

2022

2022 LEARNING SYSTEM
VERSION 5.0

MODULE 5

FORWARD AND REVERSE LOGISTICS

CSCP

CERTIFIED SUPPLY CHAIN PROFESSIONAL



2022

2022 LEARNING SYSTEM
VERSION 5.0

MODULE 5

FORWARD AND REVERSE LOGISTICS

CSCP

CERTIFIED SUPPLY CHAIN PROFESSIONAL



APICS Certified Supply Chain Professional (CSCP) Learning System

This product is based on the APICS CSCP Exam Content Manual (ECM) developed by APICS. Although the text is based on the body of knowledge tested by the APICS CSCP exam, program developers do not have access to the exam questions. Therefore, reading the text does not guarantee a passing score.

The references in this manual have been selected solely on the basis of their educational value to the APICS CSCP certification program and on the content of the material. APICS does not endorse any services or other materials that may be offered or recommended by the authors or publishers of books and publications listed in this module.

Every effort has been made to ensure that all information is current and correct. However, laws and regulations are constantly changing. Therefore, this product is distributed with the understanding that the publisher and authors are not offering legal or professional services.

Acknowledgments

We would like to thank the following dedicated subject matter experts who shared their time, experience, and insights during the initial development and subsequent updates of the CSCP Learning System:

Greg P. Allgair Celeste Ayers, CFPIM, CSCP	Rajesh Kumar Jagadeeswaran, CPIM, CSCP	David Rivers, CFPIM, CIRM, CSCP
Curtis Brewer, CFPIM, CIRM, CSCP	Dave Jankowski, CFPIM, CSCP	Maryanne Ross, CFPIM, CIRM, CSCP
Jashobrata Bose, CSCP	Julie Jenson, CPIM, CSCP	Kimber Rueff, CPIM, CIRM, CSCP, C.P.M.
Al Bukey, CFPIM, CIRM, CSCP	Honey Johnson, CFPIM, CIRM, C.P.M., CSCP	Frank Sabin, Ph.D., CSCP
Jesús Campos Cortés, CPIM, CIRM, CSCP, PLS, C.P.M., CPSM, PMP, PRINCE2, CQIA, CEI, CPF, CS&OP, CA- AM	Rajesh Kamat, CSCP	Ignacio Sánchez-Chiappe
Luc Chalmet, Ph.D., CFPIM, CSCP	Prakash Kanagalekar, CPIM, CSCP	Carolyn Sly, CPIM, CSCP, C.P.M.
Prashant Choudhary, CSCP	Jack Kerr, CPIM, CSCP, C.P.M.	Liezl Smith, CPIM, CIRM, CSCP, ACPF, CDDP
David N. Dadich, CSCP, LSS Blackbelt	Jose Lara	Pam Somers, CPIM, CIRM, CSCP
Prasanta K. Dash, CSCP, PMP	Paul S. Lim, CPA, CSCP, CPIM, PMP	Chad Stricklin
Sudripto De, CSCP	Mike Loughman, CSCP	Shashank Tilak, CPIM, CSCP
Arnaud Deshais, CPIM, CIRM, CSCP, CPM, CPSM	Giuseppe Lovecchio, CFPIM, CSCP	Ken Titmuss, CFPIM, CSCP, SCOR-P, CPF, PLS, CS&OP, CDDP, CSCA, CDDL
Alan Downs, CPIM, CSCP	Thiagu Mathan, CSCP	Huan-Jau (Arthur) Tseng, CFPIM, CSCP
Ralph G. Fariello, CFPIM, CIRM, CSCP	Roberta McPhail, CPIM, CIRM, CSCP, PMP	Dave Turbide, CFPIM, CIRM
Sue Franks, CPIM-F, CSCP-F, CLTD-F	Richard Merritt, CFPIM, CSCP, C.P.M.	Sudeep Valmiki, CSCP
Laura E. Gram, CSCP	Steven J. Miller, CSCP	Rob Van Stratum, CPIM, CIRM, CSCP
Janice M. Gullo, CFPIM, CSCP	Alan L. Milliken, CFPIM, CIRM, CSCP	Rosemary Van Treeck, CPIM, CIRM, CSCP
Amit Kumar Gupta, BE, CSCP	Paulo Mondolfo, CPIM, CSCP	Wout Verwoerd, CFPIM, CIRM, CSCP, SCOR-P
Debra Hansford, CFPIM, CIRM, CSCP, CPSM	Peter W. Murray, CIRM	Robert Vokurka, Ph.D., CFPIM, CIRM, CSCP, C.P.M.
Marwa Hassan Aburahma, MCIPS, CSCP, SCOR-P, CMILT	Eric-Stephan Neill, CSCP, CLTD, PMP	Eddie J. Whitfield, CPIM, CIRM, CSCP
Joni Holeman, CFPIM, CIRM, CSCP	Mike Okrent, Ph.D., CIRM, CSCP	Vivek Wikhe, CSCP
Eric P. Jack, Ph.D., CFPIM, CSCP	Roberto (Jake) Ordóñez, CSCP, CQA, CTL, PLS, MPS, SCPro1	Blair Williams, Jonah, CFPIM, CSCP
	Kasthuri Rengan Ponnambalam, CSCP	
	Gautam Chand Pradhan, CPIM, CSCP	
	Ho Dong Rhee, CSCP	

Intellectual Property and Copyright Notice

All printed materials in the APICS CSCP Learning System and all material and information in the companion online component are owned by APICS and protected by United States copyright law as well as international treaties and protocols, including the Berne Convention. The APICS CSCP Learning System and access to the CSCP interactive web-based components are for your personal educational use only and may not be copied, reproduced, reprinted, modified, displayed, published, transmitted (electronically or otherwise), transferred, sold, distributed, leased, licensed, adapted, uploaded, downloaded, or reformatted.

In addition to being illegal, distributing CSCP materials in violation of copyright laws will limit the program's usefulness. APICS invests significant resources to create quality professional development opportunities for its membership. Please do not violate APICS' intellectual property rights or copyright laws.

No portion of this publication may be reproduced in whole or in part.

APICS will not be responsible for any statements, beliefs, or opinions expressed by the authors of this publication. The views expressed are solely those of the authors and do not necessarily reflect endorsement by APICS.

Version 5.0 © 2022 APICS

APICS
8430 W. Bryn Mawr Ave., Suite 1000
Chicago, IL 60631

Module 5: Forward and Reverse Logistics

Forward and reverse logistics are at the core of supply chain management. We start this module with a discussion of managing supply chain logistics, including distribution networks and related distribution services. This includes warehousing and transportation strategies as well as materials-handling services such as picking, packing, and put-away. Value-added services such as postponement can also be done at warehouses. Trade considerations are also addressed, including import/export regulations and related standards such as Incoterms® trade terms or the Harmonized Tariff Schedule.

Reverse logistics includes handling returns as well as repairs, remanufacturing, and disposition of waste. How to determine reverse logistics requirements and how to design a reverse network that is cost-effective and then implement it are addressed. The waste hierarchy, hazardous waste, and waste exchanges are covered.

Section A: Logistics and Distribution

This section is designed to

- Define logistics and explain its relationship to supply chain strategy
- Identify the functions within logistics
- Explain the objectives of logistics
- Describe the tactics used to create an effective logistics strategy
- Differentiate between 3PLs and 4PLs and describe their appropriate use
- Enumerate warehousing objectives
- Identify warehousing considerations of ownership, number, location, configuration, and support systems
- Discuss how storage locations can be organized to maximize velocity and cube utilization
- Describe several stock location methods for grouping inventory in storage locations
- Discuss how to forecast warehouse capacity
- Explain the mechanized and automated systems in warehousing along with their advantages and drawbacks
- Describe materials-handling options in warehouses in terms of space use, labor, equipment, and automation
- Describe the dual objectives of transportation
- Discuss how to forecast transportation capacity
- Discuss how to assess capacity constraint factors when evaluating bids from carriers
- Enumerate advantages and disadvantages of transportation modes
- Discuss selection of the appropriate mode of transportation given various factors.

The supply chain is about “moving”—or “transforming”—raw materials and ideas into products or services and getting them to customers. Logistics, one of the most critical functions in supply chain management, is about moving materials or goods from one place to another. It is, in that sense, a service provider to design, production, and marketing that can bring added value by being quick and effective.

Topic 1: Logistics

Here we start with the big picture of logistics, including a discussion of its scope, components, and value proposition. Then logistics objectives and enabling tactics are addressed. Using 3PLs and 4PLs and their pros and cons are discussed after that.

Logistics Road Map

The APICS Dictionary, 16th edition, defines **logistics** as follows:

- 1) In a supply chain management context, it is the subset of supply chain management that controls the forward and reverse movement, handling, and storage of goods between origin and distribution points. 2) In an industrial context, the art and science of obtaining, producing, and distributing material and product in the proper place and in proper quantities.

Note that the SCOR model refers to “...obtaining, producing, and distributing material...” as sourcing, making, and delivering.

At a basic level, logistics includes the various tasks required to get the right product to the right customers at the right time. More comprehensively, it also means getting the right quantity of product in the right condition to the right place at the right price.

Logistics is part of supply chain management. As Douglas Long writes, “Supply chain management is logistics taken to a higher level of sophistication.” Where one ends and the other begins is subject to debate.

In *Supply Chain Logistics Management*, authors Bowersox, Closs, Cooper, and Bowersox include several functions that are treated in their own areas of this course, such as forecasting and inventory management. Whether these functions are or are not within the scope of logistics, all agree that inventory and forecasting must be considered when designing and managing an effective, efficient logistics system.

Logistics has a slightly different definition in different regions of the world as well. For example, in Europe, logistics goes from raw materials to the final delivery to the customer, thus including manufacturing, while in the U.S., manufacturing is not usually under the purview of logistics. Exhibit 5-1 illustrates how the scope of logistics may or may not include various parts of the supply chain.

Exhibit 5-1 : Logistics in the Supply Chain

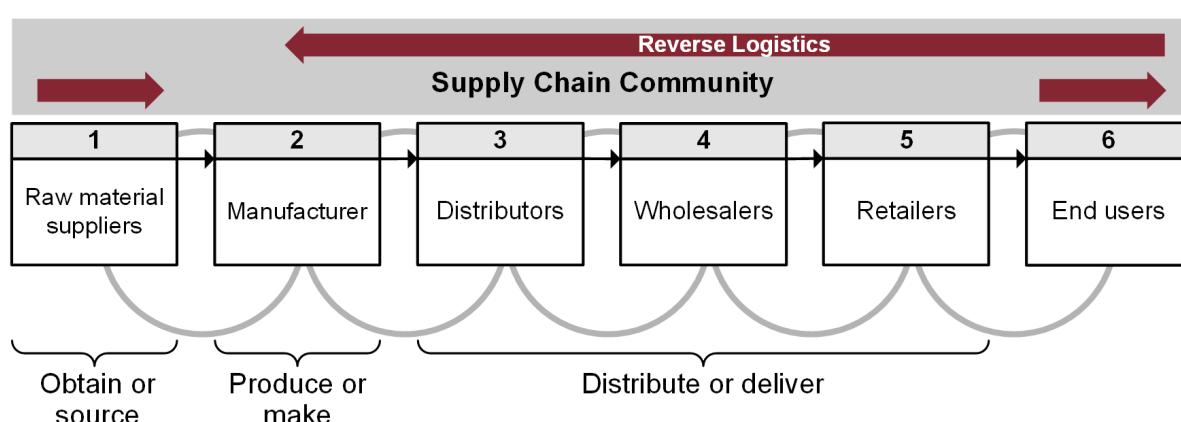
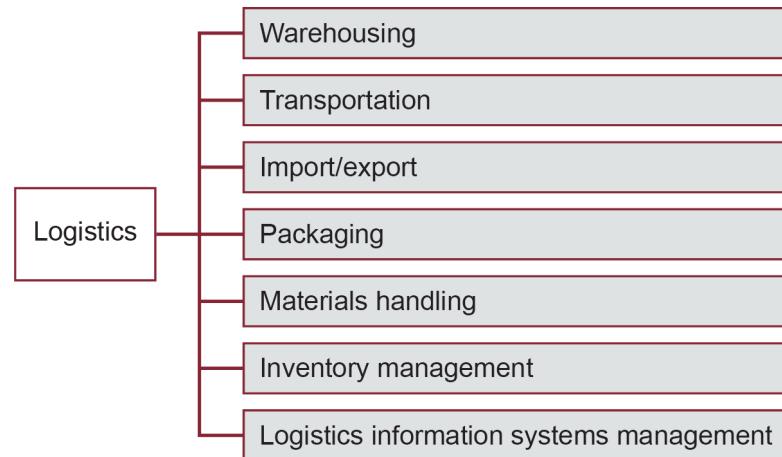


Exhibit 5-2 provides an overview of what is typically included in logistics.

Exhibit 5-2: Functions of Logistics



Warehousing and transportation are essential functions of logistics that are inextricably linked. The type and number of warehouses have a large impact on transportation costs. Note that import/export, packaging, inventory management, and logistics information systems (including transportation and warehouse management systems) and their management are addressed elsewhere in these materials. Logistics enabling technologies are also addressed elsewhere; these include various methods of data exchange, application programming interfaces, bar codes, RFID, the Internet of Things (IoT), sensors, telematics, and other automatic identification and data capture (AIDC) technologies. AIDC and integrated logistics information systems provide faster information visibility and increased transaction accuracy. Logistics technology enables automated tracking of the movement of goods across the supply chain, leaving employees to handle just the physical movement of goods.

Logistics is the only function in the supply chain that is required to operate 24/7/365; there are no days off. That is why customers often take it for granted; they've come to expect that product delivery will be performed as promised. However, excellent customer service can be expensive and takes expertise, especially since logistics is now a globally integrated endeavor. For example, during the global pandemic of 2020, there was an initial slowdown of demand followed by a large spike in demand that resulted in large trade imbalances (more imports than exports in many countries), which in turn triggered a massive shortage of containers and a spike in container prices. According to the United Nations Conference on Trade and Development, by early 2021, due to this container shortage, freight rates from China to South America had increased by 443 percent while rates from China to North America increased by 63 percent. Importers on longer routes or routes with more stops were hardest hit.

Supply chain partners must efficiently and effectively carry out logistical tasks to achieve competitive advantage. In a global market, this may require mastery of languages, currencies, divergent regulations, and various business climates and customs.

Logistics Value Proposition

The right configuration of transportation modes, warehouses, and other logistics assets and functions is needed to meet each customer's expectations and requirements. How will you know when you've got

the right balance? If you keep in mind that logistics must be managed as an integrated effort to achieve customer satisfaction at the lowest total cost, then it makes sense that cost minimization and service are the key elements in this value proposition.

Service

Logistics customer service implies that customer orders are complete, undamaged, delivered on time, and consistently correct over time. Any level of logistical service can be achieved if a company is willing and able to pay for it. Technology isn't the limiting factor for logistics for most companies—it's the economics. For instance, what does it cost to keep the service level high if a company keeps a fleet of trucks in a constant state of delivery readiness or it keeps dedicated inventory for a high-volume customer? How do you decide if it's money well spent? The key is to determine how to outperform competitors in a cost-effective manner.

In most situations, the benefit-cost impact of a logistical failure is directly related to the importance of the service to the customer. When a logistical failure will have a significant impact on a customer's business, error-free logistics service should receive higher priority. For instance, a missing part that causes a plant shutdown might justify flying the parts to the destination, while a late delivery that requires dipping into safety stock will be negligible. The customer that never has expensive delays and very few lost sales will have higher customer satisfaction and loyalty.

Cost Minimization

The second element of the value proposition, cost minimization, should be interpreted as the total cost of logistics. The *APICS Dictionary*, 16th edition, describes the **total cost concept** of logistics as

the idea that all logistical decisions that provide equal service levels should favor the option that minimizes the total of all logistical costs and not be used on cost reductions in one area alone, such as lower transportation charges.

For many decades, the accounting and financial departments in organizations sought the lowest possible cost for each individual logistical function, with little or no attention paid to integrated total cost tradeoffs. Instead, today's leading supply chain companies develop functional cost analyses and activity-based costing activities that measure the total cost of logistics. The goal now is for logistics to be cost-effective as determined by a benefit-cost analysis, taking into account how a logistical service failure would impact a customer's business.

Logistics Trends

Today the bulk of the logistics budget goes toward transportation costs. According to the 31st annual "State of Logistics Report" by the Council of Supply Chain Management Professionals, United States companies spent US\$1.63 trillion performing logistical services in 2019, a 0.6 percent increase over the prior year. Of this amount, over US\$680 billion was for motor carrier transportation and over US\$378

billion was spent on all other forms of transport, which together constituted about 65 percent of total logistics costs.

According to the “State of Logistics Report,” in 2019

- Inventory storage costs rose by 6.6 percent over the prior year due to limited warehouse capacity.
- Costs for transportation modes were as follows (in billions):
 - Truck: US\$680.4
 - Rail: US\$83.9
 - Parcel: US\$114.4
 - Water: US\$47.9
 - Air: US\$75.2
 - Pipeline: US\$57.4
- U.S.-China trade tensions and the start of the global pandemic promoted a push toward making supply chains more resilient by increasing sourcing diversification and backup capacity. The report warned against going too far with a single-sourcing, Just-in-Time cost focus.

Logistics Objectives and Tactics

At the highest level, logistics shares the objective of supply chain management: to meet customer requirements. Other objectives include

- Responding rapidly to changes in the market or customer orders
- Minimizing variances in logistics service
- Minimizing inventory to reduce costs
- Consolidating product movement by grouping shipments
- Maintaining high quality and engaging in continuous improvement
- Supporting the entire product life cycle, including reverse logistics.

An effective logistics strategy depends upon the following tactics:

- Coordinating functions
- Integrating the supply chain
- Substituting information for inventory
- Regulating supply chain partner numbers to ensure that each purchasing category has an optimum number of suppliers (not too many, not too few)
- Pooling risks

We'll analyze each of these tactics.

Coordinating Functions

Logistics has interlocking, interdependent parts. Before the advent of modern logistics management, however, each area had its own separate management and pursued its own strategies and tactics. Rather, a cross-functional approach is needed in logistics, just as in supply chain management. Teams that cross functions are also very likely to cross company or national boundaries to accommodate international supply chains.

Logistics has tradeoffs. An improvement in one area may very well have negative consequences in another unless decisions are coordinated. For example, locating warehouses in the countryside may save considerable money (Walmart does this), but it makes it harder to provide same-day delivery (which is why Amazon has warehouses in key urban areas). Different packaging will almost certainly affect shipping and storage. The desired level of customer service still must be profitable.

The overall goal of logistics management is more value in the supply network as measured by customer satisfaction, return to shareholders, etc. There is no point, for instance, in raising the cost of shipping—thus, the price to the customer—to deliver faster than the customer demands. Fast delivery, in other words, is not an end in itself, and the same is true of any aspect of logistics or supply chain management.

Integrating the Supply Chain

Integrating the supply chain requires taking a series of steps when constructing the logistics network. In a dynamic system, the following steps may be taken out of order and retaken continuously.

1. Locate in the right countries.

- Map all countries in the forward and reverse supply chains.
- Analyze the forward and reverse chains to see if selecting different geographic locations could make the logistics function more efficient and effective. (Countries differ by infrastructure, labor, stability, regulations, and taxes.)

2. Develop an effective import-export strategy.

- Determine the volume of freight and the number of SKUs (stock keeping units) to move.
- Decide where to place inventory for strategic advantage. This may involve deciding which borders to cross and which to avoid as well as determining where goods should be stored in relation to customers. (Some shipping companies now add a “war risk surcharge” if transport is near a nation with civil unrest or war.) Both geographic location and distance from the suppliers and/or customer can affect total costs and delivery lead times.

3. Select warehouse locations.

- Determine the optimal number of warehouses.
- Calculate the optimal distance from markets.
- Establish the most effective placement of warehouses globally.

4. Select transportation modes and carriers.

- Determine the mix of transportation modes that will most efficiently connect suppliers, producers, warehouses, distributors, and customers.
- Select specific carriers.

5. Select the right number of partners.

Select the optimum number of companies—freight forwarders, third- or fourth-party logistics providers—to manage forward and reverse logistics. In selecting logistics partners, consider their local market and regulatory knowledge.

6. Develop state-of-the-art information systems.

Reduce inventory costs by more accurately and rapidly tracking demand information and the location of goods. Developing state-of-the-art information systems may be difficult in some regions. Such situations make defining the processes and information flows vital.

