customer needs and wants.

Electronic data interchange (EDI) Computer-to-computer transmission of business data in a structured format.

Electronic procurement (e-procurement) Uses the Internet to make it easier, faster, and less expensive for an organization to purchase goods and services.

Embargoes Prohibition of trade between particular countries.

Enterprise resource planning (ERP) system Lets a company automate and integrate the majority of its business processes, share common data and practices across the enterprise, and produce and access information in a real-time environment.

Ergonomics The science that seeks to adapt work or working conditions to suit the abilities of the worker.

Excess capacity Unused available space.

Excess (surplus) materials Stock that exceeds the reasonable requirements of an organization.

Exempt carrier For-hire carriers that have been exempted from economic regulation through provisions in various pieces of legislation.

Expatriate workers Employees who are sent to other countries for extended periods of time.

Expediting The need to rapidly move a shipment to its final destination.
Expenses (costs)  Provide a dollar value for the costs incurred in generating revenues during a given period of time.

Export management company  Firm that acts as the export sales department for a manufacturer.

Export packers  An international logistics specialist that custom packs shipments when the exporter lacks the equipment or expertise to do so itself.

Facility closing  A company discontinues operations at a current site because the operations are no longer needed or can be absorbed by other facilities.

Facility location  Refers to choosing the locations for distribution centers, warehouses, and production facilities to facilitate logistical effectiveness and efficiency.

Facility relocation  A firm must move operations to another facility to better serve suppliers or customers.

Fast supply chain  Emphasizes a speed or time component.

FinTech  Refers to companies that use cloud-based software to optimize the connection between procurement and accounts payable.

Fixed order interval system  Inventory is replenished on a constant, set schedule and is always ordered at a specific time; the quantity ordered varies depending on forecasted sales before the next order date.

Fixed order quantity system  Inventory is replenished with a set quantity every time it is ordered; the time interval between orders may vary.

Fixed slot location  Each product is assigned a specific location in a warehouse and is always stored there.

FOB destination  A transportation term that signifies that the seller retains title and control of a shipment until it is delivered.

FOB origin  A transportation term that signifies that the buyer assumes title and control of a shipment at the point of pickup.

Focus strategy  Concentrates an organization’s effort on a narrowly defined market to achieve either a cost leadership or differentiation advantage.

Form utility  Refers to a product’s being in a form that (1) can be used by the customer and (2) is of value to the customer.

Fourth-party logistics (lead logistics provider)  General contractor that ensures that third-party logistics companies are working toward relevant supply chain goals and objectives.

Fragmented logistics structure  Logistics activities are managed in multiple departments throughout an organization.

Free trade zone  An area, usually near a port or an airport, where goods can be stored or processed before entering through the importing nation’s customs inspections.

Freight bill  An invoice submitted by a transportation carrier requesting to be paid.

Freight claims  A document that notifies a transportation carrier of wrong or defective deliveries, delay, or other delivery shortcoming.

Freight forwarder  Consolidates freight shipments and buys transportation services in volume rates.

Fulfillment center  Refers to a special type of distribution center that focuses on e-commerce orders.

Global positioning systems (GPS)  Use satellites that allow companies to compute vehicle positions, velocity, and time.

Global procurement (sourcing)  Refers to buying components and inputs anywhere in the world.

Globally Harmonized System of Classification and Labeling of Chemicals (GHS)  An effort by the United Nations to classify and label hazardous materials that provides three key pieces of information: 1) a symbol; 2) a signal word; and 3) a hazard statement.

Global Supply Chain Forum (GSCF) model  A framework that identifies eight relevant processes, such as customer relationship management, demand management, and order fulfillment, associated with supply chain management.

Grid systems  A location technique utilizing a map or grid, with specific locations marked on the north–south and east–west axes. Its purpose is to find a location that minimizes transportation costs.

Gross world product  Refers to the sum of the gross domestic product of all countries.

Hazardous material(s)  Any item or agent (biological, chemical, physical) which has the potential to cause harm to humans, animals, or the environment, either by itself or through interaction with other factors.

Humanitarian logistics  The process and systems involved in mobilizing people, resources, skills, and knowledge to help people who have been affected by either a natural or man-made disaster.

Import quota  Absolute limits to the quantity of a product that can be imported into a country during a particular time period.

Importer Security Filing (ISF) rule  Also known as “10 + 2;” a regulation that stipulates that importers are required to file 10 pieces of information, and carriers two pieces of information, before cargo is loaded at non-U.S. water ports.

Income statement  Shows revenues, expenses, and profit for a period of time.

Incoterms  Terms of sale for international transactions that represent, from the seller’s viewpoint, the different locations, or stages, for quoting a price to an overseas buyer.

Information  A body of facts in a format suitable for decision making.

Intermodal competition  Refers to the number of transportation modes available to prospective users.

Intermodal transportation  Using a container that can be transferred from the vehicle of one mode to a vehicle of another, and with the movement covered under a single bill of lading.

International freight forwarders  An international trade specialist that can handle either vessel shipments or air shipments and that offers a number of different functions such as booking space on carriers, obtaining consular documents, and arranging for insurance, among others.

International logistics  Refers to logistical activities associated with goods that move across national boundaries.
Internet of things (IOT)  
The sensors and data-communication technology that is built into physical objects that enables them to be tracked and controlled over the Internet.

Intramodal competition  
Refers to competition among carriers within a particular mode.

Inventory  
Stocks of goods and materials that are maintained for many purposes.

Inventory carrying (holding) costs  
The costs of holding an inventory, such as interest on investment, insurance, deterioration, and so on.

Inventory shrinkage  
Refers to the fact that more items are recorded entering than leaving warehousing facilities.

Inventory tax  
Analogous to personal property taxes paid by individuals, an inventory tax is based on the value of inventory that is held by an organization on the assessment date.

Inventory turnover  
The number of times an inventory is used or replaced each year.

Investment recovery  
Identifies opportunities to recover revenues or reduce costs associated with scrap, surplus, obsolete, and waste materials.

ISO 9000  
A set of generic standards used to document, implement, and demonstrate quality management and assurance systems.

Just-in-time (JIT) approach  
Seeks to minimize inventory by reducing (if not eliminating) safety stock, as well as having the required amount of materials arrive at the production location at the exact time they are needed.

Judgmental forecasting  
Refers to forecasting that involves judgment or intuition and is preferred in situations where there is limited, or no, historical data.

Kickbacks  
Money paid after an exchange.

Kraljic’s Portfolio Matrix  
A tool used by managers to classify corporate purchases in terms of their importance and supply complexity.

Land bridge services  
Refers to a combination of water transportation and surface transportation between an origin and destination port.

Landed costs  
Price of the product at its source plus transportation costs to its destination.

Leagility  
Combines agility and leanness as a way to focus part of one's supply chain on a timely response to customer orders and/or product variety and another part of the supply chain on leveling out the planning requirements to smooth production output.

Lean manufacturing (lean)  
Focuses on the elimination of wastes and the increase of speed and flow.

Lean Six Sigma  
Integrates the goals and methods of the lean and Six Sigma approaches and recognizes that organizations cannot focus only on quality or speed.

Lean supply chain  
Focuses on eliminating all waste, including time, and ensuring a level schedule.

Less-than-truckload (LTL) carrier  
Shipments that range from about 150 to 10,000 pounds; they are often too big to handle manually, yet they do not fill an entire truck.

Letter of credit  
An international payment option that is issued by a bank and guarantees payment to a seller provided that the seller has complied with the applicable terms and conditions of the particular transaction.

Liabilities  
Financial obligations that a company owes to another party.

Line-haul  
Terminal-to-terminal movement of freight or passengers.

Load centers  
Major ports where thousands of containers arrive and depart per week. These ports specialize in the efficient handling of containers.

Locavore strategy  
Refers to food companies that purchase locally grown or produced foods.

Lock  
Raises or lowers barges so that they can meet the river’s level as they move upstream or downstream.

Logistics  
According to the Council of Supply Chain Management Professionals, that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption to meet customers’ requirements.

Logistics information system (LIS)  
People, equipment, and procedures to gather, sort, analyze, evaluate, and distribute needed, timely, and accurate information to logistics decision makers.