Information in Place of Inventory

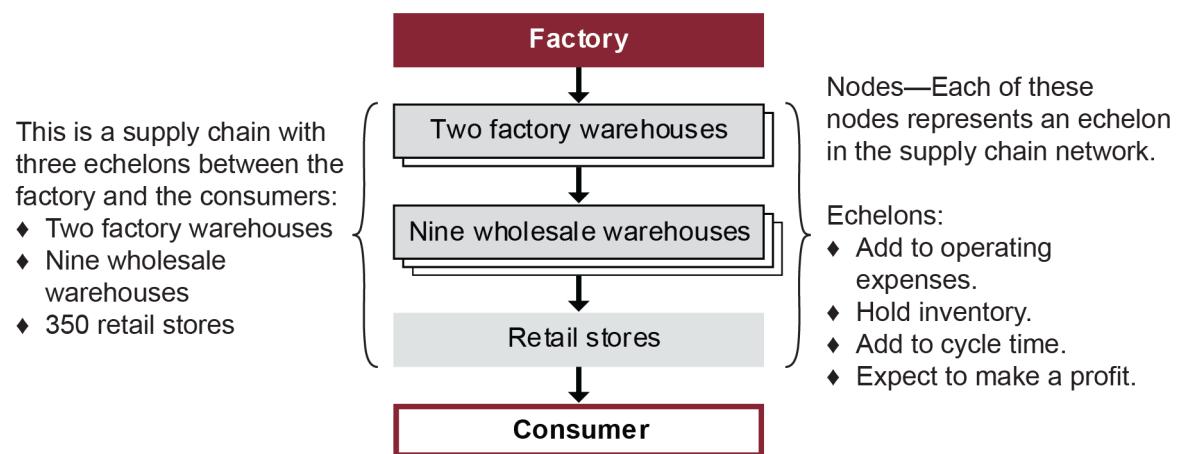
Physical inventory can be replaced by information in the following ways:

- **Improve communications.** Talk with suppliers regularly about plans and trends. Use continuous improvement tools.
- **Collaborate with suppliers.** Implement the right interfaces and develop the needed relationships to share data. Use Just-in-Time methods to coordinate deliveries from suppliers. Remove obsolete inventory.
- **Track inventory precisely.** Track the exact location of inventory using bar codes and/or RFID (radio frequency identification) with GPS (Global Positioning System).
- **Keep inventory in transit.** Keeping inventory in transit can reduce inventory costs. One method of doing this is cross-docking. A payload area can be considered a mobile warehouse. Rolling inventory should be closely tracked by GPS to reduce risk of loss and facilitate rapid adjustments if a customer changes an order at the last minute.
- **Use postponement centers.** Avoid filling warehouses with the wrong mix of finished goods by setting up postponement centers to delay product assembly until an actual order has been received.
- **Mix shipments to match customer needs.** Match deliveries more precisely to customer needs by mixing different SKUs on the same pallet and by mixing pallets from different suppliers.
- **Speed up customs.** Reduce customs time by preclearing freight.
- **Make more products or components on demand.** In addition to make- or assemble-to-order manufacturing methods, another example is using a 3D printer to generate replacement parts on demand rather than stocking items with highly variable demand.

Regulating Number of Supply Chain Partners

Having fewer logistics partners generally increases efficiency but could create tradeoffs in other logistics objectives, so it is best to have just the right number of partners. One way to optimize for efficiency and customer service is to look for an entire echelon (tier) you can do without—such as all the wholesale warehouses or factory warehouses. See Exhibit 5-3.

Exhibit 5-3: Costs of Multiple Echelons



Having too many partners is more often the problem than having too few. The more partners there are in the supply chain, the more difficult and expensive the supply chain is to manage. Handoffs among partners cost money and time. Having many partners means carrying more inventory. Reducing the number of partners can reduce operating costs, cycle time, and inventory holding costs. There is, however, a lower limit below which you create more risks and problems than you solve, which is why this is an optimization process rather than a minimization process.

Pooling Risks

The APICS Dictionary, 16th edition, defines **risk pooling** as

a method often associated with the management of inventory risk. Manufacturers and retailers that experience high variability in demand for their products can pool together common inventory components associated with a broad family of products to buffer the overall burden of having to deploy inventory for each discrete product.

In regard to inventory management, pooling risks is a method of reducing stockouts by consolidating stock in centralized warehouses. The risk of stockouts increases as supply chains reduce the safety stock or component parts inventories held at each node and move toward Just-in-Time ordering procedures. With every entity attempting to keep inventory costs down in this manner, the risk of stockouts rises.

Statistically speaking, when inventory is placed in a central warehouse instead of in several smaller warehouses, the total inventory necessary to maintain a level of service drops without increasing the risk of stockouts. This is because aggregating customer requirements reduces variation in demand. An unexpectedly large order from any one customer will still be small in relation to the total supply.

There are tradeoffs to consider. Because the central warehouse may be further away from some production facilities than the smaller warehouses would be, lead times and transportation costs are likely to go up. Again, logistics has to be managed from the point of view of improving the value of the overall system, not just one part of it.

Logistics Service Providers

Since the 1980s, there has been a trend toward using outside companies to handle warehousing, shipping, and other logistics responsibilities. This outsourcing of some or all logistics operations is especially common among larger companies, such as 3M.

The most compelling reason to let another party take over logistics functions is the decision to focus on core competencies.

There are many logistics ownership models. In a 1PL, the organization is not outsourcing logistics; the organization owns and operates its own fleets. In a 2PL, the organization does all of the route planning itself but outsources vehicle ownership, operation, and maintenance to a third party. The two types of outside logistics companies we'll look at here in more detail are third-party logistics providers (3PLs) and fourth-party logistics providers (4PLs).

According to the *APICS Dictionary*, 16th edition, in a **third-party logistics** arrangement

a buyer and supplier team with a third party that provides product delivery services. This third party may provide added supply chain expertise.

Fourth-party logistics is described in the *Dictionary* as follows:

Fourth-party logistics differs from third-party logistics in the following ways: (1) the 4PL organization is often a separate entity formed by a joint venture or other long-term contract between a client and one or more partners; (2) the 4PL organization is an interface between the client and multiple logistics services providers; (3) ideally, all aspects of the client's supply chain are managed by the 4PL organization; and, (4) it is possible for a major 3PL organization to form a 4PL organization within its existing structure.

Early versions of logistics outsourcing involved transactional relationships with third parties offering single services—trucking from Ryder, shipping from the United States Post Office (USPS) or UPS, overnight air from FedEx. (One traditional type of outsourcing has been the use of the government postal services to deliver business mail and small parcels.) The recent trend in 3PL arrangements, however, is toward long-term contractual relationships with providers of integrated services, such as transportation plus storage. The 4PL setup extends that trend by removing all logistics functions from the client company and putting them under integrated management by a general contractor.

How 3PLs and 4PLs Are Related

References to logistics outsourcing commonly use the term “3PL” to cover all types. Technically, there is a distinction:

- In a 3PL arrangement, the third party takes over some or all logistics functions and performs them itself. A 3PL may be a specialized provider that focuses, for instance, on air or over-the-road transport or warehousing. It may also be a multipurpose logistics provider capable of taking over the entire logistics function.
- In a 4PL arrangement, a logistics specialist takes over the entire logistics operation and subcontracts some or all specific functions. In the role of general contractor, the fourth-party provider hires out the various logistics services and coordinates the efforts of the subcontractors on the client's behalf. Sometimes this is still called third-party logistics, but the presence of subcontractors makes this in reality a fourth-party setup. Typically, the 4PL charges a fee for its service, not a markup.

Advantages/Disadvantages of 3PLs and 4PLs

Using third-party contractors to carry out some or all logistics functions can provide the following benefits:

- **Improved business focus.** Outsourcing logistics functions allows both the company and its contractor to focus on what they do best.
- **More current logistics technology.** Contract logistics providers are generally able to stay current with technology. Contractors may be quicker to incorporate new software and better able to upgrade to the hardware necessary to run it well. The client company, on the other hand, may have to spread its software and hardware budgets over several functional units in addition to logistics.
- **Greater technological flexibility.** The third-party logistics provider is better positioned to adapt to different technologies used by the company's clients. This potentially expands the company's customer base at a reduced cost.
- **More efficient warehousing for rapid replenishment.** Rapid replenishment may require more warehouses in regions that are closer to clients. Using the 3PL's warehouses is cheaper than building or acquiring the company's own, specifically because in a 3PL warehouse, there is only a cost for the space occupied by your product. The 3PL, if it uses warehouses for multiple clients, can generate economies of scale.
- **Improved service to customers.** Third-party providers may be better able to offer a variety of services to the company's customers.
- **More workforce and resource flexibility.** It's quicker and simpler to hire a contract specialist for a new function—or to drop a contractor when business shifts to a new market—than to hire and lay off

internal workers.

Benefits of the 4PL arrangement include the following:

- **Improved business focus.** Contracting out the entire logistics function frees up the company to focus on its core business.
- **Higher-quality logistics operations (or reduced costs, or both).** The 4PL's special competence in managing logistics should result in lower-cost, higher-quality service with less damage and fewer delays. As a logistics specialist, the 4PL can find the best subcontractors for each function and can design an efficient overall process.
- **Greater business flexibility.** Having a highly competent provider in charge of logistics gives a company the ability to adapt its warehousing, transportation, and packaging needs more rapidly to new market strategies or new products. The provider can renegotiate with current subcontractors or replace them with providers that have the capacities, skills, locations, or other features appropriate for the new venture.

Realizing the benefits of third-party logistics may create some risks:

- **Loss of control.** It may be more difficult to develop a comprehensive logistics strategy when the company has given control of some aspect of the system to a contractor.
- **Potential for inefficiency.** A 3PL that takes over logistics functions for which the company was doing a good job may actually perform worse in that area.

Turning over logistics to a 4PL involves the following risks:

- **Loss of direct control** over the logistics process and all specific functions
- **Potential for less effective or more costly operations** if the 4PL writes biased contracts rather than seeking out the most efficient suppliers

Logistics outsourcing may put the contractor into direct communication with the company's customers, and this entails risks. The 3PL employee (or 4PL subcontractor) becomes a representative of the client company, which may be judged by the contractor's behavior. A 3PL may contract with a client's competitors, raising the risk that confidential information may pass through the contractor to the competitor.

Outsourcing Considerations

Before outsourcing logistics to a third- or fourth-party provider, a company should ask itself the following questions:

- **What are our current costs?** When evaluating bids from potential third- or fourth-party logistics providers, a company needs to know what the functions in question currently cost. It also needs to take into account potential savings in time plus improved quality of service to customers. There's no point in paying more than current costs unless the arrangement will provide other benefits. And there's no point in saving money on logistics if the contractor increases delivery errors or otherwise alienates your customers.
- **What customer skills does the contractor possess?** Has the bidder researched your needs and company culture? If not, how likely is it to do the background work necessary to provide high-quality service to you and to your customers? Is the company reliable? What do its other customers have to say about it? (Be sure to use credible references.)
- **What are the contractor's special strengths?** Many contractors began as providers in one area, such as trucking, mail delivery, or warehousing, and added other logistics competencies as they grew. UPS, for instance, is now a fully integrated transportation company and a logistics consultant, but in the beginning it was a single-purpose company. The shipper needs to evaluate the match between its needs and the contractor's competencies.
- **Will the contractor hire the most-qualified partners (if necessary)?** Especially when considering a 4PL, a company should evaluate the contractor's ability to subcontract effectively. Some contractors are biased toward their own divisions (or favored subcontractors), even if those aren't the best-qualified options.

Contract Considerations

Once a 3PL or 4PL has been selected, it is important to develop a mutually beneficial contract to ensure that the relationship can be successful. Achieving long-term benefits for both parties requires both parties to identify what the end result will look like as well as how the parties will get there. Many 3PL or 4PL relationships have poor initial start-up periods that can cause the relationship to fail or falter and thus harm the long-term relationship, so an important contract consideration is to specify what each party will do to ensure that the first six to 12 months of the relationship go smoothly. This difficult period will require commitments of time and energy from both parties as well as formal specification of shared risks and rewards.

On the communications front, contracts can promote regular communications in both directions, for example, forwarding customer feedback to the 3PL. From a monitoring and controlling standpoint, it is important to carefully select the performance metrics to be used to assess the success of the relationship. These metrics need to address strategic priorities such as level of customer service.

Specific rules that should be included in contracts include confidentiality clauses, subcontractor clauses, clauses for remedies, and escape clauses. Since 3PLs or 4PLs are working so closely with

your suppliers and customers and likely have direct access to organizational data, confidentiality clauses need to be robust. Subcontractor clauses help set subcontractor quality and other selection criteria, which is especially important when working with 4PLs since you are ceding control. From a remedy standpoint, a specific process for correcting variances from performance targets needs to be laid out in advance and agreed to by both parties. These clauses need to specify the use of arbitration to avoid costly court settlements. Escape clauses provide both parties with the specific allowed reasons for and methods of ending the relationship.

Topic 2: Warehousing and Materials-Handling Strategy

Warehousing is a key logistics activity that helps ensure that products are close enough to their demand locations to enable their distribution within the needed lead time. Materials handling encompasses activities that take place within a warehouse or on its grounds. Proper design of warehouses and the selection of mechanized and/or automated materials-handling equipment can keep warehousing costs acceptable while providing the needed level of customer service.

Warehousing Strategy

Warehousing involves “the activities related to receiving, storing, and shipping materials to and from production or distribution locations” (*APICS Dictionary*, 16th edition).

Warehousing can contribute to logistical goals in a number of ways:

- **Respond rapidly to changes in the market or customer orders.** To enable rapid responses, organizations use demand planning data such as forecasts and market analysis to anticipate changes in the market or customer needs. Changes may include the number and placement of warehouses relative to markets, management of inventory levels, efficient product movement through the facility, and technology to track products. The transportation and warehousing interface is critical.
- **Minimize variances in logistics service.** In today’s times of rapid change, efficient tracking and handling of inventory in the warehouse is critical to achieving predictable service. Loading, unloading, packaging, and order picking each have a role in minimizing variability in service.
- **Minimize inventory to reduce costs.** The more efficiently warehouses are managed and the more strategically they are placed in relationship to markets and transportation, the less inventory will build up in the system.
- **Consolidate product movement by grouping shipments.** The tactic of aggregating smaller shipments into larger ones for more cost-effective transportation depends upon the efficient placement and management of warehouses. Expeditious unloading, tracking, repackaging, and reloading are all crucial to effective consolidation of movement.

- **Maintain high quality and engage in continuous improvement.** Every aspect of warehouse operations should be subject to continuous improvement, with the goal of eliminating errors.
- **Support the entire product life cycle and reverse logistics.** The number, placement, and efficiency of warehouses must take into account the early life cycle phases and the end of the product life cycle—returns (repair, replace, or recycle).

Based on these goals, the following considerations must be taken into account regarding warehouses:

- Determining mix of private, public, or contract warehouses
- Determining the optimum number of facilities necessary to aid in reduction of inventory while reducing stockouts
- Selecting the right location for each warehouse to ensure cost-efficient access to supply, markets, and transportation
- Designing each facility to be the right size and configuration for its products and processes
- Developing management systems that employ space, labor, equipment, and information technology to minimize delays, product damage, and product loss

Together, these factors can increase the overall value of the supply chain and improve its competitiveness. The first three of these considerations are addressed next.

Owned Versus Leased Warehouses

Warehouse ownership takes three forms: private, public, and contract.

Private Warehouses

Private warehouses are owned by the company. The benefits of ownership are straightforward.

- **Control.** Private warehouses can be built or, to a lesser extent, remodeled to suit the company's type and size of inventory, its staff, its operations, and its location preferences. Deciding whether to build or remodel can involve some serious calculation and guesswork. Building provides the greatest flexibility to suit the current product mix and operations. Before deciding to build, the company may want to forecast and decide how long the current size and configuration will work before the facility needs renovation. Remodeling may or may not be less expensive than building.
- **No markup.** A company can avoid paying a markup by owning its own warehouse.
- **Market presence.** A company may be able to reinforce its presence in a local market by placing a warehouse near its customers. Proximity can facilitate faster and more personal service.

The downside of private ownership is a loss of budgetary flexibility. A warehouse is a depreciating asset. The fixed costs of ownership also persist even if business turns down and the warehouse capacity isn't used. Selling a specialized facility—especially in the midst of a general downturn in

business—can be time-consuming and hard on the bottom line. Companies have been known to walk away from useless real estate.

Public Warehouses

Public warehouses are independent businesses offering various services for a fee. Independently owned warehouses are available in a variety of configurations—refrigerated, bonded, general merchandise, household goods, other specialties, for example. And they may offer benefits that more than compensate for the loss of control and market presence provided by ownership.

- **Flexibility.** By hiring warehouse services, a company gains the flexibility to increase or decrease its warehousing costs to match market fluctuations.
- **Potential cost reduction.** Despite the markup charged by the owner, a public facility may offer lower overall costs than a private facility by providing economies of scale and lower labor costs. The public warehouse may serve more than one client, thereby making more efficient use of its capacity than is possible in a privately owned, single-use facility.

Contract Warehousing

Contract warehousing has evolved from public warehousing, and it offers a combination of the benefits of public and private facilities. It involves contracting for the service over fixed period of time, but the contract can provide a guaranteed amount of space and include service level agreements for value-added services that are normally not available in public warehouses.

- **Potential cost reductions.** Compared to private warehousing, a contract warehouse may be able to provide equal or better service and do so cost-effectively. When comparing costs, the logistics manager can measure the relative merits of each on performance indicators such as fill rates, units shipped per hour, and rate of on-time deliveries. The contract warehouse may gain a pricing edge on the private warehouse in several ways. First, because the contractor is a specialist, its warehouses may be run more efficiently than warehouses owned and managed by the manufacturer. This may result from the contractor's ability to hold down wages and benefits and to provide economies of scale in transportation. The profit motive prompts a contractor to keep operating costs down to win business.
- **Tailored services.** In return for the stability of a longer-term relationship, the contract warehouse can tailor its services to the needs of a particular client more than a public facility can afford to do.
- **Flexibility.** While a contract locks in the company for a longer time period than a hiring arrangement, it provides more flexibility than private warehousing can offer. Using a short-term contract arrangement, a company can also gain the flexibility of testing new markets without investing capital in new facilities.

- **Expanded geographic market.** A third-party provider may own and operate a widely dispersed network of warehouses that can expand a client company's access to new geographic markets.

Mixing Ownership Types

Mixing and matching the three ownership types works well for many companies. For instance, a company may use private facilities to handle its year-round business and hire or contract for extra warehouse space during seasonal peaks.

Determining Right Number of Warehouses

Once, it was easy to decide the number of warehouses: one per market. This was often due to an organization's marketing strategy rather than logistics decisions. Management was mainly concerned with locating distribution centers within easy reach of each market and with storing plenty of inventory in each one to avoid shortages. As logistics matured, however, warehousing became much more strategic.

Now deciding on the number of warehouses requires systems thinking. Every decision about the structure of a system requires a series of follow-up decisions to deal with the impact of the first one. Decisions about warehousing, for instance, may affect transportation, lead times coming into and going out of the warehouse, available labor, packaging, locations, taxes, tariffs (in global supply chains), etc.

Selecting an appropriate number of warehouses for the logistics system is all about tradeoffs. As you add warehouses to the system, some costs will tend to increase and some will decrease.

An increased number of warehouses in a system can affect the following:

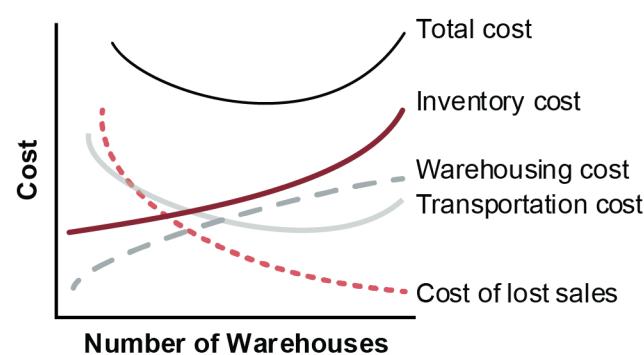
- **Customer service.** The main reason to increase the number of warehouses is to place goods closer to more customers, thereby improving customer service. Today, however, the general trend is to optimize the number of warehouses and to optimize logistics operations so that high customer service levels are maintained and total costs are minimized.
- **Transportation costs.** Adding warehouses can be an effective way to reduce transportation costs by shortening the distances between the warehouses and the points of origin and delivery. There are other considerations, however. A centralized system of warehouses will likely facilitate more rapid inventory turnover. It will also benefit from economies of scale, realized by consolidating outbound shipments into full loads that qualify for lower rates. Transportation costs also reflect the efficiency of service, which may decline with the addition of warehouses. On the other hand, with additional warehouses, inbound transportation costs could increase if there are deliveries by partly full payloads.
- **Inventory.** As you add warehouses, you tend to increase the amount of total floor space in relation to the space available for storage, due to redundancies. While more facilities mean less safety stock per

site because of shorter lead times, aggregate safety stocks go up.

- **Setup and overhead costs.** More warehouses require more expenditures on construction or renovation, setup, and maintenance. Overhead increases include duplication of equipment (one for each place) and labor. As you increase the total number of warehouses, you also increase the probability of adding relatively inefficient facilities to the system. To reduce the number of warehouses, one can start by eliminating the inefficient locations.

Exhibit 5-4 provides a rough picture of the tradeoffs in costs that occur with the increase in the number of warehouses in a logistics chain. Note that in this example, two main components of inventory carrying cost are shown separately: the cost of the inventory itself and warehousing overhead costs.

Exhibit 5-4: Cost Effects of Increasing Number of Warehouses



As the exhibit shows, the overall costs in the system tend to decline as the number of warehouses increases, but only up to a point. After that point, the total cost of warehousing rises per warehouse added. That happens because increasing costs in many areas eventually overwhelm savings in other areas. The relative rates of the increases and declines will differ by logistics system; these are general observations.

Despite the potential savings resulting from a strategic consolidation of warehousing to serve the same customer base, a logistics chain may benefit from adding warehouses in the following instances:

- Local customers want rapid delivery, and it is an order qualifier because competitors offer it.
- Transportation can't provide the required service without adding warehouses.
- Small-scale customers require fast, frequent shipments that are better accommodated by a decentralized system of warehouses.

Determining Right Locations for Warehouses

Deciding upon the location of warehouses is closely linked with decisions about the number of warehouses. Logically, the decision about numbers comes first, because it depends upon the size of the customer base, the volume and timing of demand, and customer service targets. After deciding how much storage space is required for meeting these targets, the location decision comes next. However, some location decisions will be made independently of these warehouse number estimates. If, for example, a supply chain serves markets in several nations, it may be necessary to locate distribution

centers in each country, regardless of market size, due to economic considerations and product differences. Availability of transportation also influences choice of location.

Below are the significant factors to be considered when locating warehouses:

- **Available services.** The most important feature of a potential warehouse location is the availability of required services. These may include rail lines or access for trucks, electricity, water, and other municipal services, including adequate police services. Absence of a required service can be a deal breaker.
- **Neighborhood.** Warehouses can be located anywhere zoning allows them. Warehouses may also be located in central shopping areas, such as downtowns; in any commercial zone; or in sparsely settled areas. If the warehouse will be new construction, the area has to meet certain requirements such as available space.
- **Costs.** The costs of procuring and setting up a warehouse are related to available services and to location. Such costs can vary significantly. Insurance costs exist within a wide range depending upon local social and environmental conditions. Cost of land varies with location; in general, the closer to urban centers, the more the land costs. Warehouse design should take into account the efficient use of space, especially on expensive property. There may be a tradeoff in cost of transportation and cost of land, since cheaper land may be more distant from the market to be served.
- **Community inducements.** An area eager to attract business may offer tax incentives that impact the location decision. An available, appropriate workforce is also a requirement, though workers are mobile enough to influence only the general area, not the neighborhood in which the warehouse locates.
- **Regulatory concerns.** Environmental impact statements can slow down construction and run up costs.

The factors influencing warehouse locations are interdependent and impact the rest of the system. Consequently, they require careful analysis. Many of the decisions discussed so far are intensified in a global supply chain, especially decisions related to available services, insurance costs, and the workforce. For example, Toyota decided to locate a plant in Canada rather than in a previously favored region of the southern United States. They based that decision on an assessment of the relative quality of the workforce in each region and the difference in health insurance costs, which are paid for by the employer in the United States and by the government in Canada. Such factors are also of concern in locating storage facilities.

Internal Warehouse Design and Capacity Forecasting

Internal warehouse design starts with the end in mind by determining requirements related to warehouse activities and desired inventory flows. Advances in information technology and warehouse equipment have made intelligent, efficient storage and retrieval much easier, and warehouse designs also take the desired level of investment in such capabilities into account.

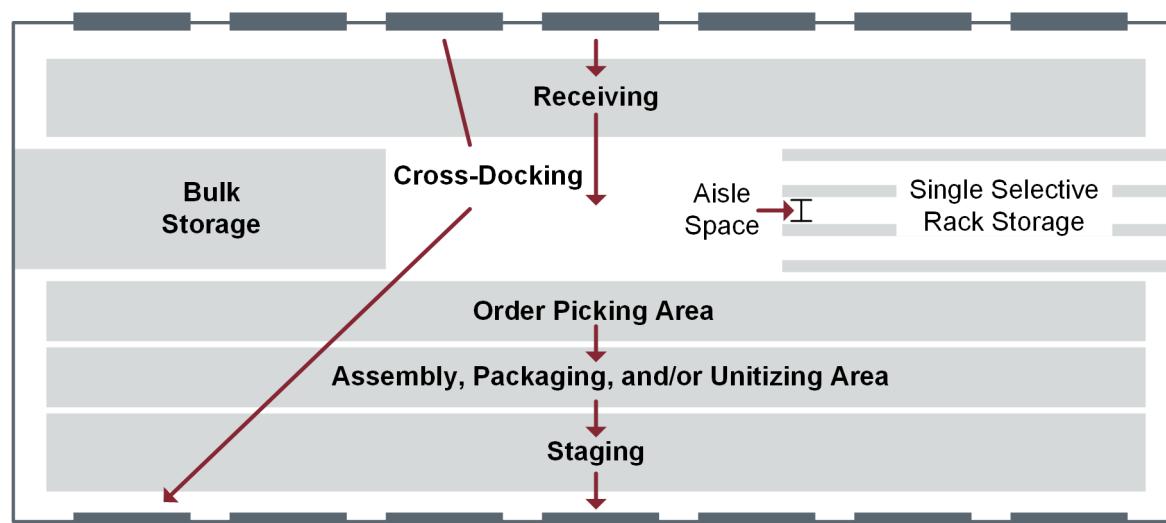
A requirement might be for the fastest-moving products or parts to be the most easily accessible, while the slow movers can be parked out of the way. In terms of inventory flows, some organizations will want to store different goods for different periods of time while others want to keep inventory in motion such as by using cross-docking.

Storage locations themselves are designed to maximize efficiency and the effective use of space. Warehouse space involves a large capital investment for an organization, so it must be arranged to maximize the amount of storage while leaving sufficient space for equipment movement and other warehouse activities such as receiving, cross-docking, order picking, assembly, packaging, and staging.

Warehouse Layout

Exhibit 5-5 shows the basic layout of a warehouse.

Exhibit 5-5: Basic Warehouse Layout



Warehouses are generally designed as one-floor systems. Rack storage maximizes the cubic space of the warehouse—called cube utilization—by storing items on vertical racks. The maximum height is determined by the equipment used to place and pick pallets or other inventory or by existing warehouse height limitations. Filling an entire warehouse with single selective racks (multi-story racks that are one pallet-width deep on each side of an aisle) might maximize the amount of this type of inventory that can be stored, but the workflow areas will be congested and overall throughput could be abysmal. A velocity analysis can be performed to optimize warehouse flow. The ideal system has 100 percent accessibility, meaning that all inventory can be accessed without having to first move some other inventory.

Note how cross-docking involves moving freight directly from receiving to outgoing shipping in the graphic. Deliveries often need to be reconfigured in the staging area to new assortments, such as each

retail store being sent a variety of goods from various manufacturers. Also, while cross-docking could be one service a warehouse offers, other facilities do cross-docking exclusively. The design maximizes dock space and minimizes internal material movement distances.

Once a layout that optimizes velocity and cube utilization is determined, the next concern is to organize stock locations.

Stock Location

To perform the inbound receiving process, warehouse personnel need to know what the inventory is and where best to take it (rack storage, bulk storage, outgoing dock, break-bulk, sorting, packaging, and so forth), even if the organization has millions of SKUs (stock keeping units), as is the case for many large businesses. For the order picking and filling process, warehouse personnel need to know exactly where the required items are stored, in which order to pick the items, and the route to take.

Stock location involves deciding where to store specific inventory in a warehouse. The idea is to optimize storage based on the organization's prioritization of speed of access or cube utilization.

Here are some stock location methods:

- **Using random-location storage .** As defined in the *APICS Dictionary*, 16th edition, random-location storage is

a storage technique in which parts are placed in any space that is empty when they arrive at the storeroom. Although this random method requires the use of a locator file to identify part locations, it often requires less storage space than a fixed-location storage method.

Random-location storage is also called floating inventory location. This method maximizes cube utilization and can be rapid if the organization uses warehouse automation systems such as directed pick and put-away.

- **Using fixed-location storage .** Fixed-location storage is defined in the *Dictionary* as

a method of storage in which a relatively permanent location is assigned for the storage of each item in a storeroom or warehouse. Although more space is needed to store parts than in a random-location storage system, fixed locations become familiar, and therefore a locator file may not be needed.

This method may be acceptable for warehouses that do not need dense cube utilization because space is not at a premium, throughput is low, or there are not many SKUs. It is also often used for relatively slow-moving items like spare parts or for situations where order pickers do not get a picking list (e.g., there are relatively few items in inventory).

- **Using ABC classification.** Inventory can be grouped by its ABC classification and could use secure or fast-moving storage areas.
- **Grouping functionally related items together.** Items can be grouped by their use, for example, all modular components for the same product family, all kitchen appliances, or all hardware. A related storage type is called point-of-use storage, which has special assembly staging areas and nearby inventory storage.
- **Grouping high-velocity items together.** Items that arrive and leave quickly, but not quickly enough for cross-docking, can be placed in locations near the outbound staging area.
- **Grouping items by similar physical characteristics.** Hazardous materials need to be stored in an area with strict security measures. Frozen or refrigerated items are stored together. Bulky or odd-shaped items, such as couches, can also be stored together.
- **Grouping reserve stock separately.** Reserve stock can include bulk storage of items when working stock is considered a partial pallet for picking, or it can refer to defective or obsolete items and returns. Reserve stock can be stored out of the way. The working stock can be replenished from the reserve stock.

Warehouse Capacity Forecasting and Planning

Warehouse capacity forecasting and planning is a must before building or leasing warehouse space, because the warehouse will need sufficient capacity for the next three to five years. Changes to warehouse capacity in a shorter time frame tend not to be cost-effective due to building and/or setup expenses, lease negotiations, and so on.

Capacity forecasting is a function of inventory levels in the aggregate. Individual inventories will vary between a minimum (equal to safety stock) and maximum level. We are looking for the most common inventory level—an average, called the mode. The mode (most common level) will be approximately halfway between the safety stock level and the maximum level. For the rest of the discussion in this area, interpret “average” as meaning the mode.

While calculating warehouse size using forecasted average inventory may not seem to leave enough room for maximum inventory, when random-location assignment is used, the inventory that is currently at a maximum level will balance inventory that is currently at a minimum level. If, instead, fixed warehouse locations are assigned to specific items, the size of the warehouse would need to be the sum of all maximum space per item. The warehouse will frequently have a large amount of unused space. Warehouse capacity is therefore typically forecasted as this average inventory level.

A few items need to be considered before calculating the forecasted average inventory level:

- Averages must first be calculated for each type of unit. Various units can be aggregated based on their storage requirements; items of like size can be aggregated because it is the total cubic meters or feet used that needs to be calculated.
- Some average warehouse space requirements may need to be calculated. Often, the number of items that fit on a pallet within a storage bay (including a calculation of how high the pallet can be stacked) could be estimated; the pallet size could be used for its cubic volume requirement. In practice, this analysis is often simplified from cubic meter/feet requirements to the number of pallet storage bays needed to house the forecasted average aggregate inventory. Many organizations and industries standardize their pallet size to allow all pallets to fit in any storage bay. For our calculations, each pallet would then be one unit.
- Some compensation is often added for pallets that are used for individual items rather than shipped as whole pallets. A pallet that can store 18 boxes but holds only one box at present still takes up an entire storage bay.
- Any bulk storage capacity requirements would be calculated separately.
- For each year of the three- to five-year warehouse space requirements, a forecast must be calculated. The year with the highest capacity requirement will indicate the overall warehouse capacity requirement—expressed in cubic meters or feet or in storage bays.

As an example, let's say that the sum of all forecasted average inventories for an organization takes up 18,000 cubic meters (m^3) in the highest forecasted year of a five-year plan. All inventory fits on a standard-size pallet that, when full, is 1.2 meters deep \times 1.0 meters wide \times 1.5 meters tall = $1.8\ m^3$. Calculating the need for storage bays divides the space requirement by the standard pallet cubic space: $18,000\ m^3 / 1.8\ m^3 = 10,000$ storage bays. The organization multiplies this by a factor of 1.1 to account for partially filled pallets. This factor is based on historical analysis of existing warehouse usage. Then $10,000 \times 1.1 = 11,000$ storage bays needed.

After determining the requirements for the inventory, the calculation is adjusted to account for other space requirements. When storage bays are used, the process might work as follows:

- **Determine the raw space footprint.** Multiply the number of needed bays by the square meters used per pallet. (Vertical storage and thus cubic space utilization is accounted for in a later step.) This results in a square meter (m^2) space requirement for just the inventory. Finding the square meters or feet requirement is useful because real estate is sold or leased using this unit of measure. To continue the prior example, $11,000\ \text{storage bays} \times 1.2\ m^2$ of floor space (1.2 meters deep \times 1.0 meters wide) = $13,200\ m^2$ of floor space needed just for inventory.
- **Factor in space for all inventory movements.** Multiply this result by a factor that is greater than one to account for space around inventory in each storage bay, aisle space, handling equipment

space, and space for picking, sorting, consolidating, and so on. This is typically at least a multiplier of three. Organizations can analyze existing warehouses that use the same types of warehouse equipment to determine the right factor to use. In this example, the factor is 3, so the calculation is $13,200 \text{ m}^2 \times 3 = 39,600 \text{ m}^2$.

- **Account for vertical space utilization.** Determine how many levels of vertical storage will exist for pallet storage bays. For example, if there will be four levels of vertical storage for all bays, then the raw space footprint could be divided by four (e.g., ground storage plus pallet racks that are three levels high). In this example, there are four levels, so the calculation is $39,600 \text{ m}^2 / 4 = 9,900 \text{ m}^2$.
- **Add space for expansion or excess capacity.** Divide by a factor for the target utilization of the warehouse. This is a way of building in excess capacity. For example, if the target utilization rate is 80 percent, then the warehouse floor space would be divided by this percentage to find the total necessary space. In essence, this warehouse would be only 80 percent full under the current forecasts. This utilization rate would be set by organizational policy based on strategic and risk analyses. Since the rate here is 80 percent, the calculation is $9,900 \text{ m}^2 / 0.8 = 12,375 \text{ m}^2$. This much land could be leased or purchased to build a new warehouse, or an existing warehouse of this size (and sufficient vertical height for the racks) could be leased or purchased.

Note that there are many ways of determining warehouse space capacity requirements. Organizations that use fixed-location storage, for example, may use maximum inventory requirements rather than average inventory requirements so as not to run out of space when orders arrive. Additionally, the space requirement could be divided among several distribution centers. If this is the case, the volume of goods to be stored in each warehouse would be divided first, and then the remaining adjustments would proceed separately. This would result in a larger total space requirement, because each warehouse would need its own functional areas for goods handling.

Materials-Handling Strategy

The APICS Dictionary, 16th edition, defines **materials handling** as follows:

Movement and storage of goods inside the distribution center. This represents a capital cost and is balanced against the operating costs of the facility.

The goal of materials handling is to contribute value to the supply chain by making effective and efficient use of warehouse space, human labor, materials-handling equipment/automation, and related information technology. When all of these considerations are combined effectively, materials handling and distances traveled are minimized, time spent in stock locations is minimized, space utilization is optimized, and order put-away or picking is logical and efficient.

While all warehouse tasks used to be accomplished by manual labor, mechanical or automated assistance can make most tasks easier, faster, safer, and more efficient. When selecting the best

combination of equipment and human labor for the products, space, and type of operations, the supply chain manager will most likely need the assistance of warehouse equipment experts who have access to optimization software.

Note that poor selection of equipment or automation may add to expense without increasing value if it can't be used effectively in the available space. A wise selection will be justified by future cost savings. Therefore, it is important to determine an overall strategy for the mechanized and automated materials-handling options the warehouse will use. This strategy needs to be consistent with the skill levels of the workforce. Training or talent acquisition may be needed. Exhibit 5-6 provides an overview of the various materials-handling options an organization might consider. It is divided into mechanized systems and automated systems.

Exhibit 5-6: Materials-Handling Options

Type	Features and Uses	Benefits	Limitations
Mechanized Systems			
Forklift trucks	<ul style="list-style-type: none"> Load and unload vehicles Lift pallets or slipsheets Available in numerous configurations 	<ul style="list-style-type: none"> Flexible uses Can lift and retrieve in high shelf areas Automation available 	<ul style="list-style-type: none"> Expense to buy, train, and maintain Inventory damage Safety requirements
Conveyors	<ul style="list-style-type: none"> Store and retrieve goods Load, unload some types of vehicles Motorized/nonmotorized Scanners for fast, accurate information 	<ul style="list-style-type: none"> Inexpensive operation Reduced labor costs Efficient use of space 	<ul style="list-style-type: none"> May block access to aisles and/or shelves
Towlines	<ul style="list-style-type: none"> Four-wheeled container towed by dragline (floor or overhead mount) Used in order selection Automated models can switch lines Scanners available 	<ul style="list-style-type: none"> Efficient use of space Can improve inventory identification and accuracy 	<ul style="list-style-type: none"> Expensive to automate, use in complex systems Rapid obsolescence
Tow tractors with trailers	<ul style="list-style-type: none"> Like towlines, used mainly for order selection Can tow multiple trailers Driver required 	<ul style="list-style-type: none"> More flexible than towlines 	<ul style="list-style-type: none"> More expensive than towlines (driver)
Bridge and wagon cranes	<ul style="list-style-type: none"> For heavy lifting Bridge cranes: overhead on movable girder Wagon cranes: on floor (like forklifts) 	<ul style="list-style-type: none"> Can lift heavier objects than forklift or conveyor Efficient use of space Automation, remote operation available (bridge) 	<ul style="list-style-type: none"> Very expensive Single bay linear travel only
Carousels	<ul style="list-style-type: none"> Series of multilevel bins on oval track Rotates Moves inventory to a stationary order selector 	<ul style="list-style-type: none"> Reduces order selection labor Reduces storage requirements Eliminates paperwork given computer-generated pick lists and rotation 	<ul style="list-style-type: none"> Item size Item weight

Type	Features and Uses	Benefits	Limitations
Automated Systems			
Automated guided vehicle systems	<ul style="list-style-type: none"> Move on floor on tape or wire Similar in use to forklift and tow tractors Riderless with programmed stops Can have tines or platforms 	<ul style="list-style-type: none"> Programmable for flexibility without need for operator Maximum use of space; fit in narrow aisles, reach high shelves 	<ul style="list-style-type: none"> High acquisition cost
Automated sorting systems	<ul style="list-style-type: none"> Usually used with conveyors Automate direction of items into shipments Most devices programmable for different speeds to fit shipment specifications 	<ul style="list-style-type: none"> Reduced human time and labor for retrieval and storage Speeds of up to one package per second 	<ul style="list-style-type: none"> High acquisition cost
Robotics	<ul style="list-style-type: none"> Used to build and break down unit loads Programmed to recognize product stacking patterns and place products in a predetermined position on conveyor belt 	<ul style="list-style-type: none"> Used in difficult or dangerous environments Can integrate program logic Increases speed, dependability, and accuracy 	<ul style="list-style-type: none"> High cost
Live racks	<ul style="list-style-type: none"> Contains roller conveyors Designed to be loaded from the rear, where it is elevated, using gravity to move product to front of rack 	<ul style="list-style-type: none"> Reduces need for lift trucks to transfer unit loads Offers potential for automatic rotation of product 	<ul style="list-style-type: none"> Little access to stock in middle
Automated storage and retrieval systems	<ul style="list-style-type: none"> Automate storage and retrieval Use very high storage racks Machine moves both horizontally and vertically Programmed at end-of-aisle station 	<ul style="list-style-type: none"> Maximum storage allowed per square foot of floor space High storage and retrieval speed with few errors Reduced labor cost and human errors 	<ul style="list-style-type: none"> High cost

Mechanized Systems

Mechanized systems include a wide range of types of materials-handling equipment, including forklift trucks, conveyors, towlines, tow tractors with trailers, bridge and wagon cranes, and carousels.

Forklift Trucks

Type of fuel/battery, amount of lifting power, size and shape (some models are adapted especially to narrow aisles), and other features can be mixed and matched. Forklifts can drive directly into semi trailers or in other vehicle payload areas. Forklifts allow pallets to be raised up or down from the tops of high stacks, and some can also reach both high and deep. Some models are adapted to lifting slipsheets instead of pallets. (A slipsheet is a thin, pallet-sized sheet of plastic, laminated paperboard,

or corrugated fiberboard that slides underneath a load.) Automation is available in a computer-controlled, driverless model.

Conveyors

Conveyors, as seen in Exhibit 5-7, move goods into or out of some types of vehicles and storage spaces. The basic decision when selecting a conveyor is whether or not to have a motor. The roller conveyor relies on gravity to move goods slowly down the line; the belt conveyor (or conveyor belt) is motorized to provide more speed or move goods uphill. Conveyors can be equipped with scanners to read bar codes on items traveling along them, thus speeding up inventory and reducing error rates.

Exhibit 5-7: Conveyor



Source: Photograph used with permission from Metzgar Conveyors, © 2011.

Conveyors offer several advantages:

- Inexpensive operating costs (especially with the roller type)
- Reduced labor costs (including costs for injuries and accidents)
- Efficient use of space (They fit into narrow aisles.)
- Ability of scanners to read bar codes or RFID
- Movement of far more inventory than trucks could move at far less cost (for example, moving coal from a mining area to a storage area)

The tradeoff is that using conveyors can potentially block access to the area where loading takes place.

Towlines

The towline, shown in Exhibit 5-8 and also called a towline conveyor, uses a four-wheeled container that is towed by a dragline, which can be mounted overhead or in the floor. Overhead lines are easier to install and move than in-floor lines. Some automated models can be uncoupled from one line and attached to another, giving them access to more than one dock. Overhead lines with automated

decoupling provide more flexibility than standard belt or roller conveyors, but, on the whole, they are much less flexible than forklifts.

Exhibit 5-8: Towlines



Source: Photograph used with permission from Rhodes Systems International, Inc., © 2011.

Towlines may also be equipped with scanners to identify the goods being conveyed. Automated systems can be complex and very expensive.

Towlines provide several advantages:

- Efficient use of space (They fit into narrow aisles.)
- Potential to improve inventory identification and accuracy

Tradeoffs include the following:

- Requirement of heavy capital investment when automated
- Need to invest significant time and money to design complex systems
- Relatively rapid obsolescence, especially in elaborate systems

Tow Tractors with Trailers

Tow tractors can pull several trailers conveying pallets. They are generally used, like towline conveyors, in order selection. Tow tractors are not automated, and, because they require a driver, they are more expensive to operate than towlines. However, they are also more flexible.