Logistics optimization models  
Utilize spreadsheet software and add-ins to help logisticians make complex judgments and decisions about key logistics issues at strategic, tactical, operational, and collaborative levels.

Logistics Performance Index (LPI)  
An index that is designed to measure a country’s performance across six logistical dimensions.

Logistics service quality  
Refers to a firm’s ability to deliver products, materials and services without defects of error to both internal and external customers.

Logistics social responsibility  
Refers to corporate social responsibility issues that relate directly to logistics.

Logistics uncertainty pyramid model  
A model that identifies uncertainty sources that can affect the risk exposure for logistics activities.

Machine learning  
Computer-based discipline that leverages algorithms than can “learn” from data. These algorithms use data to build and constantly update their prediction models for activities such as forecasting.

Macroenvironmental influences  
The uncontrollable forces and conditions facing an organization and include cultural, demographic, economic, natural, political, and technological factors.

Make-to-order  
Products are produced after receiving a customer order.

Make-to-stock  
Products are produced prior to receiving a customer order.

Malcolm Baldrige National Quality Award  
An award that recognizes U.S. organizations for their achievements in quality and performance.
Maquiladora plants  Manufacturing plants that exist just south of the U.S. –Mexican border.

Marketing channels  A set of institutions necessary to transfer the title to goods and to move goods from the point of production to the point of consumption and, as such, which consists of all the institutions and all the marketing activities in the marketing process.

Mass logistics  A one-size-fits-all approach in which every customer gets the same type and levels of logistics service.

Materials handling (material handling)  The short-distance movement of material between two or more points.

Materials management  The movement and storage of materials into a firm.

Methods of payment  With respect to international transactions refers to the manner by which a seller will be paid by a buyer.

Multichannel marketing systems  Refers to separate marketing channels to serve customers.

Multiclient warehousing  Mixes attributes of public and contract warehousing; services are more differentiated than a public facility but less customized than in a contract facility.

Multiple sourcing  A procurement philosophy that suggests that by having more than one supplier increased amounts of competition, greater supply risk mitigation and improved market intelligence can arise.

Nearsourcing  Refers to companies reconfiguring their logistics networks to bring some production facilities closer to key consumer markets.

Net profit margin  Measures the proportion of each sales dollar that is kept as profit.

Nontariff barriers  Restrictions other than tariffs that are placed on imported products.

Nonvessel-operating common carrier (NVOCC)  In international trade, a firm that provides carrier services to shippers but owns no vessels itself.

Obsolete materials  Refer to materials that are not likely to ever be used by the organization that purchased it.

Occupational Safety and Health Administration (OSHA)  A U.S. federal agency that regulates workplaces to ensure the safety of workers.

Ocean carrier alliances  Refers to an alliance in the container trades in which ocean carriers retain their individual identities but cooperate in the area of operations.

Omnichannel retailing  Refers to a multichannel approach to sales that seeks to provide the customer with a seamless shopping experience whether the customer is shopping online from a desktop or mobile device, by telephone or in a bricks-and-mortar store.

Omnichannel strategy  Allows retail customers to order products anywhere, any time, and on any device, while also allowing them to take delivery when and where they want.

On-demand software (software-as-a-service)  Refers to software that users access on a per-use basis instead of software they own or license for installation.

Open account  A method of payment for international transactions where a seller sends the goods and all documents directly to the buyer and trusts the buyer to pay by a certain date.

Open skies agreement  Refers to an agreement between two or more countries that liberalize international aviation opportunities and limit federal government involvement.

Order cycle  Elapsed time between when a customer places an order and when the goods are received.

Order delivery  The time from when a transportation carrier picks up the shipment until it is received by the customer.

Order fill rate  The percentage of orders that can be completely and immediately filled from existing stock.

Order management  The management of the various activities associated with the order cycle.

Order picking and assembly  Includes all activities from when an appropriate location is authorized to fill an order until goods are loaded aboard an outbound carrier.

Order processing  The time from when the seller receives an order until an appropriate location is authorized to fill the order.