Bridge and Wagon Cranes

For heavy lifting, warehouse managers may turn to cranes. The two basic types are bridge cranes (also called overhead cranes) and wagon cranes.

The “bridge” part of a bridge crane, shown in Exhibit 5-9, is a horizontal girder, or pair of girders, that rests at each end on a truck.

Exhibit 5-9: Bridge Crane



The trucks run along tracks, giving the crane the ability to move objects horizontally in the direction of the runway. They can also move objects perpendicular to the track, along the direction of the girder that runs between the tracks.

Because they are suspended, bridge cranes leave the floor space below them free for other activities. Bridge cranes are best used in low- to medium-volume activities that require moving items that are large, heavy, or awkward to maneuver.

Wagon cranes, also called crane trucks or stacker cranes, offer the mobility that is provided by forklifts and is absent from conveyor systems. They can negotiate narrow aisles and use all three dimensions of warehouse space—height included. They are available in fully automated models that can lift objects in and out of storage without the assistance of a human operator.

Though these cranes are generally used to lift and swing objects that are too heavy or oddly shaped to be moved by other types of equipment, they can also be used to move objects horizontally for short distances.

Advantages of cranes include

- Easy access to most areas within the lifting bay (bridge crane)
- Extension to areas outside the building (bridge crane)
- Ability to lift heavy objects that can't be handled with forklifts or conveyors (especially the bridge crane)
- Ability to negotiate narrow aisles and to use all dimensions of a warehouse, including its height (wagon crane)
- Overhead suspension that leaves all floor space free for other uses (bridge crane)
- Available with radio control for remote operation (bridge crane) or fully automated for driverless picking and storing of items.

The main drawback of either type of crane is capital expense. The logistics manager may have to justify the expense by documenting the crane's appropriateness to the functions and space requirements of the warehouse.

Carousels

A carousel consists of a series of bins mounted on an oval track with the option of multiple track levels. The entire carousel rotates, moving inventory to a stationary order selector rather than requiring that person to go to the inventory storage location.

The advantages of using a carousel include the following:

- It reduces labor required for order selection by reducing walking length and time.
- It can significantly reduce storage requirements, especially when stackable or multilayered carousels are used.
- Paperwork can be eliminated when the system uses computer-generated pick lists and carousel rotation.

A pick-to-light system uses a series of lights that indicate the right pick location and the number of items to remove from that bin in the carousel. In some pick-to-light systems, a computer generates the pick lists and operates the carousel. A similar system, pick-to-voice, uses computer-generated voice commands to guide picking.

Advantages include

- Efficient use of floor space
- Reduction of time and labor required to pick items from storage
- Available automation to further enhance productivity.

Automated Systems

Mechanized handling methods are often supplemented by automated systems, which can include automated guided vehicle systems, automated sorting systems, robotics, live racks, and automated storage and retrieval systems. These systems involve a higher capital expense than less complex systems but often can eliminate some labor costs, meaning that the warehouse will have relatively higher fixed costs and relatively lower variable costs. This can result in higher profits when volumes are high enough to cover the fixed expense but also higher losses if volumes are too low.

Automated Guided Vehicle Systems

Automated guided vehicle systems (AGVS) perform much the same type of work as pallet trucks or tow tractors with trailers, and they operate without a rider. Instead of running on tracks, they move along optical tape or a magnetic wire in the floor, and they can be programmed to stop at various stations

along their paths. Models are available with tines for lifting pallets or with platforms; some models are specially designed to move materials into high storage areas along narrow aisles.

Advantages include

- Programmability to increase flexible use without the expense of a human operator
- Ability to maximize use of warehouse space by operating in narrow aisles and providing access to high shelves.

The primary drawback is the high cost of acquisition.

Automated Sorting (Sortation) Systems

Generally used with conveyors, automated sorting systems direct items on a conveyor into their proper locations in a shipment. The system receives the required sorting information from a code on the master cartons of the items to be shipped. Most automated sorters can be programmed to work at different speeds to fit the requirements of particular shipments.

Advantages include

- Reduced labor costs
- Increased speed (up to one package per second).

Robotics

Robotics in warehousing is used to build and break down unit loads. To break down a load, the robot is programmed to recognize product stacking patterns and place products in a predetermined position on the conveyor belt. To build unit loads, that process is reversed.

The following are advantages of using robotics:

- It can be used in situations that are difficult or dangerous for humans, such as high noise areas or areas with extreme temperatures (such as food freezers) or in working with hazardous materials.
- It has the capacity to integrate program logic and increase speed, dependability, and accuracy.

The drawback of robotics can be the cost. For example, Amazon purchased warehouse robotics system manufacturer Kiva in 2012 to control the cost of these devices, which is still US\$15 to US\$20 million per warehouse after the purchase, according to an article by Ananya Bhattacharaya. Amazon also restricted these systems to its exclusive use. Since there were no similar competitors, it took the industry four years to develop viable alternatives, according to an article in Bloomberg News by Kim Bhasin and Patrick Clark. These robots pick up storage racks and move them to where they are needed, and since the robots require less space to operate, the warehouses that use them can hold 50 percent more inventory per square foot, cutting operating costs by 20 percent, or close to US\$22 million, per warehouse. They also reduce the “click-to-ship” cycle to 15 minutes from 60 to 75 minutes. If implemented in all warehouses, Deutsche Bank estimates this would be a one-time savings for Amazon of US\$800 million net of robot installation costs. For the rest of the U.S. warehouse market, as

of 2021, a number of competitors have emerged, many originating in Europe, to capture the 95 percent of U.S. warehouses that had yet to be fully automated (ten percent of these were already semi-automated), according to an article by Scallog Logistics, which cites research by DHL.

Live Racks

The live rack contains roller conveyors and is designed to be loaded from the rear where it is elevated, thereby using gravity to move product to the front. When an item or carton is removed from the front, the items behind it slide forward.

Using live racks provides these advantages:

- It reduces the need for lift trucks to transfer unit loads.
- It offers automatic rotation of product—the first product on the conveyor will be the first out (first-in, first-out, or FIFO).

A drawback of using live racks is that access to the stock in the middle can be hampered.

Automated Storage and Retrieval Systems

The most advanced automated systems are called automated storage and retrieval systems (AS/RS). In addition to automating both storage and retrieval, these systems feature very high storage racks that multiply the capacity of the warehouse.

The storage and retrieval functions are handled by a programmable AS/RS machine that moves both horizontally and vertically. The storage racks themselves may rise 100 feet or more, towering over standard warehouse racks. Because of the design of the storage and retrieval machine, the racks can be arranged along very narrow aisles.

The AS/RS machine is programmed at pickup and discharge stations located at the ends of aisles.

Another handling device, such as a towline, conveys incoming items to the AS/RS, which is programmed with instructions for delivering the items to specific bins in a specific sequence.

When an AS/RS is being sent into the racks to retrieve items for an outgoing shipment, software helps it find the required items in the most efficient way. The AS/RS machine moves through the racks at high speeds—300 to 400 feet per minute horizontally and 100 feet per minute vertically. Computers may be dedicated to the AS/RS station.

The advantages of AS/RS systems include

- Maximum storage density per square meter or foot of floor space
- Tight control of storage and retrieval for high speed and freedom from error and pilferage
- Fast throughput to enable things like same-day delivery order promising
- Reduction of labor costs (and human error).

The obvious drawback is capital cost. AS/RS systems are complex, large, and very expensive. However, some systems are scalable in that one can upgrade part of a facility at a time, adding more aisles and picking shuttles as needed without affecting the existing AS/RS aisles. A single failure point might also take the entire system off line, though some systems avoid this issue by enabling individual picking units to be taken on or off line for maintenance independently. Other disadvantages may include added labor required to properly put away materials, dedicated space, loss of flexibility (it's not easy to move such a system), and equipment failures.

Topic 3: Transportation Strategy

We'll begin our consideration of transportation by looking at two of its objectives: product movement and temporary storage. Next we'll examine capacity constraints and capacity forecasting and planning.

Transportation Objectives

Transportation and warehousing are key logistics functions that need to be in balance. Supply chain managers weigh the costs of warehousing to reduce lead times against the costs of transportation. The transportation market has long been deregulated, which places the power and responsibility of refining a supply chain's transportation tactics in the hands of logistics and supply chain professionals. Success in transportation planning and administration will provide tangible benefits to the organization's bottom line.

The primary objective of transportation is product movement: carrying goods and materials between supply chain partners and customers. A secondary objective is providing temporary storage for in-transit inventory.

Product Movement

Since the movement of materials around the supply network is both necessary and expensive, keeping down the costs in time, money, and environmental impact is of strategic importance.

Efficient Use of Time

Efficient use of time is a factor in developing a successful transportation strategy because inventory in transit isn't available for use in production or for sale to customers. This puts a premium on moving materials and goods as infrequently and as rapidly as possible. But the premium isn't absolute. There are tradeoffs to consider, since faster transport modes are expensive.

Transportation costs also trade off against inventory costs. Tactics such as Just-in-Time delivery emphasize reduction of inventory costs, and one method of keeping down inventory is to ship more frequently—thus possibly raising transportation costs.

Efficient Use of Money

Efficient use of money provides a complex set of challenges to the transportation planner. As always, it is advisable to consider all the factors that contribute to total cost. You want to become more cost-efficient in one area without raising costs by a greater amount in another area. **Line-haul costs** need to be determined. These are defined in the *APICS Dictionary*, 16th edition, as

basic costs of carrier operation to move a container of freight, including driver's wages and usage depreciation. These vary with the cost per mile, the distance shipped, and the weight moved.

Line-haul costs include the following:

- **Vehicle costs.** A supply chain partner can choose between controlling its own fleet of vehicles, hiring transportation as needed, or contracting with a carrier for a longer term. With a company fleet, the company incurs internal costs for financing, leasing, and depreciation. In a global supply chain, there are additional challenges that can make it extremely difficult to control your fleet worldwide. With commercial or public transportation, the company incurs external costs.
- **Driver/operator costs.** Unless the mode of transport is a pipeline, transportation includes the cost of labor required to operate the vehicle—drivers for trucks; pilots, copilots, and crew for air transport; engineers for rail; and so forth. Driver shortages can drive up costs due to higher market wages, difficulties with certification, lack of investment capital, and expanded regulation.
- **Vehicle operating costs.** Operating and maintaining a fleet of owned or leased vehicles requires expenditures for repairs, cleaning, parking, etc. As fuel prices rise, operating expenses increase for road, air, rail, and water transportation. One way in which steamship companies are minimizing their costs is by running their ships more slowly to consume less fuel, which increases delivery time. For example, Wärtsilä, a ship engine producer, has calculated that reducing cargo ship speed from 27 to 18 knots results in a 59 percent fuel savings at a cost of one extra week in transit between the Far East and Europe, or fuel savings of more than US\$2 million for a one-way trip. Other companies use semi trucks without sleeping cabs or extra wheels to reduce the overall weight.
- **General and administrative costs.** Funds must be allocated to management of the transportation function.
- **Insurance and security costs.** With a private fleet, a company pays insurance costs to cover a variety of security concerns. Products may be damaged, lost, or stolen in transit. Transporting hazardous materials requires extra expense for insurance coverage, for security, and to comply with regulations. Air, rail, and water transport must provide protection against terrorism as well as vandalism and theft.

Minimal Harm to Environment

Finally, transportation of all types makes demands on the environment, some of which show up as costs of doing business. Transportation constitutes a large portion of domestic petroleum consumption in the United States and a rapidly growing amount in other areas of the world, especially in emerging economies such as China and south Asia.

As supply chains extend over increasing distances, fuel for commercial transport and the pollution that goes with it are bound to become increasingly problematic. The costs of fuel and the associated pollution add to the reasons for managing transportation and information efficiently.

However, some progress is being made on this issue both in the U.S. and the European Union.

For the neighboring ports of Los Angeles and Long Beach, California, the Clean Truck Program was signed into law in 2008, requiring diesel-powered, short-haul drayage trucks to meet new environmental standards that will reduce their air pollution by 80 percent. (Drayage trucks transport shipping containers from docks to off-site warehouses.) Trucks that do not meet the standards currently pay a fine but will eventually be banned from Los Angeles and Long Beach. Since these ports handle nearly 45 percent of container goods entering the U.S., this is a significant step in reducing harmful pollutants in these areas.

Also, by 2023, per the California Air Resources Board, almost all heavy trucks in California need to have a 2010 or newer engine model year. (A special retrofit filter is currently required for older models.)

The U.S. EPA's Clean Air Nonroad Diesel Rule (also known as Tier 4), affecting industrial equipment, generators, and transportation infrastructure such as heavy forklifts and airport service equipment, was fully implemented in 2015, reducing allowed particulate matter and nitrogen oxides. Ultra-low-sulfur diesel was also fully implemented in 2014 for nonroad, locomotive, and marine engines. (It was fully phased in for trucks in 2011.)

The European Union has established low emission zones (LEZs) in which high-polluting trucks are prohibited. Specifically, regulations prohibit higher-emission heavy-duty diesel trucks from entering certain EU cities. Vehicle emissions are classified into Euro standards for the vehicles they apply to; trucks are rated Euro VI, Euro V, Euro IV, etc., with the lower numbers having more restrictions due to their higher emissions or lack of particulate filter or catalytic converter. Before a truck enters into an LEZ, the driver must know the emissions standard for that particular vehicle. (For more information on emission standards, see the links in the online Resource Center.)

The European Union also places restrictions on the movement of trucks, both to reduce traffic congestion and to encourage more efficient transport modes. For example, in Switzerland and Austria, for Alps crossings, there are truck bans during the night and during some days. Trucks are encouraged to use piggyback rail transport.

Note that transportation also affects the environment through water and noise pollution.

Adopting fuel-efficient vehicles and developing new fuels that aren't petroleum-based may slow the growth trend, but any declines resulting from fuel efficiency will be balanced against greater consumption of other resources as markets continue to develop around the world. Not all of these effects are reflected in the costs of doing business.

Temporary Storage

Transportation vehicles are not designed for long-term storage and are generally not used for that purpose. Nevertheless, it can sometimes be more economical to "warehouse" inventory in a vehicle than to unload, store, and reload the carrier. However, that necessitates space to park the vehicle, and fees are charged for temporary parking of a trailer. Carrier charges and fees are also added when land or water vehicles are retained beyond a specified loading or unloading time. Those charges are called demurrage fees if they involve rail freight cars or ships and detention fees if they pertain to truck trailers. If the goods to be stored need to be kept at a certain temperature, refrigerated trailers may be kept running as long as temporary storage is needed, but this can be quite costly.

Three situations provide the most frequent examples of the use of vehicles for temporary storage:

- **Short-term storage.** Trailers and railcars sometimes park at a facility without being unloaded if the contents need to be stored but are scheduled to move again in a few days. In the global arena, logistics parks (designated areas for storage and distribution built to complement industrial zones) are a growing option for efficient short-term storage. Some trucking companies have their trucks set up with two trailers so the driver can park one temporarily outside an urban area. After the first delivery, the driver retrieves the second trailer and delivers those goods. Logistics warehouses in China are classified as either bonded or nonbonded. Bonded logistics parks (BLPs) are often located near ports and serve as cost-effective holding areas where shipping orders can be consolidated from various locations before being exported. Nonbonded logistics parks, which have cheaper rental rates than BLPs, are increasingly being developed on the expanding road network (such as that connecting Shanghai to other cities in the Yangtze River delta).
- **Crowded facility.** If a warehouse is too full to accept the contents of an arriving truck or railcar, some of the contents of the warehouse may be loaded into another vehicle. That vehicle then takes a slower and often cost-equivalent or cheaper route to its destination. In other cases, the limited shipping dock capacity at the outgoing facility may be the reason to ship something early but by a slower method. In some cases, the cost-equivalent but slower method will be intermodal. The tradeoff in extra transportation time and costs must be balanced against the enhanced storage capacity.
- **Changed destination.** With global positioning to track in-transit inventory, the destination could be changed mid route. (One generally needs to select a destination to release an order.) Reasons to divert a shipment of goods while in transit include to make the best use of available warehouse space

or to accommodate changes in customer orders, such as last-minute cancellations or new orders. In the case of crude oil, in many cases the oil is traded on the market as soon as the tanker is under way toward a general destination like the U.S. West Coast, and the delivery time frame continually grows shorter as trading continues. The final owner chooses the specific destination based on the best available deal.

Transportation Capacity Forecasting and Planning

As with warehouse capacity, transportation capacity needs to be forecasted and planned in advance. Transportation capacity is easier to scale up quickly than warehouse capacity, since there are numerous options for increasing carrier capacity. Doing so efficiently and economically is the challenge.

A number of constraints on transportation capacity need to be considered when forecasting and planning, so these are discussed first. After addressing forecasting and planning, the benefits of investing time in this area are covered.

Capacity Constraints

When evaluating bids from carriers or forecasting transportation requirements, a logistics manager should understand the capacity constraints with which he or she is operating, including distance, volume, density, stowability, handling, liability, and conflicts of interest. The following discussion analyzes the impact of these factors.

Economies of Distance and Scale

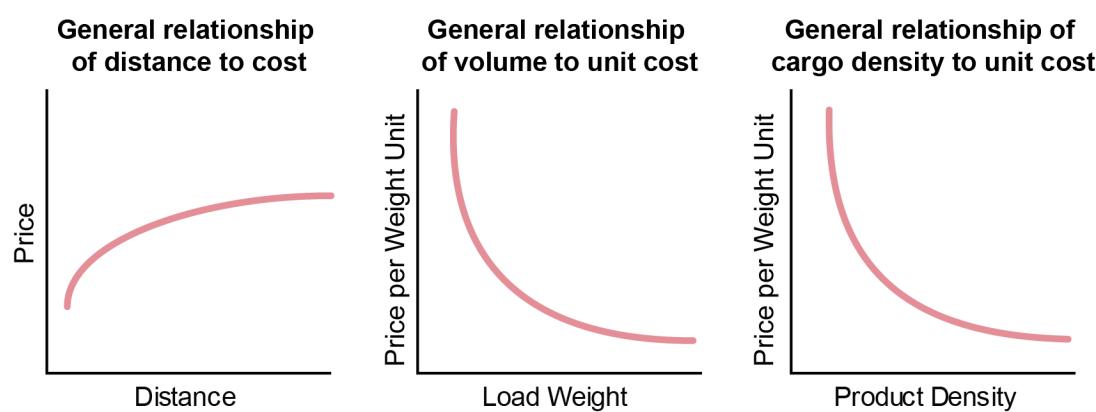
Constraints in these categories include distance, volume, and density.

- **Distance.** The farther your shipment travels, the more it will cost you. It consumes more fuel, requires more labor, causes more wear and tear, and, in general, increases variable costs. However, the principle of economies of distance—similar to economies of scale—decreases the impact of that upward trend. The reason is that all miles are not equally costly, and longer trips usually include a greater percentage of the less-expensive miles. graphs the relationship in a general way. For one thing, starting and stopping use more fuel and cause more stress on vehicles than cruising. Line hauls especially benefit from this phenomenon, because they generally include a large proportion of highway miles.
- **Volume.** As you pile more weight into a vehicle payload, economies of scale reduce the cost per pound or kilogram, as pictured in . Why? Because you’re spreading fixed costs over a larger number of units. Thus, a full load is more cost-effective to transport than a partial load, so consolidate your small loads into larger ones whenever possible. If you don’t do so, the carrier may do it for you by adding stops to take on cargo to fill the empty spaces. Someone has to pay for those side trips.

- **Density.** In shipping, low-density goods will cost much more per pound or kilogram to transport than denser goods like coal, the reason being that a truck filled with feathers is carrying far less weight than a truckload of dense coal. The variable costs for labor and fuel aren't much affected by the weight of the load, and the fixed costs are spread over the greater number of pounds or kilograms. Density can be increased by packaging as well. For example, items that require assembly after purchase are often configured this way to increase density.

There is a limit to the positive effects of high-density shipping, however, because there is a cap on the amount of weight a truck can carry—legally or practically. Dense liquids, such as laundry detergent, will reach the weight limit long before filling up the volume of a truck. Setting aside that limiting case, graphs the general relationship of increasing density to decreasing cost per pound or kilogram of cargo.

Exhibit 5-10: Economies of Distance and Scale in Transportation



Stowability

Items with odd shapes that prevent them from efficiently sharing cargo space cost more to ship than items of similar density and weight that stow more efficiently. Redesigning awkwardly shaped products for efficient storage can greatly reduce the costs of transport and warehousing. For example, items shipped in bales are given a less expensive freight rate by shippers than the same items shipped in individual sale units, to account for the lower total number of items that can fit in a vehicle payload.

Handling

Challenges involved in handling the cargo during the loading and unloading of vehicles affect pricing. Some questions to consider include

- Is special equipment required to move the cargo?
- Are physical dangers involved?
- Have the materials been properly grouped and packaged for ease of handling and storage all along the logistics supply chain?

How the freight is packaged and grouped before and during loading makes a considerable difference in ease of handling at all subsequent stages of the process. Consequently, packaging has significant cost implications. Different supply chain partners, with different concerns, will be affected by packaging and

grouping—the shipper, the carrier, and the recipient (or recipients) who warehouse, distribute, and, finally, unpack the goods for display and sale. At the end of the forward logistics supply chain, someone has to dispose of the packing materials—the pallets, boxes, wrappings, etc.—by reusing, returning, or recycling them.

Consider, for example, automobiles and motorcycles. From the perspective of easy handling, both the shipper and the consignee—such as a dealership—might be happiest to ship assembled vehicles that could be driven up and down ramps into and out of the shipping vehicle. To improve logistics, however, both foreign and domestic manufacturers now often ship parts and assemble the vehicles in plants near markets. Handling is far more efficient for containers of parts. (This can also enable postponement, since parts can be assembled into different models.)

Packaging also needs to take into account marketing needs without hindering logistics priorities of safe and efficient handling during shipping. The most productive, cost-effective packaging meets the following criteria:

- Efficiency of handling during loading, unloading, and storage
- Protection against damage to the cargo
- Communication (that is, packages should be labeled for ease of identification, tracking, customs, and handling)
- Low environmental impact

Liability

The cost of transport is affected by the need to protect the cargo against various dangers. If carriers are required to insure the cargo or cover any claims on their own, they will pass along the costs. Examples of major liability concerns follow:

- **Susceptibility to damage.** Televisions, for instance, are more of a liability issue than paper products.
- **Perishability.** Fresh fish pose a series of problems. Any delays in shipment or refrigeration failures can be ruinous.
- **Value per pound.** Shipping precious metals or antiques exposes the carrier to liability risk.
- **Susceptibility to theft.** Some goods are more valuable than others to thieves. The likelihood of theft is also increased if the cargo will sit for part of the trip or will change hands frequently. Shipments awaiting customs clearance are susceptible.

Conflicts of Interest

Each party in the supply chain has different needs and goals. Suppliers typically want flexible delivery times, large yet stable volume demands, and consistent material mixes. Manufacturing organizations strive for high production output and low production costs. Logistics and warehousing management seek to minimize transportation costs by using quantity discounts and minimizing inventory levels.

Finance wants to minimize order changes, inventory, and product variety. Retailers need short order lead times and quick delivery. Customers demand variety and low prices.

In short, conflicts of interest seem to be built into the supply chain. Because of the advances in technology, supply chain managers now have the information resources to make strategic decisions for optimal impact throughout the supply chain. While tradeoffs were more one-sided in the past, it may now be possible to come close to meeting the goals of all participants in the supply chain. Here are some key examples.

- **Lot size versus inventory.** Manufacturers often prefer large lot sizes because they improve process control and reduce per-unit setup costs. However, this creates high inventory and storage expenses.

Advanced manufacturing processes seek to reduce inventories and improve system responsiveness. These processes make it possible to meet the needs of retailers and customers by enabling the manufacturer to respond more quickly to customer demand while retaining process control cost efficiencies.

Information technology can reduce the lead times required by manufacturers to react to the needs of supply chain partners. Technology also allows retailers and distributors to track the status of inventory throughout the process, enabling them to better manage customer expectations. The improved information flow also gives retailers and distributors a better idea of the process flow and the capabilities of manufacturers. The increased confidence level allows retailers and distributors to reduce the inventory held in anticipation of manufacturing problems. The result is better coordination of supply with demand.

- **Inventory versus transportation costs.** When a payload is full, the operating costs are distributed among more items, thereby reducing the per-item delivery cost. When payloads are only partially full, transportation costs are higher, as more deliveries—as well as more gas, salaries, and maintenance—are needed for the same amount of goods. However, when units are delivered by full loads, it takes longer for stock to be depleted, increasing storage costs.

Information technology can minimize this conflict. Distribution control systems combine forecasting and delivery schedule information to allow a materials manager to transport goods from various warehouses together, minimizing deliveries and transportation costs. Retailers may also choose to combine shipments from different manufacturers by break-bulking. Decision support systems enable the supply chain to find a suitable balance between transportation and delivery costs.

- **Lead time versus transportation costs.** Lead time consists of time committed to processing orders, procuring and manufacturing items, and transporting items. While transportation costs are lowest when high quantities are transported together, lead times are reduced when goods are transported

as they are manufactured. So there is a tradeoff between holding items until there is enough build-up to reduce shipping costs and transporting them early to reduce lead time.

Information can be used to reduce the impact of this tradeoff, such as by using forecasting and information systems to anticipate demand or by helping consolidate loads into full shipments.

- **Product variety versus inventory.** Organizations producing a variety of products incur higher manufacturing costs while their manufacturing efficiency decreases. In order to maintain lead times competitive with those of a manufacturer of fewer types of products, smaller amounts must be transported. The more different products a warehouse stores, the less space there is for any single product's inventory. An additional challenge is forecasting the demand for each product since substitutes compete for the same customer. As a result, higher total inventory levels must be maintained to ensure the same level of service. Product variety, therefore, increases both transportation and warehousing costs.

One solution is delayed differentiation, which involves shipping generic products as far out as possible, allowing the variations or customization to be added later. An example would be from a clothing manufacturer whose main challenge is to predict which styles will have the most demand, since production begins months before the selling season. A shipment of blue jeans can have specific pant lengths be quickly finished at a distribution center before shipment. Delayed differentiation aggregates customer demand across all products. This produces a more accurate demand forecast with less variability, allowing reduced safety stocks and better matching of supply with demand.

Forecasting and Planning

With an understanding of the constraints on transportation and the tradeoffs that are needed for the organization's products, supply chain managers can forecast their transportation capacity requirements and thus develop plans for purchasing the right size and type of fleet or contracting with the right type of carrier and transportation mode. As with all capacity planning, the goal is to have sufficient capacity while avoiding the costs of excess capacity. Getting capacity just right moves the organization away from the reactive and toward the proactive—in other words, from an emergency mentality to a graceful flow of logistics.

The main problem with traditional transportation forecasting is that it uses actual orders rather than demand forecasts, so the time available for planning is very short. Historical averages can be used, but these fail to account for critical forward-looking information such as an upcoming product promotion.

Emerging transportation capacity forecasting tools, which may be part of a transportation management system, improve upon this system by linking to and incorporating the following types of information:

- Customer demand information from the organization's demand forecasting process

- Marketing information so planned promotions can be reflected as an increase in transportation capacity requirements
- Manufacturing and product strategies and decisions
- Required carrier mode, type, protection class, and other transportation details related to specific product characteristics

A good transportation forecast is broken down by transportation lanes such as various sea shipping lanes as well as by transportation mode.

Benefits of Transportation Capacity Forecasting and Planning

The benefits of integrating information from other parts of the supply chain into transportation forecasting include the following:

- The spot market for transportation is rarely used.
- Several weeks of notice can be given to supply chain managers responsible for carrier procurement.
- Carrier procurement can be detached from order creation. (The carriers will be reserved but given their assignments later.)
- It is easier to arrange for intermodal shipments (e.g., rail to truck), which can lead to significant savings.
- Backhauls can be planned with sufficient time to reduce deadheading (empty vehicle return trips).
- Sufficient transportation capacity can allow warehouse staffing to be planned more accurately.
- For owned fleets, transportation staff and equipment will be more accurately planned.
- Transportation becomes not only less expensive but more responsive, because you will have time to raise or lower capacity.
- Arranging things in advance allows for more time for collaboration between transportation providers and supply chain partners on the receiving end of the shipments.

Section B: Distribution Services and Transportation Choices

This section is designed to

- Explain how basic warehouse activities such as picking, packing, and put-away can add value when done efficiently
- Describe other value-added services that can be provided in a distribution network, such as postponement
- Describe various delivery patterns, which are the ways that customers choose to receive their goods (i.e., through various supply chain echelons)
- Understand the impact of changing delivery patterns
- Explain the tradeoffs between various transportation modes so the best mode can be selected for a given requirement
- Describe the value density versus packaging density relationship
- Describe each mode of transport (rail, motor, water, pipeline, air, and intermodal), including its background, capabilities, market conditions, and limitations
- Differentiate classifications of carriers, including common carriers, private carriers, contract carriers, and exempt carriers.

Distribution services are the services that various distribution intermediaries provide. Basic services include things like pick, pack, and put-away, but a wide range of value-added services are now available to be leveraged. Supply chains also need to consider which delivery patterns they will support, a decision that is based strongly on customer demand. These patterns are moving toward more and more e-commerce.

Transportation requires knowing a lot about the various modes of transport so that the best mode can be selected for the product's features and requirements. Each of the various modes is described along with its pros and cons. Once a mode is determined, then a specific carrier needs to be selected, and some general categories of these are presented.

Topic 1: Distribution Services and Delivery Patterns

Distribution services include warehouse activities such as picking and value-added services such as consolidation. Delivery patterns are the methods that customers choose to acquire products, and this could include things like drop shipping or use of distributors and retailers.

Warehouse Activities

The following activities may take place in a warehouse. (Some of these may be considered value-added, such as if they have been streamlined, but inspection during receiving is an example of something not considered value-added.)

- **Receiving** is defined in the *APICS Dictionary*, 16th edition, as

encompassing the physical receipt of material, the inspection of the shipment for conformance with the purchase order (quantity and damage), the identification and delivery to destination, and the preparation of receiving reports.

- **Prepackaging** refers to the situation in which products are received in bulk from a supplier and subsequently packaged in smaller quantities or combined with other products to form kits or assortments.

- **Put-away** , as defined in the *Dictionary*, involves

removing the material from the dock (or other location of receipt), transporting the material to a storage area, placing that material in a staging area and then moving it to a specific location, and recording the movement and identification of the location where the material has been placed.

- **Storing** refers to putting items under warehouse control (in a storage point upstream of a workstation).

- **Order picking** is defined in the *Dictionary* as

selecting or “picking” the required quantity of specific products for movement to a packaging area (usually in response to one or more shipping orders) and documenting that the material was moved from one location to shipping

It is also known as order selection.

- **Moving** is “the physical transportation of inventory from one location to another within a facility” (*Dictionary*).

- **Shipping** is defined in the *Dictionary* as

the function that performs tasks for the outgoing shipment of parts, components, and products. It includes packaging, marking, weighing, and loading for shipment.

Packaging and packing and marking are related to this definition.

Packaging is

the materials surrounding an item to protect it from damage during transportation; the type of packaging influences the danger of such damage.

Packing and marking includes all

the activities of packing for safe shipping and unitizing one or more items of an order, placing them into an appropriate container, and marking and labeling the container with the customer shipping destination data as well as other information that may be required.

Warehouse Functions and Value-Added Services

Warehouses today offer economic and service benefits that go well beyond simple housing of raw materials, parts, or finished goods. On the economic side, warehouse operations can reduce the overall cost of logistics by their efficiency and effectiveness in receiving goods and packaging or arranging them for reshipping. At the same time, warehouse operations may improve customer service by cutting lead times, packaging goods for easy handling and identification, and arranging shipments to fit the recipient's unique requirements. Warehouses are places of constant activity as workers and machines unload, store, retrieve, repack, arrange, and reload inventory that they may also assemble-to-order.

Functions that add supply chain economic or service value include

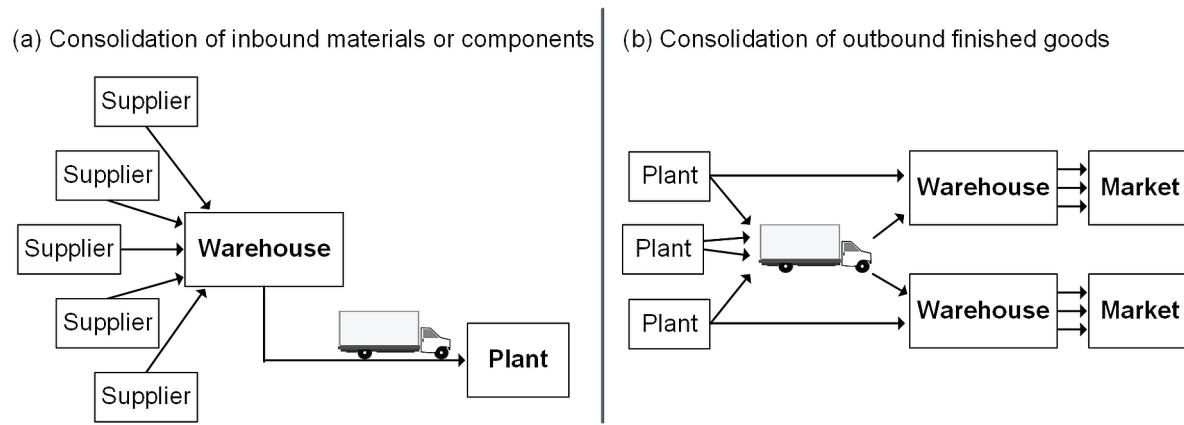
- Consolidation of materials for shipping
- Break-bulk and cross-dock facilities
- Postponement
- Stockpiling seasonal inventory
- Spot-stocking advance shipments
- Assortment (similar to spot-stocking)
- Mixing (similar to break-bulk).

Consolidation

Consolidation occurs when a warehouse receives materials from more than one plant and combines them into outgoing containerload (CL) or truckload (TL) shipments (shipments that fill up the entire cargo bay) to a specific customer. It reduces logistics costs through economies of scale, because the consolidated shipments qualify for CL and TL discounts. It also reduces congestion at the customer's dock. However, the warehouse may have to add sorting and perhaps assembly capability. There will be training and possibly hiring costs—plus costs for remodeling if more space is required.

Exhibit 5-11 provides a graphic view of consolidation as it functions for inbound shipments (a) and outbound traffic (b).

Exhibit 5-11 : Consolidation



Break-Bulk and Cross-Dock Facilities

Operations at break-bulk and cross-dock facilities are similar except for the way orders come into the warehouse.

The *APICS Dictionary*, 16th edition, defines **break-bulk** as

- (1) Dividing truckloads, railcars, or containers of homogeneous items into smaller, more appropriate quantities for use. (2) A distribution center that specializes in break-bulk activities.

A break-bulk facility can build new truckloads of assortments of goods all destined for a given location.

The *Dictionary* defines **cross-docking** as

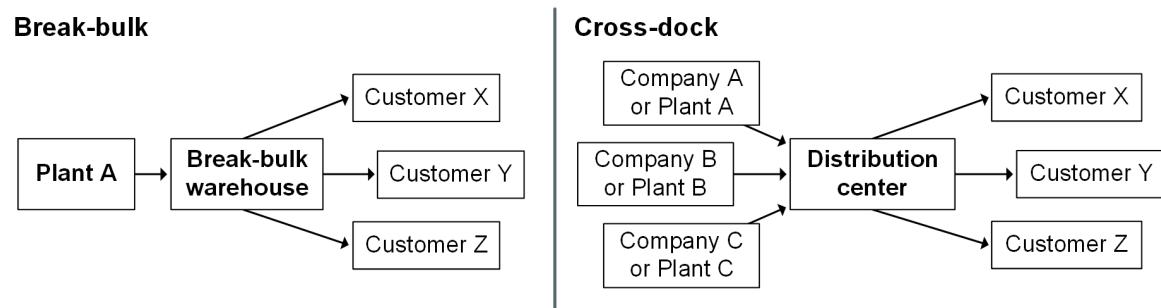
the concept of packing products on the incoming shipments so they can be easily sorted at intermediate warehouses or for outgoing shipments based on final destination. The items are carried from the incoming vehicle docking point to the outgoing vehicle docking point without being stored in inventory at the warehouse. Cross-docking reduces inventory investment and storage space requirements.

An example of a break-bulk operation is food retailers. They receive full truckloads of combined customer orders from manufacturers. The break-bulk warehouse sorts or splits individual orders and ships them to the retail customers. Because the long distance transportation movement is a large shipment, transport costs are lower and there is less difficulty in tracking. For example, Walmart's customers are its retail stores. If a supplier sends a bulk order of camping cots, the right number gets put in each truck bound for a different retail location as part of an assortment of goods for that store. That assortment may itself constitute a TL.

Break-bulk and cross-dock facilities provide the benefits of consolidated, full-trailer shipment into the facility, out of the facility, or both. They also reduce handling costs because put-away and picking are avoided.

Exhibit 5-12 depicts break-bulk and cross-dock operations.

Exhibit 5-1 2: Break-Bulk and Cross-Dock Operations



Postponement

Goods enter a postponement center in component form for later final assembly. The goal is to enable both production efficiency and responsiveness. (Typically these are tradeoffs.) Final configuration of the finished product is postponed until an order arrives, allowing parts to be assembled to fit the specific order. For example, since Europe uses four different plugs for electricity, generic printers arrive at a European distribution center and, once orders are received, workers add the correct cable along with written materials and labels in the correct language.

Components can generally be stored more efficiently than finished products. Also, forecasting is easier for the family of products that can be assembled from the parts than it would be for the separate end products. If the warehouse contained finished products, it would require safety stock for each item. There will, however, be costs for training or hiring staff with final production skills. Processing at the warehouse may be more expensive than finishing the product at the plant would have been.

Anticipation (Stockpiling Inventories)

Anticipation inventory, such as seasonal clothing, lawn furniture, or agricultural products, is stored at the warehouse in anticipation of future demand.

Stockpiling enables more efficient use of production capacity by reducing the need to increase capacity for the seasonal demand. In the case of agricultural products, it's the "production" that is seasonal rather than the demand. So the product is stored in larger amounts as it becomes available and then distributed as demand comes in. A disadvantage of stockpiling is that more warehouse capacity is required than would be necessary for a Just-in-Time delivery system.

Spot-Stocking

Spot-stocking is focused on strategic markets. It is allocating inventory in advance of heavy demand in strategic markets rather than the inventory being stocked year-round or shipped as it's being produced.

Advance shipments from a plant are sent to key markets to be sure they are close to customers in season. Agricultural products are spot-stocked during the harvest season to put them close to key markets and then are warehoused centrally for the rest of the year.

Customers and producers benefit from spot-stocking of items in key markets to minimize the chance of a shortage during peak demand.

Assortment Warehousing

Assortment warehousing is a technique that stores the goods close to the customer to ensure short customer lead times.

Assortment benefits the customer by reducing the number of suppliers it has to deal with to acquire the assorted goods. It also reduces transport costs by allowing larger shipment quantities.

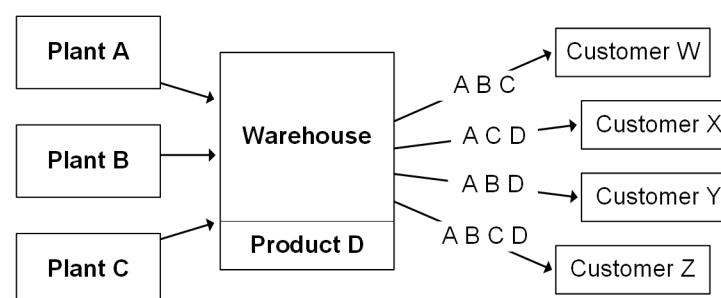
Mixing

Mixing resembles break-bulk but involves shipments from more than one manufacturer. In a typical mixing setup, the warehouse receives full-vehicle shipments of different products from manufacturers in diverse locations, with each shipment receiving the full-load discount. (A full-load discount is a quantity rate discount offered for a CL or TL, e.g., usually set at 10,000 pounds (4,536 kilograms) for a truckload. A full load may occur when the cubic volume is full or when the weight limit is reached, whichever comes first.)

At the warehouse, shipments are broken down and assembled into the product mix desired by each customer or market. A particular outgoing shipment may contain goods that just arrived (as in break-bulk or cross-dock facilities), or it may combine the current shipment with products from storage.

Mixing avoids multiple smaller shipments from each manufacturer along with the required separate handling, storage, and display. It also makes more efficient use of storage space in the warehouse. Exhibit 5-13 illustrates the process of mixing shipments.

Exhibit 5-13: Mixing



Delivery Patterns and Fulfillment Channels

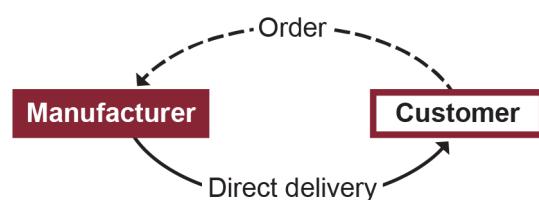
Delivery patterns, also called shipping patterns, refer to trends in how customers are buying goods and getting them to their place of business or home. Organizations can leverage some general order fulfillment channels described here. Note that the direct-to-consumer model has radically shifted delivery patterns for many organizations and logistics specialists.

The type of distribution network a supply chain adopts will have a huge impact on facility numbers and location decisions. Distribution channel strategy is determined during strategy formation; however, some tactical selections can be determined during network design.

There are several types of fulfillment channels, each having different levels of service outputs (break-bulking, spatial convenience, waiting and delivery time, variety and assortment) and channel design intensity (i.e., the complexity of the network and number of options or locations for customers).

- **Manufacturer storage with direct delivery.** Exhibit 5-14 shows the type of network in which the manufacturer uses direct delivery. The manufacturer takes a customer order through any number of sales channels (direct, catalog, website, etc.) and directly ships the goods to the customer, with no intermediaries other than perhaps a carrier (unless the manufacturer owns a fleet).

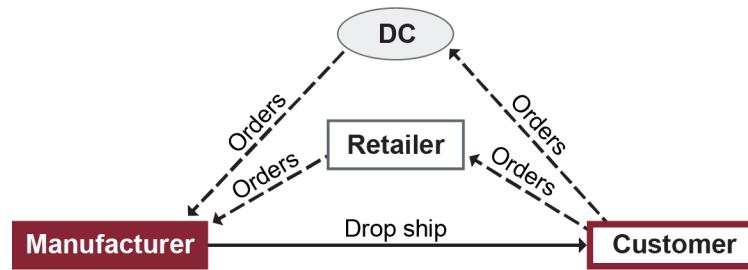
Exhibit 5-14: Manufacturer Storage with Direct Delivery



This model is common in business-to-business (B2B) settings but can also be used for business-to-consumer (B2C) sales. An example of its appropriate use in the B2B setting is for perishable goods that need to be on retail shelves as quickly as possible to maximize their useful lives. This could also be a supplier that produces large lot-size quantities. The primary benefit to the manufacturer is a direct relationship with its customers so it can directly interact with and market to them in the future. For B2C, it is used primarily for low variety, make-to-order goods that the customer is willing to wait for, since lead times can be long. Since there is only one echelon, the manufacturer has complete control over inventory and has low carrying costs. Shipments are typically in truckload (TL) or containerload (CL), but logistics costs can be high and intermediaries may be needed to reduce these costs.