Order to cash cycle  The length of time it takes an organization to receive payment for an order.

Order transmittal  The time from when the customer places or sends the order to when the seller receives it.

Order triage  Classifying orders according to preestablished guidelines so that a company can prioritize how orders should be filled.

Ordering costs  The costs associated with ordering inventory, such as order costs and setup costs.

Owners' equity  Difference between what a company owns and what it owes at any particular point in time.

Packaging  Materials used for the containment, protection, handling, delivery, and presentation of goods.

Pallet (skid)  A small platform (made of plastic, steel, or wood) on which goods are placed for handling by mechanical means.

Parcel carriers  Companies that specialize in transporting parcels.

Part-to-picker system  The pick location is brought to the picker (e.g., carousels).

Partnerships  Positive, long-term relationships between supply chain participants.

Perfect order  An order that simultaneously achieves relevant customer metrics.

Physical distribution  Storage of finished product and movement to the customers.

Picker-to-part system  An order picker goes to where the product is located (e.g., a forklift).

Pick-to-light technology  The orders to be picked are identified by lights placed on shelves or racks.

Piggyback transportation  Truck trailers on flatcars, also referred to as TOFC.

Pilferage  Employee theft.
Pipeline (in-transit) stock  Inventory that is in route between various nodes in a logistics system.

Place utility  Having products available where they are needed by customers.

Possession utility  Refers to the value or usefulness that comes from a customer being able to take possession of a product.

Postponement  The delay of value-added activities such as assembly, production, and packaging to the latest possible time.

Private carrier  Companies whose primary business is other than transportation provide their own transportation service by operating truck, railcars, barges, ships, or airplanes.

Private warehousing  A warehousing facility that is owned by the firm using it.

Procurement (purchasing)  Raw materials, component parts, and supplies brought from outside organizations to support a company’s operations.

Procurement card (p-card)  Is similar to a credit card for personal use, only a p-card is used for organizational purchases.

Productivity  The amount of output divided by the amount of input.

Psychic stock  Inventory that stimulates demand in the sense that customer purchases are stimulated by inventory that they can see.

Public warehousing  Serves all legitimate users and has certain responsibilities to those users.

Pure materials  Materials that lose no weight in processing.

Quality-of-life considerations  Their intent is to incorporate nonbusiness factors (e.g., cost of living, crime rate, educational opportunities) into the decision of where to locate a plant or distribution facility.

Radio-frequency identification (RFID)  The use of radio frequency to identify objects that have been implanted with an RFID tag.

Rail gauge  The distance between the inner sides of two parallel rail tracks.

Rate  The price charged for freight transportation.

Regrouping function  Involves rearranging the quantities and assortment of products as they move through the supply chain.

Relational exchanges  A long-term orientation among supply chain parties that is characterized by trust, commitment, dependence, joint investment and shared benefits.

Reorder (trigger) point (ROP)  The level of inventory at which a replenishment order is placed.

Responsiveness  The degree to which an organization can accommodate unique or unplanned customer requests.

Return on assets (ROA)  Indicates what percentage of every dollar invested in the business ultimately is returned to the organization as profit.

Revenues (sales)  A dollar value of all the products and/or services an organization provides to their customers during a given period of time.

Reverse auction  A buyer invites bids from multiple sellers, and the seller with the lowest bid is often awarded the business.

Reverse logistics  Goods that flow from the consumer to the manufacturer (e.g., product recalls and product recycling).

Right-to-work laws  State laws that specify that a worker does not have to join the union to work permanently at a facility.

Routing  The process of determining how a shipment will be moved between origin and destination.

Routing guide  Provides guidance in terms of a preferred list of carriers for shipments moving between two points.

Safety (buffer) stock  Inventory that is held in addition to cycle stock to guard against uncertainties in supply and/or lead time.

Sarbanes-Oxley Act (SOX)  A piece of legislation focused on restoring investor confidence by providing increased transparency in financial reporting for public companies.

SCOR Model (Supply Chain Operations Reference Model)  A framework that identifies five key processes—plan, source, make, deliver, return—associated with supply chain management.

Scrap materials  These are materials that are no longer serviceable, have been discarded, or are a by-product of the production process.