- **Manufacturer storage with drop ship.** Exhibit 5-15 shows the drop ship model, in which a distributor or retailer (or direct sales or online merchant) takes orders from customers and the customers receive the goods directly from the manufacturer. The distributor or retailer may have a floor model but no inventory. This model would probably use transload and cross-dock facilities. It would be best for high-value, sporadic demand items; these might be bulky items like refrigerators or be make-to-order, customized, or postponed items that can be finished when the order arrives. Shipments may be in small lots, and thus transportation costs can be higher and lead times longer, but the manufacturer can control delivery service reliability.

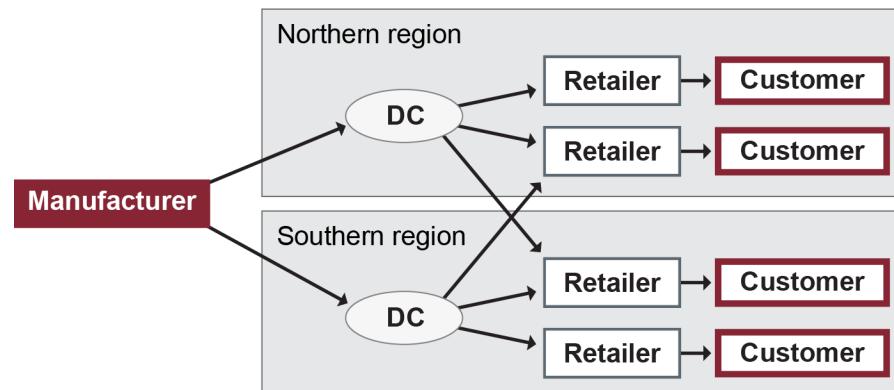
Exhibit 5-1 5: Manufacturer Storage with Drop Ship



In this model, the manufacturer doesn't have direct contact with the customer, so customer knowledge is less than with the prior model. At the same time, the manufacturer does not need to maintain a sales force or other functions like credit approval.

- **Manufacturer to distribution center to retailer.** Exhibit 5-16 shows the traditional supply chain, a manufacturer working with regional distributors. The distributors supply retail locations (in which customers buy goods) and handle the local delivery portion with their own vehicles. There can be one or more distribution centers (DCs) in this model, and a wholesaler echelon could also be added. The multiple echelons all need inventory, so this model is inventory-intensive. It is best for mass-produced, inexpensive goods with high competition. It produces strong product availability and high levels of customer service.

Exhibit 5-1 6: Manufacturer to Distribution Center to Retailer

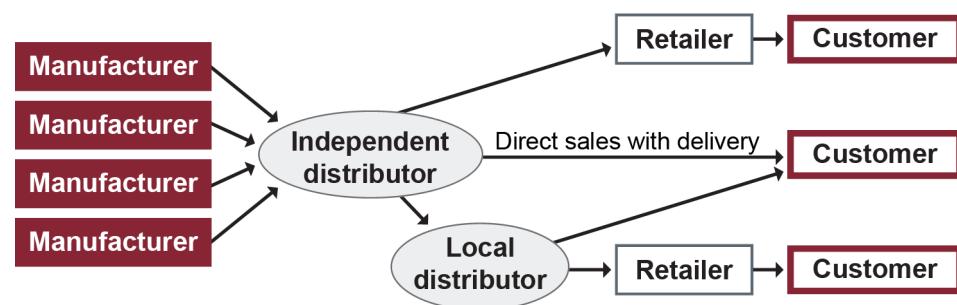


The channel intermediaries and retailers are generally independent, but some DCs could be owned if this can be done for less than 3PLs can do it after all facility and inventory carrying costs are accounted for. Distributors provide break-bulk activities and minimize inventory by using fewer, more centralized warehouses. The retailers take over all customer-facing functions and their associated costs. The organization may need to negotiate for preferred shelf space and may not have much control over promotions or access to customer information without forging information-sharing partnerships.

- **Independent distributor with omni-channel network.** Exhibit 5-17 shows a network where an independent distributor is the channel master, buying goods from multiple manufacturers (or other distributors) in bulk and aggregating them for a one-stop shop for retailers, local distributors, wholesalers, or direct customers. Having an omni-channel network means that the independent

distributor maintains multiple customer contact methods, such as a sales force, a call center, a website/app (both mobile- and computer-accessible), and a series of wholesale and/or retail locations. Regardless of the method of customer contact, the customer experience should be seamless and consistent. Manufacturers join these independent distributors to gain another sales channel and access to a larger market. Retailers and distributors can often buy assortments in TL or CL shipments, and they gain economies of scale in pricing so they can sell at a competitive price for a profit.

Exhibit 5-1 7: Independent Distributor with Omni-Channel Network



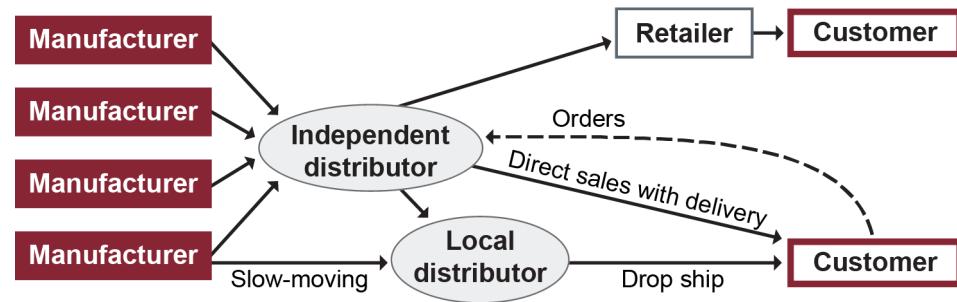
The distributor needs to develop these local distributor and retail partnerships carefully to ensure that they build and maintain a large enough customer base. This will be accomplished, in part, by holding high inventory levels of fast-moving items. These organizations might negotiate exclusive contracts for markets, but competitors might do the same, and therefore they may not have full market access.

These distributors need a thorough and efficient transportation network of owned or contracted carriers to provide high customer service while controlling relatively high transportation costs. They can provide value-added services like aggregate inventory storage and bulk shipping of assortments. If they want customer information or information on promotions, they will need to form information-sharing partnerships.

They will also have a large number of suppliers they need to coordinate and partner with, when possible, to control prices, lead times, quality, and availability. They might even negotiate cost-sharing contracts.

- **Independent aggregator with e-business network.** The model shown in Exhibit 5-18 is very similar to the previous model, but it depends more heavily on direct marketing to individuals through its own heavily branded website, which may sell all manner of goods. Alibaba and Amazon are examples. Direct shipment of goods to customers through parcel services is very common, but these organizations may also own a fleet or sell or ship through local distributors (which they may own). They move slow-moving goods directly from manufacturers through local distributors rather than carry this inventory themselves.

Exhibit 5-18: Independent Aggregator with e-Business Network



Other independent distributors will sell specialty goods to B2B or B2C niche markets using web sales. The independent distributor gains direct access to customers and can manage this customer information and customize the customer's web interactions. They often use loyalty programs that offer free shipping for an annual membership fee. To keep this customer loyalty, they need very high levels of customer service.

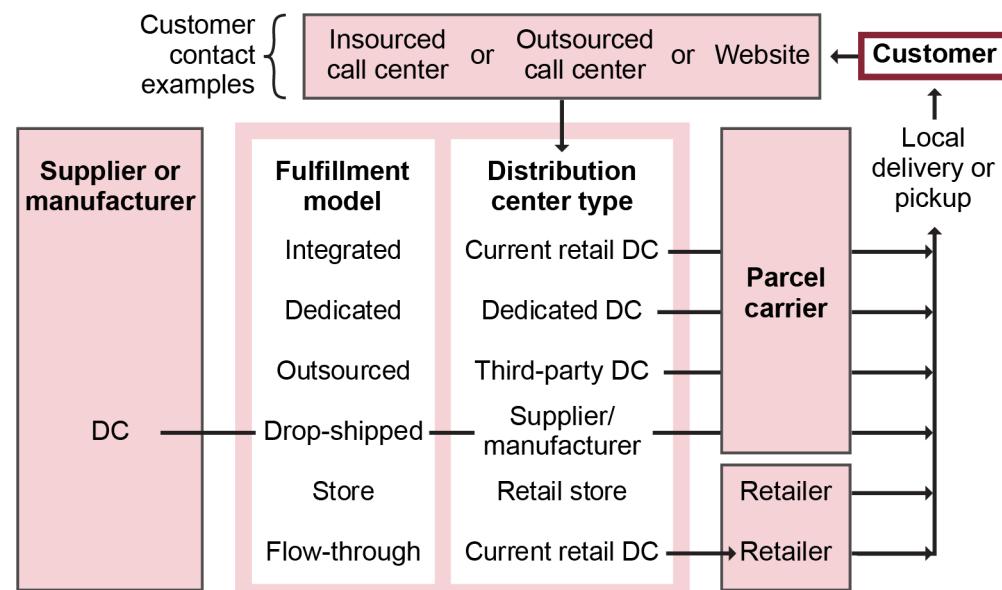
The exhibit also shows that some independent distributors in this model still sell goods to local distributors, retailers, or even to other e-businesses. This allows the organization to offer omni-channel fulfillment such as buy online/pick up in store. (Usually the retailer would also be the distributor in this case.) The 2020 pandemic vastly increased the number of retailers who adopted some form of this model, selling both online and in retail stores.

Each type of channel, by virtue of how it's structured, will perform at different levels on the key dimensions that impact customers' satisfaction levels, including customer service level, product assortment, product availability, delivery time, channel complexity, inventory cost, transportation costs, and channel facilities. There are always tradeoffs to be made between channel types and the exact service attributes that make customers happy. The ability of customers to track and trace on their own is a clear example of an order qualifier these days. The convenience and variety of the direct-to-consumer model has seen a trend of delivery patterns shifting in this direction, so this model and its implications for logistics are discussed next.

Direct-to-Consumer Model

Exhibit 5-19 summarizes some of the order fulfillment channels that relate to the direct-to-consumer model but also shows some other permutations, because a variety of tactics can be used to accomplish direct-to-consumer delivery patterns. Other order fulfillment channels can likewise be accomplished in more than one way.

Exhibit 5-19: Direct-to-Consumer Permutations



As online shopping continues to make strong inroads into more and more areas that were traditionally retail purchases, organizations are facing strong changes in delivery patterns. In 2012, U.S. retail e-commerce sales were around 5 percent of total quarterly retail sales. This rate steadily increased each year, to about 10 percent by the beginning of 2020, but then spiked during the pandemic to almost 15 percent. As of the first quarter of 2021, the rate had fallen to 13.6 percent, according to the Census Bureau of the U.S. Department of Commerce. This represents almost \$200 billion of commerce for that quarter.

The retail delivery pattern involves shipments of goods or components from multiple suppliers, consolidation at distribution centers, and shipment from there to retailers. This pattern emphasizes multimodal transportation for efficiency and economies of scale. The direct-to-consumer delivery pattern, on the other hand, involves the same first steps of getting goods and consolidating them at distribution centers, but from there it becomes a series of small package deliveries directly to consumers. In some cases, the direct-to-consumer delivery pattern involves forwarding individual packages directly from suppliers to customers with no intermediaries.

Even the direct-to-consumer delivery pattern has been shifting. While there has been a movement toward next-day delivery, for consumers who are working during the day, this has resulted in packages left outside doors or missed deliveries. One innovative solution developed by Wehkamp, a large Dutch mail-order company, was to ask “When do you want your delivery?” to help make deliveries when customers are actually home. They even developed same-day delivery, in part by reducing their time from customer order to ready to ship to 30 minutes. Other European services have started making deliveries to small village grocery stores or gas stations for customer pickup.

The magnitude of the shift in delivery patterns from large shipments to retailers to individual shipments to consumers is immense for the logistics industry. Third-party logistics providers who specialize in truckload and less-than-truckload (LTL) delivery networks are under pressure from the reduction in demand for their services. Mergers and acquisitions are occurring among traditional 3PLs as they seek to scale upward to be large enough to start offering services other than just TL and LTL. If this trend

continues, there will be far fewer logistics providers in the market, and those that survive will need to be able to provide their traditional functions plus functions that are currently provided by the likes of UPS, FedEx, and USPS. For example, according to a Bloomberg article by Black and Day, to improve the reliability of their same-day and two-day deliveries, Amazon has been investing in a private fleet of airplanes, and in 2019 it abandoned its contract with FedEx for air cargo. Per an article by Katie Canales, Amazon was also working to double the size of its private delivery fleet in 2021 by providing business start-up assistance to small trucking companies in exchange for exclusively working with Amazon. Part of its strategy to achieve same-day delivery is to open distribution centers in these urban areas rather than locating them in the countryside, as is the case with many retailers, including Walmart.

Topic 2: Transportation Mode and Carrier Selection

Transportation modes include rail, motor, water, pipeline, air, and intermodal combinations. Some selection criteria are provided up front, followed by a discussion of each mode. Carriers are the individual organizations providing transportation services. Various types of carriers are discussed.

Transportation Mode Selection Criteria

When it comes to the method of transporting goods, a logistics manager first decides which mode of transportation best fits with the overall logistics needs for the product and the marketing channel. Modes of transportation include rail, motor, water, pipeline, air, and intermodal combinations.

Exhibit 5-20 shows the weight of freight shipments broken down by mode in millions of tons for 2017 and the projected usage for 2028 in the United States.

*Exhibit 5-20: Weight of Freight
Shipments by Mode in U.S. (millions of
tons)*

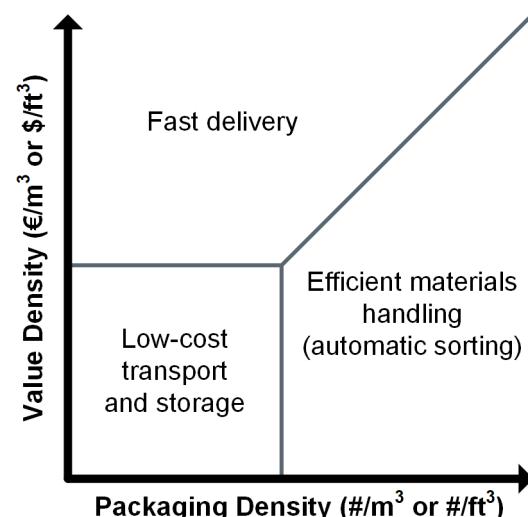
Shipment Mode	2017 Totals	2028 Projected Totals
Truck	10,731	13,916
Rail	1,731	1,842
Rail intermodal	200	286
Air	14	18
Water	930	1,036
Pipeline	1,567	3,625
Total	15,172	20,730

Source: Adapted from Bowersox et. al., *Supply Chain Logistics Management*, 5th edition, which cites the *Freight Transportation Forecast, 2017-2028*, American Trucking Association Inc., 2017.

A given mode will not necessarily be competitive for a given set of logistics requirements. Each mode has its own inherent advantages and disadvantages. The best mode to select will depend upon the product type, size, weight, value, delivery speed, and lane volume needed to meet customer requirements. Lane volume is the volume of traffic in a given shipping lane (an origin-destination pairing) and is a factor in both land and water carrier pricing. The higher the volume in the lane, the lower the price for that transportation mode (and therefore the transportation mode needs to be highly efficient to compete). This is because low-volume lanes may not have available materials for backhaul, so carriers add fees due to the greater potential for empty vehicle return trips (deadheading) or stranded empty containers.

Exhibit 5-21 shows that a reliable method to find the best mode of transportation for shipping a specific product type is to compare the product's value density (the value of units being transported per cubic foot or meter) versus its packaging density (the amount that can be packed per cubic foot or meter).

Exhibit 5-21 : Value Density versus Packaging Density



To help weigh the importance of shipping options with different costs and delivery speeds, keep this in mind: Items with a higher value density usually merit shipping by a faster method, and items with lower value density can usually be sent by a slower method and then held in inventory. On the other hand, the more units that are handled per cubic foot or cubic meter, the more the need for automated materials handling.

Let's look at an example.

Postal offices or organizations do not own the letters they ship, so for them the value density is about zero. They collect letters from letterboxes and then bring them to a hub. Once there, the letters need to be sorted and sent forward to the next hub. At this second hub, the letters are re-sorted according to street address. The packaging density is very high (more than 10,000 letters per cubic meter), so the focus is on automatic materials handling.

Bricks are an example of a product with low value density and low packaging density. The value per brick is very low, and bricks are sent to customers on pallets, so the packaging density is also low. The

preferred way to treat this kind of low value/low density goods is to load the pallets at the manufacturing plant and directly transport them to the customer site using a low-cost transportation mode.

When looking at manufacturers of copy machines and digital cameras, you will discover that they use different modes of transportation. Copy machines have a low value density and are shipped in containers from the Far East to the U.S. and Europe. Cameras have a high value density, so the emphasis is more on how to recover the invested money quickly. These products will be transported by airplane.

Rail Transport

Rail transport is very fuel-efficient. Based on data provided by the Association of American Railroads (AAR), in 2021 U.S. railroads averaged 480 ton-miles to the gallon (a railway fuel efficiency measurement that means an average train moved a ton of freight across 480 miles on a gallon of fuel), which makes it three to four times more fuel-efficient than truck transport. Transport by rail rather than truck reduces greenhouse gas emissions by 75 percent. Rail transport has increased its transportation volume by almost double from 1980 levels (2,222 tons per railcar in 1980; 3,817 in 2020) while reducing its overall fuel consumption by 104 percent from 1980 levels. (Fuel efficiency was only 235 ton-miles per gallon in 1980.)

Background

At one point, railroad transport accounted for more than half of the intercity freight in the United States. While deregulation stabilized rail's percentage share of the intercity transport market, it resulted in an ongoing decline in the number of large carriers, miles of track, and total revenues as rail carriers abandoned unprofitable lines and cut rates to be competitive. The U.S. trucking industry was the major beneficiary of the decline in rail.

Rail transport between countries of the European Union has never been especially efficient because of national differences in gauge widths and signaling systems and other differences in infrastructure and organization as well as politics. Moreover, the reliance on rail for commercial transport entered into serious decline in the latter part of the 20th century under competitive pressures from other modes of carriage. In 1995, rail hauled 20.2 percent of freight in the EU, but this declined over the years and in 2019 was at 17.6 percent. Over the same period, road transport increased its share of freight transport from 67.4 percent to 76.3 percent (as noted in the European Commission's "EU Transport in Figures Statistical Pocketbook 2012" and updated with information from Eurostat).

On the other hand, rail transportation has grown in importance in the national and international movement of goods in Asia. China has its New Silk Road initiative that seeks to finance rail and other logistics infrastructure projects in multiple countries (but with strings attached). The following are reasons often cited for the increase of rail's importance in Asia:

- Twelve of the 30 landlocked countries of the world are located on the Asian continent, with the nearest ports often several thousands of kilometers/miles away.
- The distances linking the origins and destinations (both domestically and internationally) justify the economics of rail transport.
- There is a reliance on ports to connect national economies to the world's markets, especially in the context of growing containerization and intermodal transport.
- Several Asian countries are major exporters of mineral resources, and rail transport is crucial to their logistics.
- A steadily increasing volume of goods is being exchanged globally.
- Rail is recognized as environmentally friendly and safe.

Beyond Asia, rail transport is a crucial aspect of many other country and regional transport networks. Growing international trade, the establishment of free trade areas, and requirements for increased efficiency and improved quality of transport services are all factors that should sustain and grow rail transport for future decades in locales such as Australia, North Africa, the Middle East, and numerous other areas.

Capabilities

What railroads do especially well is to carry heavy loads of low-value goods over long distances at relatively low rates. The rough ride over steel rails and the jarring impact of coupling tends to cause more damage to cargo than occurs with other modes of transportation (about 3 percent of tonnage)—hence, in part, the focus on low-value, durable freight. Also, the relatively low rate structure—about one-tenth the cost per ton-mile of truck transport—makes rail transport attractive for low-value freight. As the value of the cargo declines, the cost of transportation consumes a greater portion of the selling price.

Rail transport offers a clear advantage in carrying very heavy loads when compared to motor carriers and airplanes. Compared to water transport, which is also well adapted to heavy loads, rail carriers have the edge in accessibility to diverse destinations and points of origin. Trains have an advantage over other modes of travel in bad weather conditions, which disrupt their travel times very little. They also offer the logistics manager considerable safety, although in exchange for safety the logistics manager must budget more for expensive packaging.

Trains have the capability to carry virtually any product or material except very bulky items—the need to cross bridges and pass through tunnels restricts the size of the items carried—but in recent years they have narrowed their focus to concentrate on raw materials mined or harvested far from waterways. They have also broadened their appeal by developing specialized equipment, such as refrigerated cars, cushioned cars for appliances, and double-stacked containers. Unit trains carrying one product, such as grain or coal, are able to speed up delivery times by avoiding switching yards and traveling directly to one destination.

In 2020, intermodal transport made up 25 percent of the revenue for major U.S. railroads, the largest single component. Half of this was for imports and exports. Much of the rest of the U.S. rail business comes from carrying coal, with smaller slices allotted to chemicals and other raw materials or commodities.

Market Conditions

The transportation manager who is considering available options for U.S. rail transport will find few rail carriers available. Because of high fixed costs for equipment, buildings, and tracks, railroads tend to be very large, heavily capitalized businesses. If high fixed costs are the bad news for rail economics, low variable costs are the good news. Since deregulation, U.S. railroads have lowered their variable costs even more by renegotiating labor agreements. Use of computers and technologies such as anti-idling devices in railyards has also increased the efficiency of train movement, lowering expenses for fuel and labor.

When they were more tightly regulated, U.S. railroads were more numerous. Since deregulation, however, smaller lines have dropped out of business or consolidated into larger companies. About 560 companies have survived, but only a small number—big names such as Union Pacific and Burlington Northern—account for the majority of revenue.

There is little room for expansion in the industry in most countries because of the overwhelming expense of laying new track and the difficulty of locating available land for right of way. The exception to this rule is China and elsewhere in Asia, and rail lines there are expanding.

To compensate for limited ability to expand their service to new locations, railroads have heavily entered into intermodal transport of goods. In combination with trucks, ships, or planes, trains can deliver goods to domestic and overseas locations. Not only is trucking freight rail's biggest competitor, it's also its biggest customer. Some transportation experts say that truckers are losing their edge because of highway congestion, higher fuel costs, driver shortages, and pending safety regulations. Meantime, railroads have made a huge bet on intermodal service, spending hundreds of millions of dollars on new facilities and upgraded tracks to handle the increasing traffic volume.

Issues/Challenges

Though rail lines reach more destinations than are available to waterborne carriers, their access to multiple destinations pales in comparison to the reach of highways. There is no flexibility in railroad right of way. Both shipper and recipient must have facilities near the tracks; otherwise they will have to arrange with another type of carrier to get their goods to or from the terminal. This makes rail virtually useless for direct delivery to a retail location.

Railroad transport is relatively slow. This can result from the necessity of stopping at numerous locations, from the slow procedures required to decouple and recouple cars in a switching yard, and

from practical restrictions on speed related to current infrastructure.

In the EU, the problems with speed have been especially great because of the different standards among nations. In addition to the generic constraints applying to all railroads, the EU's rail carriers are hampered by the need to change crews and locomotives at border crossings and by the requirement to give priority to passenger services. However, this last limitation has received EU regulatory attention. The European Rail Network for Competitive Freight (Regulation EU 913/2010) came into force in 2010 and requires better balance between freight and passenger service. In addition, the ERTMS (European Rail Traffic Management System) is a digital command and control system that has replaced national systems with a single European system that has standards for technical interoperability. It includes voice communication between train drivers and signallers and also helps automatically regulate train safety. This change sped up trains and increased rail infrastructure capacity.

As mentioned earlier, rail transport tends to cause more damage to fragile products than other modes of transport, and consequently it requires special care to be taken in packaging fragile products.

Motor Carriers

As rail transport has dwindled, trucking has expanded. Motor carriers haul produce, raw materials, parts, cars, stage sets, hazardous materials, fish, flowers, and farm animals through Europe, Asia, Africa, Australia, and the Americas. There are approximately four million miles of highway in the United States alone. From the smallest pickup truck to the longest semi with two or three trailers hitched to its cab, motor carriers have become absolutely essential to the world's supply chains.

Capabilities

The market for truck transport is the relatively small shipment of high-value items traveling a short distance. Accessibility is the strong suit of the motor carrier. There are virtually no locations that are off limits for trucks. They don't require ports, vast switching yards, or large terminals. All trucks need is a road to the shipper's and recipient's docks or door.

Assisted by the expansion of the road network, motor carriers in the United States have moved into parts of the market previously served by the railroads. Most freight arrives at retail stores via truck. Light and medium manufacturers also rely on trucking. When cargo travels by other modes, trucks often carry the freight to and from the port or rail yard.

Motor carriers also offer speedier delivery than rail or water transport. Barges, of course, are slow. Trains generally have to stop at switching yards to add or remove cars. Trucks can be more direct.

Market Conditions

Motor carriers benefit from relatively low fixed costs, associated with the vehicles themselves and terminal facilities. Unlike trains, trucks ride on a surface built and maintained by taxpayers. The

American Trucking Associations' truck tonnage index (an index set relative to 2015 tonnage, with that year set to 100) showed a significant dip in tonnage in the beginning of 2020 from 110 to less than 105. By January 2021, this rate was still 2.1% below the January 2020 rate.

Compared with other transport modes, over-the-road hauling provides relative ease of entry. Currently there are about 65,000 general freight trucking companies in the U.S. (The 50 largest companies account for 40 percent of revenue.) Indeed, the industry depends on those (sometimes highly) independent operators who get into the business by purchasing a cab, getting licensed, and offering their services to anyone with a trailer to haul. There are some regulatory limits placed on what a carrier can haul and where it can operate. For example, carriers may be limited to carrying only commodities, only explosives, only building materials, etc.

The trucking industry comprises three segments: truckload (TL), less-than-truckload (LTL), and specialty.

- The TL segment includes many carriers who compete on their rates. A truckload shipment weighs over 15,000 pounds (6,818 kilograms). Because they are fully loaded, trucks in the TL segment generally travel straight from the loading dock to the destination; they don't have to stop and take on more pallets to fill up the trailer.
- In the LTL segment, trucks start with loads of less than 10,000 pounds (4,536 kilograms). Because they have space in the trailer, these trucks often have to stop at intermediate locations to take on more cargo. This, of course, extends their delivery time, uses more fuel, and raises labor costs for the drivers and dockworkers. The higher costs of doing business in this sector have led to more consolidation than in the TL sector.
- Specialty carriers include companies such as United Parcel Service (UPS) and Federal Express.

Issues/Challenges

Although motor carriers benefit from low fixed costs (trucks being much cheaper than ships or planes), they do have to contend with high variable costs. Trucking companies are beset by rising costs for equipment, repairs, and the wages paid to drivers and the laborers who load and unload cargo.

Trucking is more labor-intensive than its competition, so it is impacted more than other modes by rising labor rates. Ongoing truck driver shortages have also contributed to these rate increases. Truckers address these cost challenges by various means, including computerized billing, mechanization at terminals, more efficient scheduling with fewer intermediate stops at terminals, and coordination with other modes of transport.

Since deregulation in the U.S. in 1980, competition for customers has increased in the trucking industry. The result has been lower rates, which are a boon for the logistics manager but have caused many carrier bankruptcies.

For high-value or less-durable goods, trucking may be less hazardous than rail or water transport. Air-filled tires provide a better cushion for cargo than steel wheels on steel rails. Vehicle suspensions, too, are better than they used to be. Riding long hours in the cab can still be hard on the operators.

Water Transport

Water transportation forms an important part of domestic and international trade. It includes several categories: inland waterways, lakes, coastal and intercoastal ocean, and international deep sea. In international shipping, water is the dominant mode, and it is the most inexpensive method of shipping high-bulk, low-value commodities.

Capabilities

Water carriers can handle huge loads, measured either in weight or size. A barge traveling slowly down the Rhine or some other European waterway, for example, might be loaded down with 1,500 metric tons (or tonnes) of high-density cargo (approximately 1,654 U.S. tons), while a fully loaded semi-trailer truck traveling across a bridge above it carries only 7 metric tons (7.7 U.S. tons) and itself weighs approximately 36.3 metric tons (40 U.S. tons). In other words, the barge could hold the weight equivalent of more than 30 fully loaded double-trailer trucks.

Rather like trains, however, barges and other floating carriers find their most fitting use in conveying low-value, high-density cargo over long distances, with loading and unloading accomplished mechanically.

Probably the largest vessels on the water are the oil tankers. They are usually classified by function and size. There are two functional types of the vessels: the crude tankers, which carry unrefined crude oil from the field to refineries, and the product tankers, which carry petrochemicals from refineries to market areas. Sizes range from inland or coastal tankers to gigantic supertankers. Most newer tankers have a double hull, thereby creating extra “safety” space between the storage tanks and the hull. Each very large ship can transport two million barrels of oil. In light of recent serious oil spills in oceans, both the U.S. and the EU have passed laws regarding pollution and double hull requirements that are in effect as of 2015 and 2010 respectively.

The primary value that water transport provides the logistics manager is low cost. At less than a penny charged per ton-mile, shipping by water is even cheaper than using a train. Water carriers also make highly efficient use of fuel. According to their 2012 annual report, the American Waterway Operators found that one gallon of fuel moves one ton of cargo 616 miles by inland barge, 478 miles by train, and only 150 miles by truck. A 2017 study by the U.S. National Waterways Foundation upgraded the inland barge estimate to 647 miles for a ton of cargo on one gallon of fuel. Water transport can also relieve congestion on crowded highways—a significant consideration in the European Union and near urban centers generally. In the Asian region, more than one billion tons of freight moves by inland water

carrier annually on waterways such as the Yangtze and the Ganges, and one-third or more of all cargo travels by water in Bangladesh, the Lao People's Democratic Republic, and Myanmar. In some areas of Asia where there are few roads or railroads, waterways constitute the sole means of connecting remote rural communities to urban centers.

Shipping containers play a big role in domestic and most international water shipments. In fact, it has been said that containerization has transformed global trade in manufactured goods as dramatically as jet planes have changed the way we travel and the internet has changed the way we communicate. The shipper places cargo into a container at its facility. The container is then transported by rail or trucking carriage to a water port for loading onto a containership. After arrival at the port, the container is unloaded and loaded onto a rail or trucking carrier and delivered to the customer.

Containers are typically 8 feet/2.44 meters high by 8 feet/2.44 meters wide and of various lengths, from 20 feet/6.1 meters to 53 feet/16.15 meters. Many new containerships are capable of carrying 18,000 20-foot equivalent units (TEUs) or the equivalent of that many 20-foot containers. (The largest vessel can carry 23,964 TEUs.) But the container is much more than a box and has become increasingly sophisticated. Depending upon the cargo, there are stringent container temperature and storage requirements.

Market Conditions

In the United States, water transport has remained stable, in the range of 15 to 17 percent of total ton-miles, over the past five decades. During that time, however, the portion of that amount due to Great Lakes shipping (shipping on the five freshwater lakes of central North America between the United States and Canada, connecting midwestern U.S. ports with the Atlantic Ocean via the St. Lawrence Seaway) has declined to a fraction of its peak in the 1950s, while river and canal transport have increased to make up the difference. The ships used on the Great Lakes are deep-water vessels, which can harbor only in deep-water ports such as those on the Lakes or the coasts. Canal and river transport relies on flat-bottomed barges with more flexibility as to where they can travel. In the EU, freight moves on such major rivers as the Rhine, the Rhone, the Danube, and their many tributary canals.

According to a 2020 article in PortNews, in 2019, China had 127,000 kilometers of inland waterways (first in the world) upon which were shipped 3.913 billion tonnes of freight that year. Of the 19,000 kilometers of high-level inland waterways planned to be ready by 2020 (i.e., suitable for larger barges), 13,400 miles had reached the desired standard by the end of 2019. The Yangtze, one of its major rivers for transporting coal and steel, had 2.39 billion tonnes of freight that year, also a first-place record. The network is continuing to grow in efficiency and profitability.

The primary products transported on inland waterways include commodities such as cement, chemicals, and some agricultural products. U.S. Great Lakes vessels mostly carry ore, coal, and grain. The bulk of this trade qualifies for exemption from government economic regulation. These exemptions,

combined with low fixed costs (an amount somewhere between rail and road), mean that shippers can afford to transport goods in their own vessels rather than hiring a third-party carrier. Like trucks, and unlike trains, water carriers are relatively affordable. The waterways, like highways, are maintained by the taxpayers.

Despite the worldwide economic downturn in recent years, maritime transport has continued to grow. According to information by Statistica, in 2020, containership capacity was 275 million metric tons of cargo compared to approximately 11 million metric tons in 1980. These and other modes of transport moved 1.83 billion metric tons of cargo in containers in 2017 (one quarter of all cargo by weight and one half of all cargo by value). According to Costamare Inc., containerized cargo trade tripled between 2000 and 2017, which was twice the rate of the growth in GDP. Maritime container volume is also continuing to grow. The area of oil transport has also shown significant growth. Per Statistica, the world's oil tanker fleet's capacity grew by over 77 percent to about 601 million deadweight tonnage from 1980 to 2020, and this reflects about 29 percent of global ocean trade.

Issues/Challenges

There are two obvious drawbacks that might prevent a logistics manager from using water transport: limited accessibility and lack of speed. There are fewer miles of inland waterways than there are roads and railroad tracks, and if the shipper and the recipient have no direct access to a port, they have to use another mode of transportation to get products to and from the carrier.

Once on the water, progress is slow on a barge or in a deep-water vessel. Not only are barges—or the diesel-engine vehicle that tows them—slow-moving, but on natural waterways they must make their way through a series of locks. When rail lines run parallel to a waterway, trains make strong competitors for water carriers for transporting the kinds of heavy, low-value goods carried on barges. The tradeoff is between the greater speed of the train and the far lower rates for water transport.

Barges using major waterways must compete with other important uses, such as passenger transport, fishing, recreation, drinking water, nature conservancy, and energy generation. Discharges from cargo carriers can be a significant source of pollution, along with runoff from mining and agriculture, and pollution is incompatible with the competing uses of rivers for recreation and drinking water. Some of the major waterways in Europe, which pass through many countries with separate and various levels of regulation, have become seriously polluted over the years.

Globalization has increased the need for efficient and reliable international transport routes and networks. Their development requires creating new infrastructure or upgrading existing national and international infrastructures to accommodate the increase in maritime traffic volumes. The use of containers for intermodal logistics can reduce staffing needs, minimize in-transit damage and pilferage, and shorten transit time. But there can be problems at the ports impacting the timeliness of unloading containers from ocean liners. In some countries, the shortage of containers can limit supply chain

capabilities. The increase in import volumes, aging port equipment, shortage of rail capacities, and limited numbers of truck drivers and carriers can lead to delays.

For example, the 2015 U.S. West Coast port strikes created severe backlogs for the trucking and container/tanker shipping industries. With 70 percent of imports from Asia coming through the West Coast, the strike impacted all organizations shipping or awaiting their goods. Ports were gridlocked, and dozens of containerships were queued for miles during the nine-month strike. Some supply chain managers had to resort to expensive air shipment, including Fuji Heavy Industries, which flew parts to its Subaru auto plants, adding approximately US\$59 million per month in transportation costs.

The risk that terrorist organizations could use the mechanisms of international trade and commerce poses additional considerations, including specific concerns that containers could be used to transport dangerous goods or carry out large-scale attacks. The challenge is to advance port and maritime container security while ensuring continued free movement of legitimate trade.

Pipeline Transport

There's a reason pipelines aren't the first mode of transport that comes to mind. Other modes move the entire vehicle; the pipeline instead holds still while the cargo moves. Pipelines move a higher percentage of U.S. freight than water transport, largely because of their special adaptation to conveying crude oil and petroleum products.

Natural gas is also transported in pipelines. Although there are about 305,000 miles of inter- and intrastate pipelines in the U.S., many carrying natural gas are nearing their capacity. Due to the aging infrastructure of some underground pipelines, gas companies are compelled to invest in ongoing maintenance and repair work.

Capabilities

Not only are pipelines unique in being stationary carriers; they generally move their cargo in only one direction—thus eliminating the need to be concerned about backhaul carriage. Also, no packaging is required to move cargo through a pipe. The pipe is the package and also a storage facility.

Pipelines are special, too, in that they are available for continuous use on all days, in all seasons, and at all hours. Unlike air, motor, and rail carriers, they pose no noise problems. They will, however, cease to move cargo during power outages, since the pumps that cause the contents to flow depend upon electricity. Even an information systems failure could stop a pipeline, as the ransomware attack on the Colonial pipeline in 2021 showed. (It caused widespread gas shortages.) Also on the downside, pipelines are expensive to construct and maintain. Since pipelines are fixed in place, they have the highest fixed costs of all modes of cargo transport but the lowest variable costs—a cost structure otherwise similar to that of rail transport. The fixed costs are mainly due to right of way, construction of facilities, and pumping capacity. The costs of operation are very low.

In general, the carrying capacity of pipelines increases relative to pipe diameter. Also, increasing diameter reduces the amount of liquid in contact with the pipe for a slight friction decrease and efficiency gain.

In the past, safety has been one of the major benefits of pipeline transport. They are unaffected by weather conditions and highly unlikely to rupture. Cargo damage and loss are virtually nonexistent. The main natural enemy of the pipeline is seismic activity. The catastrophic Hurricane Katrina that devastated the U.S. city of New Orleans in 2005 closed the port and destroyed much pumping and refining capacity but did not rupture the pipes that run cross-country to the East Coast. The rise of international terrorism, however, creates risk because long pipelines are difficult or perhaps impossible to secure against attack.

Aside from crude oil and petroleum products, pipelines carry manufacturing chemicals, municipal sewage and water, and dry materials such as cement that can be pulverized or flour that can be suspended in liquid. One coal slurry pipeline exists in the United States, and research continues into transporting other materials in suspension or slurry form.

Pipelines are natural monopolies, since constructing parallel pipelines to compete for the same business would be far too costly. In the United States, some pipelines are owned by shippers, but most operate as common carriers.

Issues/Challenges

Only liquids or liquefiable products can move through the pipe. Construction is costly. Pipes are inflexible delivery vehicles, and access to the pipeline is limited to those with facilities adjacent to it. Others have to bring their product to the pipe using other modes of transport, thus losing the benefits of the pipeline for that portion of the trip and adding variable costs of loading, unloading, and operating a vehicle.

Pipelines are of limited use in international carriage, because they are vulnerable to political disputes between the countries whose borders they cross—also a problem for other modes of transport that cross boundaries.

Air Transport

Airplanes constitute both the newest and the least-used method of transporting cargo, although they have been carrying mail for about 100 years. The primary business of the major air carriers is the transport of passengers. Commercial cargo, for the most part, has been relegated to filling up space not occupied by people and their luggage.

Capabilities

The clear advantage in speed of delivery goes to the airplane over all other modes of transport. Cruising near the speed of sound, newer airplanes can cross entire continents and oceans in a matter of hours. This allows logistics managers to reduce or eliminate safety stock and warehouses. Because air travel is relatively smooth and fast, it is especially well suited to carrying valuable, fragile, and perishable cargoes. However, air cargo is not limited to such items. Any commodity can travel by air, subject only to restrictions on weight and size. The military, perhaps the world's first and best logistics manager, air-lifts heavy equipment to battle zones. Cargo destined for travel in an airliner's hold requires significantly less packaging.

Air transport benefits from low fixed costs, ranking second in that regard only to over-the-road motor carriers. Airports are generally constructed and maintained by taxpayers—federal or local—with gates leased to carriers. Shippers can afford to purchase or lease their own fleet of airplanes. Variable costs, however, are high, due to the rising cost of fuel and the expenses accruing to a very labor-intensive business.

Market Conditions

Some industries are important to a country but may not ever be considered profitable. Transportation is a market sector where this is particularly true, especially in the case of airlines. Around the world, airlines tend to be run by governments or may be regulated, with the requirement that they persist in serving markets that may be important from a public perspective but are not necessarily profitable.

The United States, where airlines have always been privately held, is the exception. Until 1978, the U.S. airline industry was highly regulated. After legislation eased regulation, airlines were allowed to set their own rates and choose which markets to serve or abandon. Since that time, air rates have fallen dramatically, and carriers once restricted to U.S. markets have added international flights. While this might seem to offer better access for logistics purposes, the downside of deregulation has been increased instability in the industry, including many airline bankruptcies.

On the positive side, international air transport has become a strong competitor with water transport for transoceanic carriage. Air cargo (with the exception of small parcels) often flies on the same planes as passengers. Freight forwarders contract with these airlines. In addition, specialized package services, such as Federal Express and United Parcel Service in the United States, use dedicated cargo planes—no passengers allowed—to offer a range of transport services.

Issues/Challenges

Speed is the air carriers' primary advantage, with low loss and damage rates tagging along behind, but with speed comes a higher price tag. At around three times the cost of road carriage and more than 30 times the cost per ton-mile of rail carriage, air transport exacts a high cost in exchange for rapid delivery. When comparing air to ocean transport in terms of efficiency and lower cost, items that fit into the categories of smaller, express, high-value, and time-sensitive shipments are still best served by air.

Generally speaking, to justify the transport cost, air cargo almost always has to be high in value, at least to the buyer. For example, fresh fish for high-end restaurants is usually shipped via air.

Accessibility, too, is sacrificed for speed, especially in comparison to trucking. Airports are extremely expensive to build and very difficult to site. They require vast expanses of flat land and may require condemnation of existing homes and businesses, given their usual placement near cities. The major airports serve the world's large cities—for the convenience of the airlines' primary business of transporting passengers. There is little call for building airstrips near mines, forests, or farms for pickup of raw materials. However, many major cities have made huge investments in their airports in recent years, and many are now or are rapidly becoming world-class, with high capacity for cargo. In Asia, Beijing, Ho Chi Minh City, Singapore, Bangkok, Hyderabad, and Bangalore are all examples.

Air transport can suffer from delays caused by weather conditions, though advances in air control and instrumentation have somewhat decreased these problems. Major air carriers are considered to be prime targets of terrorism, but this is a drawback they share with other modes. While security concerns may add to costs and delays, they probably are not major factors in the logistics manager's calculations.