Service parts logistics  Involves designing a network of facilities to stock service parts, deciding upon inventory ordering policies, stocking the required parts, and transporting parts from stocking facilities to customers.

Service recovery  A process for returning a customer to a state of satisfaction after a service or product has failed to live up to expectations.

Service recovery paradox  Refers to a situation where a customer holds the responsible company in higher regard after the service recovery than if a service failure had not occurred in the first place.

Sharing economy  An organization making its unused resources (e.g., excess warehouse space, unused trailer space) available to other organizations.

Shippers’ associations  Nonprofit membership cooperatives that perform basically the same function as freight forwarders.

Shipper’s export declaration (SED)  Contains relevant export transaction data such as the transportation mode(s), transaction participants, and description of what is being exported.

Shipper’s letter of instruction (SLI)  Often accompanies an SED and provides explicit shipment instructions.

Shipping conferences  Cartels of all ocean vessel operators operating between certain trade areas.

Short-sea shipping  Refers to waterborne transportation that utilizes inland and coastal waterways to move shipments from domestic ports to their destination.

Simulation  A technique that models a real-world system, typically using mathematical equations to represent the relationships among components of the real-world system.

Single sourcing  Consolidates purchase volume with a single supplier with the hopes of enjoying lower costs per unit and increased cooperation and communication in the supply relationship.
Six Sigma  A practice that emphasizes the virtual elimination of business errors that strives to achieve 3.4 defects, deficiencies, or errors per one million opportunities.

Slip sheet  A flat sheet of either fiberboard material or plastic that is placed under the unit load.

Slurry systems  Transport products that are ground into a powder, mixed with water, and then shipped in slurry form through a pipeline.

Sorting  function Bridges the discrepancy between the assortment of goods and services generated by the producer and the assortment demanded by the customer.

Sorting out  Separating products into grades and qualities desired by different target markets.

Speculative stock  Inventory that is held for several reasons such as seasonal demand, projected price increases, and potential product shortages.

Statement of cash flows  A financial statement that details how an organization generates cash and where cash is used during a defined period of time.

Stock-keeping units (SKU)  Each separate type of item that is accounted for in an inventory.

Stockout  Being out of an item at the same time there is a willing buyer for it.

Stockout costs  The costs to a seller when it is unable to supply an item to a customer ready to buy.

Stowability  Refers to how easy a commodity is to pack into a load.

Strategic Sourcing  Refers to taking a supply chain perspective towards purchasing.

Strategic Profit Model  Provides the framework for conducting return on assets analysis by incorporating revenues and expenses to generate a net profit margin, as well as an inclusion of assets to measure asset turnover.

Substitute products  Products that customers view as being able to fill the same need or want as another product.

Supplier audits  A process that assesses a supplier’s structure, resources, health, and technology.

Supplier development (reverse marketing)  A degree of aggressive procurement involvement not normally encountered in supplier selection.

Supplier parks  Key suppliers locate on, or adjacent to, automobile plants, which helps reduce shipping costs and inventory carrying costs.

Supplier scorecards  Are used by organizations to report performance information to their suppliers.

Supply chain  All activities associated with the flow and transformation of goods from the raw material stage, through to the end user, as well as the associated information flows.

Supply chain analytics  Combines technology with manual employee effort to identify trends, perform comparisons and highlight opportunities in supply chain processes, even when large amounts of data are involved.

Supply chain collaboration  Cooperative, formal or informal supply chain relationships between manufacturing companies and their suppliers, business partners, or customers, developed to enhance the overall business performance of both sides.

Supply chain finance  Refers to a set of technology and financed-based processes that strive to optimize cash flow by allowing businesses to extend their payment terms to their suppliers while simultaneously allowing suppliers to get paid early.

Supply chain management (SCM)  According to the Council of Supply Chain Management Professionals, SCM encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies.

Supply chain partnership  Refers to a tailored business relationship between two supply chain members.

Supply management  A relational exchange approach involving a limited number of suppliers.

Surface Transportation Board (STB)  A U.S. government agency with primary responsibility for regulating railroad pricing and service.

Sustainable procurement  Refers to the integration of social and environmental considerations into all stages of the purchasing process.

Sustainable products  Refers to products that meet present needs without compromising the ability of future generations to meet their needs.

Sweatshops  Organizations that exploit workers and that do not comply with fiscal and legal obligations toward employees.

Systems approach  A company’s objectives can be realized by recognizing the mutual interdependence of the major functional areas of the firm, such as marketing, production, finance, and logistics.

Tachograph  A recording instrument that is installed inside a truck and produces a continuous, timed record of the truck, its speed, and its engine speed.

Tailored logistics  Groups of customers with similar logistical needs and wants are provided with logistics service appropriate to those needs and wants.

Tariffs  Taxes that governments place on the importation of certain items.

TEU  Twenty-foot equivalent unit; a measure of the number of 20-foot containers that are used or handled.

Terminal  A carrier or public facility where freight (or passengers) is shifted between vehicles or modes.

Terms of sale  For international transactions, refers to determining when and where to transfer between buyer and seller, the physical goods, the payment for goods, legal title, required documentation as well as responsibility for controlling and caring for goods while in transit.

Theft  Taking and removing personal property with the intent to deprive the rightful owner of it.
Third-party logistics (logistics outsourcing; contract logistics) The general idea behind these concepts is that one company (e.g., a manufacturer) allows a specialist company to provide it with one or more logistics functions (e.g., warehousing, outbound transportation).

Throughput  Refers to the amount of product entering and leaving a facility in a given time period.

Time series forecasting  A group of forecasting techniques that is based on the idea that future demand is solely dependent on past demand.

Time utility  Having products available when they are needed by customers.

Ton miles  The number of tons times the number of miles.

Total cost approach  Concept that suggests that all relevant activities in moving and storing products should be considered as a whole (i.e., their total cost), not individually.

Total cost of ownership (TCO)  Refers to an approach where a firm considers all the costs that can be assigned to the acquisition, use, and maintenance of a purchase.

Tracking  A carrier’s attempt to determine a shipment’s location during the course of its move.

Transactional exchanges  Refers to a short-term orientation between supply chain participants.

Transportation  Actual physical movement of goods and people between two points.

Transportation management  The buying and controlling of transportation services by either a shipper or consignee.

Transportation management system (TMS)  A software package that automates the process of building orders, tending loads, and tracking shipments, audits, and payments.

Transportation Worker Identification Credential (TWIC)  A common credential that is used to identify workers across all modes of transportation.

Truckload (TL) carrier  A motor carrier that focuses on shipments of greater than 10,000 pounds.

Unified logistics structure  Multiple logistics activities are combined into, and managed as, a single department.

Unit load (unitization)  Consolidation of several units (cartons or cases) into larger units to improve efficiency in handling and to reduce shipping costs.

Unit load devices (ULD)  An alternative name for airfreight containers.

Variable slot location  A system in which products are stored wherever there is empty space available in a warehouse.

Velocity slotting  A slotting strategy that places the most frequently picked items in the most accessible locations.

Vendor-managed inventory (VMI)  A system in which the size and timing of replenishment orders into a retailer’s system are the manufacturer’s responsibility.

Voice-based order picking  The use of speech to guide order-picking activities.

Warehouse  Emphasize the storage of products and their primary purpose is to maximize usage of available storage space.

Warehouse automation  The utilization of mechanical or electronic devices to substitute for labor.

Warehouse management systems (WMS)  Software packages that control the movement and storage of materials within a warehousing facility.

Warehousing  That part of a firm’s logistics system that stores products at and between points of origin and point of consumption.

Waste materials  These are materials that have been spoiled, broken, or otherwise rendered unfit for further use or reclamation.

Weighing out  Cargo reaches a vehicle’s or a container’s weight capacity without filling its cubic capacity.

Weight-gaining product characteristics  A product that gains weight in processing; the processing point should be close to the market.

Weight-losing product characteristics  A product that loses weight during the production process; the processing point as near to its origin as possible.

Wireless communication  Refers to communication without cables and cords, and includes infrared, microwave, and radio transmissions.
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