Although air carriers have made some progress in establishing intermodal service with road carriers, there is a natural limit on the establishment of direct links between airports and rail terminals or ports.

Intermodal Transport

Intermodal transport includes package delivery, container hauling, and other intermodal services. Many deliveries cannot be accomplished by a single mode of transport—for reasons of access, price, size or weight of cargo, etc. Therefore, intermodal integrates the different modes of transportation in various combinations to take advantage of their specific capabilities. Since deregulation, the legal barriers to mixed mode and specialized services have decreased and new types of specialized or hybrid transport providers have entered the marketplace.

In global logistics, the question of what is the most efficient and cost-effective mode of international shipping poses additional considerations. There is no definitive answer as to the ideal mode. The choice in hybrid transportation modes is driven by an organization's specific needs and the capabilities of the shipping and logistics entities.

Package Delivery Services

Package delivery services developed because traditional single-mode operators have generally been unable to carry small packages at a reasonable cost. Among the challenges to overcome when delivering small parcels are collecting enough packages from diverse shippers to constitute a load and distributing the packages to diverse, perhaps inherently unprofitable, locations. Government-run postal services have traditionally filled this niche in the market alongside, or in place of, private carriers.

In the 1970s, specialized package carriers such as UPS, DHL Express, and Federal Express (FedEx) were growing in importance, generally beginning in the United States and then spreading around the world. In addition to those U.S. services, TNT began in Australia and eventually grew into another dominant worldwide express service—all of which developed sophisticated, multimodal logistics expertise. A 2020 article on supplychaindigital.com identified the top ten largest couriers in the world, from largest to smallest, as DHL Express, UPS, FedEx, Deutsche Post, SF Express, Japan Post Holdings, Poste Italiane, Royal Mail, ZTO Express, Österreichische Post, and PostNL. Another large service is the United States Postal Service. It had 2020 revenue of over \$73 billion and employs over 644,000 people. Many other express carriers exist, such as OCS, a provider of worldwide delivery and logistics services based in Canada since 1963, and Aramex, based in Amman, Jordan, which primarily serves the Mideast.

The major benefit offered by the express carriers is speed; the major drawback is price. Manufacturers and distributors that value speed have come to depend upon same- and next-day service from express carriers. These include pharmaceutical companies, hospital suppliers, food retailers, financial services, and suppliers of repair parts to companies anxious to build customer loyalty. In the expanding marketplace of lean manufacturing, Just-in-Time delivery, and global supply chains, however, speed is becoming more a competitive necessity and less a marginal benefit.

According to Statistica, in 2020, the express carrier industry was expected to be worth 375.5 billion euros. Express services not only assist other businesses; they are, in fact, substantial contributors to national and regional economies. Their hubs attract other businesses that rely upon the express carrier for their deliveries. Express services also play an essential part in the rapidly growing marketplace of goods sold outside of stores. Online sales depend upon national postal services and their express service competitors to make their businesses attractive to customers. Finally, because they can combine deliveries from many customers, package delivery services offer small and medium-sized companies a chance to benefit from economies of scale.

Container Hauling and Other Intermodal Services

Container transport makes up a significant amount of the intermodal traffic, but other methods exist, such as transporting a truck and trailer or a truck trailer using a different mode. Air also requires truck service. Intermodal services include piggyback, trainship or containership, truck-plane, and freight truck on railcar.

- **Piggyback service (TOFC, COFC, RoadRailer).** The nickname “piggyback” signifies the placement of a truck trailer or a container of cargo on a railroad flatcar, hence the names TOFC (trailer on flatcar) or COFC (container on flatcar). The cargo travels part of its way via truck and the rest of the way by train. While the trailer provides the more direct link between train and truck, the fact that it sits on wheels creates more wind resistance during the rail portion of the shipment. Aside from their

better aerodynamics, cargo containers provide more efficiency and flexibility, since they can be double-stacked on railcars or loaded onto water carriers as well as flatcars and flatbed trucks.

RoadRailers are trailers that ride on either regular tires/wheels or steel wheels. A simple change of wheels allows them to ride on the highway behind a tractor or be pulled along the tracks as short railcars. This eliminates the need for expensive materials-handling equipment. The RoadRailer is highly cost-effective when compared with simple over-the-road hauling.

- **Trainship or containership service.** “Trainship” and “containership” refer to mixed mode transport that includes water carriage. It also is sometimes referred to as “fishyback.” As the names signify, the cargo is loaded into a truck trailer, a railcar (trainship), or a container that also spends part of its shipment time on board ship or barge.

These combinations use domestic waterways—rivers, canals, the U.S. Great Lakes, and coastal waters, and similar setups are used in overseas transport. The land bridge, for instance, combines rail and sea transport. The land bridge route may run from the coast of Asia to the U.S. West Coast by ocean vessel, from the West to East Coasts on rails, and then from the Atlantic coast to Europe on another ship. The alternative is an all-water route through the Panama Canal. In contrast, the micro land bridge moves goods over water and then land, with the final destination inland. Mini land bridge traffic moves goods over water and then land, with the final destination being on the opposite coast.

- **Truck-plane services.** Air transport generally requires some intermediary surface travel (sometimes referred to as “birdyback” services), since airport terminals are not usually located near manufacturing, harvesting, or extraction sites, and those sites are generally not equipped with their own private airstrips. Intermodal air-truck shipments, such as those routinely scheduled by UPS and FedEx, simply formalize the process and put it under unified management. But small package shippers are not the only ones relying upon truck-plane services. Other commodities travel via this mixture of modes, especially those that originate or conclude in smaller cities and towns not served by major airports and large planes. The package carriers do serve smaller cities, of course, but heavier freight generally goes to other carriers.
- **Freight truck on railcar.** In Europe (for instance, in Austria), there are now laws restricting driving at night by truck drivers hauling freight. So a truck is loaded onto a flatbed railroad car, which is transported to another location via rail while the truck driver sleeps on the train to continue moving during prohibited hours (the required rest period).

The intermodal concept offers logistics managers flexibility, efficiency, and reduced costs. The future of the combinations outlined above most likely rests upon the cargo container rather than the truck trailer or the railcar. The container provides the maximum flexibility, since it can be loaded onto trucks, trains, barges, or oceangoing ships.

Transportation management software is available to help determine the best intermodal combinations and can assist the logistics team with identifying the optimal mix in order to get materials to where they need to be in a timely manner as well as at the lowest price.

Types of Carriers

After selecting the most effective mode, or modes, of transportation, the logistics manager must decide on the appropriate type of carrier—common (public), private, contract, or exempt. This decision is influenced by consideration of each carrier’s “legal type,” that is, the operating authority granted the carrier by the relevant government regulatory body. For example, in the U.S., the authority to operate under a given legal type is regulated by federal statute and the U.S. Surface Transportation Board (STB). In the EU, it is regulated by the European Commission’s Directorate-General for Mobility and Transport.

The four types of carriers discussed below are generic in nature, and each provides a set of advantages and tradeoffs. While much of the discussion uses U.S. examples, these general types are relevant in many other countries.

Common (Public) Carriers

The *APICS Dictionary*, 16th edition, defines a **common carrier** as

transportation available to the public that does not provide special treatment to any one party and is regulated as to the rates charged, the liability assumed, and the service provided. A common carrier must obtain a certificate of public convenience and necessity from the Federal Trade Commission for interstate traffic.

The opposite of a common carrier is a private carrier. “Public carrier,” or simply “carrier,” is a term used in continental Europe and elsewhere and is the functional equivalent of a common carrier. However, to confuse the issue, in U.K. English, a public carrier refers to a contract carrier, defined later, not a common carrier. The remainder of this discussion uses the term “common carrier.”

Common carriers perform the bulk of shipping in the United States, form the basis of public, commercial transportation, and are used extensively in most logistics systems. Common carriers operate in the public interest. Granted the authority to enter the market by a country’s federal government, they are also subject to the greatest amount of regulation governing rates and the scope of their service. Government licensing and regulatory restrictions are designed to guarantee that the economy will not suffer from a lack of commercial transportation at reasonable rates. While such regulation ensures logistics managers that carriers will be available for their products and within their geographic markets, it also means that managers must understand the relevant regulations and take their effects into account when selecting modes of transport and types of carriers.

To enter the common carrier business in the United States, for example, a company must demonstrate that it is able and willing to provide service. The U.S. STB governs entry into the common carrier market for rail, motor, and marine transport; the U.S. Department of Transportation (DOT) regulates entry into air transport.

Regulation of common carriers governs public service, liability, discrimination, and rates.

- **Public service.** Common carriers may be licensed to carry all types of goods or only certain types (household goods, computers, etc.), depending upon their capabilities. Within the scope of its license, the common carrier must transport whatever goods are offered to it and deliver the goods to any point within its designated territory.
- **Assumption of liability.** Common carriers assume the risks inherent in transport—a definite benefit for the shipping company. The carrier is responsible for any damage, loss, or delays that occur while the goods are in its custody—with certain exceptions, such as inherent product defects and acts of God, public enemies (criminals, terrorists, etc.), or the shipper itself.
- **No discrimination.** Common carriers are required to take all legitimate business within the scope of their licenses, even at a loss. They may not discriminate among shippers, products, or places by charging different rates or providing different levels of service. There is some flexibility for varying rates in line with differences in the costs of doing business. Common carriers in the trucking sector generally specialize in either full truckload or less-than-truckload carriage.
- **Reasonable rates.** Common carriers must publish their rates, and the rates must not be too high (thus limiting shippers) or too low (thus endangering the carriers).

Private Carriers

A private carrier is a company that owns or leases a fleet of vehicles to transport its own products. A private carrier that purchases a fleet of vehicles incurs the costs of ownership—such as maintenance, insurance, depreciation, and financing. The vehicles also count as assets on the balance sheet, which worsens certain financial ratios. Ownership requires decisions about when to buy and sell the vehicles; leasing eliminates some of the concern with depreciation, financing, and term of possession.

Ownership and leasing are otherwise similar. In both cases the vehicles are in the possession of the company and are its responsibility.

To qualify as a private carrier, a company must own or lease vehicles for its use, manage their operation, and not be primarily in the transportation business. While private carriers are free from economic regulations that apply to other legal types of carriers, they must follow regulations that apply to hazardous materials, safety, and other matters regulated by the government.

Owning or leasing a fleet has advantages and disadvantages. On the positive side, the company has control of the vehicles for its own use. On the negative side, the size of the fleet is relatively inflexible. If business turns down, the company either has to maintain unused vehicles or divest itself of some vehicles through sale or a lease buy-out. Neither tactic is likely to be profitable.

Before deregulation in 1980 in the U.S., private carriers were forbidden to carry the goods of other companies. Since deregulation, they have been able to do so, and some private carriers are licensed in more than one legal class—a significant benefit if the vehicles can fill up with another company's products when they would otherwise be making empty backhaul trips.

At first the benefits of deregulation resulted in an increase in the number of private carriers. Eventually, however, that trend reversed as more companies sold off their private fleets and outsourced logistics functions in order to focus on their core businesses.

Contract Carriers

Unlike common carriers, contract carriers are not required to make their services available to the general shipping public, though they do require government authorization to do business and are governed by economic regulations. They enter into contracts with terms specific to the customer and then receive a permit to carry out the business defined by the contract. Contracts specify rates, type of service (number and frequency of trips, etc.), and liability.

Although U.S. contract carriers were once subject to strict regulatory limits on the number and terms of their contracts, since the Motor-Carrier Act of 1980 they are more free to compete with other types of carriers. For example, before 1980 contract carriers were limited by law to have no more than eight active contracts; now they may serve any number of current customers.

Contract carriers offer several advantages to logistics managers. Their rates are generally lower than those of common carriers, and because they aren't required to serve the general shipping public, they can adapt their business to a customer's specific needs by, for example, scheduling special deliveries or using specialized equipment. They rival private carriage in that regard while providing added flexibility.

The independent trucker is a special type of contract carrier who owns a tractor (and perhaps a trailer) and makes arrangements to subcontract with other types of carriers, including common, private, contract, and exempt carriers.

Exempt Carriers

Exempt carriers are not subject to economic regulation of their rates and terms of service. They are, however, responsible for compliance with licensing and safety laws (which are state-based in the U.S.). In the U.S. they must publish their rates if they operate across state lines. (Most exempt carriers operate locally.) The market determines their rates, services, and availability.

Exemptions are granted for specific commodities and for certain areas of operation, such as the zones around airports. Typical exempt commodities include raw materials and unprocessed agricultural products. Logistics managers rely on exempt carriers for a significant amount of business in their niches, such as local transport of agricultural products. The primary benefit offered by exempt carriers is lower rates. Their primary drawback is limited availability for many products and a limited range of operation.

Section C: Trade Considerations

This section is designed to

- Describe some common security and regulatory concerns, including risk of loss and complying with import and export requirements
- Understand the benefits of participating in voluntary security partnerships with various nations, such as C-TPAT in the U.S.
- Understand customs regulations related to prohibited goods and documentation
- Understand the impact that differences in international, country, and local labor laws can have on global supply chains
- Describe how to efficiently deal with customs when importing or exporting goods
- Enumerate the operational considerations of importing and exporting
- Define the Incoterms® trade terms used in foreign trade contracts and distinguish where and when cost responsibilities shift between seller and buyer
- Identify and describe the intermediaries involved in import and export
- Describe how the Harmonized Tariff Schedule is used in import and export transactions
- Define free trade zones and describe the requirements for and benefits of participation
- Explain trading blocs and how they impact the participants as well as those outside the supply chain.

This section examines security, legal, and regulatory factors, including customs best practices and the use of Incoterms® trade terms. It also addresses export and import documentation requirements. The section concludes with a discussion of trade considerations, including free trade zones and trading blocs.

Topic 1: Legal, Security, and Regulatory Requirements

After presenting general processes that can be used to identify, assess, and implement compliance and risk management related to legal, security, and regulatory requirements, we discuss voluntary security partnerships, import and export requirements, and compliance with labor laws.

Legal, Security, and Regulatory Requirements Road Map

Effective supply chain management encompasses a wide array of security and regulatory concerns, especially in material movements and transaction reporting. Security and compliance issues often have implications for supply chain cost management, timing, or information systems that require management's involvement. Failure to comply with security and other regulations and requirements can result in problems ranging from costs and delays to significant fines or even complete shutdown of business activity followed by civil or criminal penalties.

The management challenge is to meet the requirements imposed by countries and trading blocs as well as those mandated by tax revenue, environmental, and security agencies and to do so with the least possible financial impact. Supply chain risk management has increased in importance and has become a major focus for supply chain managers.

Key security and regulatory issues include the following:

- Ensuring the physical security of modes of transportation and storage
- Complying with import and export regulations and documentation requirements
- Meeting increased identification requirements and establishing systems to deny access of unauthorized people to supply chain materials
- Keeping supply chain information systems secure from hacking
- Deciding whether to voluntarily comply with global antiterrorism initiatives, such as the C-TPAT (Customs-Trade Partnership Against Terrorism) initiative in the United States or the AEO (Authorized Economic Operator) program of the European Union
- Maintaining proper internal operational and financial controls

An example of a risk related to physical security and compliance is the limitation on the amount of flammable materials that can be stored in a given warehouse. Warehouses with flammable (or explosive or otherwise unstable) materials need to manage risks by ensuring that there is sufficient stock of inventory to conduct business while staying below the regulatory limits for the materials.

Ensuring compliance with all safety protocols is also a key risk control.

An example of a risk related to internal operational and financial controls is compliance with the U.S. Sarbanes-Oxley Act (SOX). Compliance with this act is required for any U.S. or foreign organization whose stock is publicly traded on U.S. stock exchanges. Segregation of duties to prevent conflicts of interest is a key concern. For example, the buyer in a transaction should not also be the seller or any associate of the seller who might profit from the transaction. SOX also requires that the organization's quarterly and annual financial reports disclose certain off-balance-sheet transactions and provide detailed descriptions of certain internal control systems. The off-balance-sheet reporting disclosure requirement could impact vendor-managed inventory (VMI) arrangements, for example, because this could involve moving an asset (inventory) off of the balance sheet. Similarly, outsourcing arrangements may need to show that adequate internal controls exist. Penalties for noncompliance could include fines from civil lawsuits brought by the U.S. Securities and Exchange Commission, reputation damage, or criminal suits against executive officers accused of falsely certifying reports.

The key processes that supply chain managers need to be able to perform related to complying with standards, regulations, and sustainable best practices are

- Identifying applicable standards, regulations, and sustainable best practices
- Performing a gap analysis for compliance
- Developing and implementing an action plan.

Each of these processes is introduced next. Note that these are general overviews. The information required to plan and execute these processes is presented elsewhere in this section.

Identifying Standards, Regulations, and Best Practices

The process of identifying applicable standards, regulations, and sustainable best practices (compliance items) involves the following steps:

- Reviewing organizational processes (existing procedures, tools, and documentation) for currently applicable compliance items
- Developing, hiring, or contracting with applicable persons or organizations to gain expertise in compliance items
- Scanning for global, national, regional, community, and industry-specific compliance items (including laws and taxes) in each area of operation, differentiating between applicable versus nonapplicable items, and identifying applicable compliance items that
 - Promote operations such as by leveraging reduced tax zones
 - Constrain operations such as by imposing end-of-life reverse supply chain requirements
- Differentiating between mandatory and voluntary items
- Updating records and procedures to add any new mandatory items
- For voluntary items, doing a benefit-cost analysis to determine which compliance items are advantageous to pursue
- Updating records and procedures to add new voluntary items that are advantageous to pursue

Performing Gap Analysis for Compliance

The process of performing a gap analysis for compliance involves the following steps:

- For all mandatory compliance items, determining level of existing compliance
- Comparing actual compliance against baselines for minimum compliance
- Creating a list of mandatory item gaps
- For all voluntary compliance items, determining desired level of compliance
- Comparing actual voluntary compliance against desired compliance targets
- Creating a list of voluntary item gaps

Developing and Implementing Action Plan

The process of developing and implementing an action plan involves the following steps:

- For mandatory compliance gaps, developing and executing project plans to address the issue(s)
- Keeping relevant regulatory authorities apprised with all necessary information on remediation plans and status
- For voluntary compliance gaps, developing a feasibility study to better understand the scope of the changes, their costs, and the timeline
- Implementing approved voluntary compliance programs as projects

- Updating relevant policies, procedures, processes, and metrics to enforce compliance steps and ensure that the changes become part of operations
- Using change management to change the culture and get the workforce behind the new methods

Security Partnerships and Regulations

Because most of the imports and exports to and from a country are in the form of private party trade goods, governments wanting to increase border security and prevent terrorists from intrusion into supply chains have a choice: Subject all imports to additional security measures at enormous expense for the government and with lengthy delays to the movement of goods, or forge partnerships with organizations and other customs agencies to improve security. The primary benefit for organizations is that the customs process may be faster and smoother. Examples of security partnerships include

- C-TPAT for imports (defined below)—U.S.
- Authorized Economic Operator (AEO) program—EU
- Partners in Protection (PIP)—Canada
- Secure Trade Partnership (STP)—Singapore
- AA rating for customs—China.

The Customs-Trade Partnership Against Terrorism (C-TPAT) is a joint government-business endeavor for imports (not exports) to increase the security of supply chains and U.S. borders. Initiated by U.S. Customs, C-TPAT is based upon the idea that achieving the highest levels of security requires cooperation between the U.S. government and supply chain participants such as importers, carriers, brokers, warehouse operators, and manufacturers. U.S. Customs has used C-TPAT to establish mutual recognition security arrangements with New Zealand, Canada, Jordan, Japan, Korea, the EU, Taiwan, Israel, Mexico, Singapore, the Dominican Republic, and Peru (as of 2021).

Costs and Benefits of Participating in Security Partnerships

C-TPAT will be used to illustrate the costs and benefits of participating in security partnerships. Various partnerships have differences, but the costs and benefits should be comparable.

Costs

Participation in C-TPAT by businesses is voluntary, but participation will result in costs related to implementation, audits, and compliance actions.

Acceptance in C-TPAT is based on submission of an online application and a signed agreement to take the following actions:

- Assess/validate the company's own supply chain security in accordance with C-TPAT guidelines that encompass procedural security, physical security, personnel security, education and training, access controls, manifest procedures, and conveyance security. Guidelines are available in the Resource Center.

- Submit a supply chain security profile questionnaire to U.S. Customs.
- Develop and implement a program to enhance supply chain security in accordance with C-TPAT guidelines.
- Communicate the C-TPAT guidelines to partners in the supply chain and work toward including the guidelines in relationships with those companies.

Benefits

In return for instituting C-TPAT security guidelines, participating businesses receive the following benefits (after evaluation of the application):

- Fewer inspections, for reduced border time (Note that while many partners do experience these benefits, C-TPAT legal language specifically states that membership will not speed up clearance or help avoid searches.)
- Assigned account manager
- Access to the C-TPAT membership list (provides members with access to C-TPAT–certified providers that may be appropriate to their supply chains)
- Eligibility for account-based processes such as bimonthly or monthly payments
- Emphasis on self-policing rather than customs verifications
- Membership treated as a positive risk-assessment factor by customs
- Helps establish the organization as a good community partner
- When mutual recognition arrangements exist, less duplication of effort between the countries' customs authorities (Participants have to conform to only one set of standards, not two.)

C-TPAT began offering partnership admission to importers and carriers with the intent to expand enrollment to all supply chain participants. Partly because of this and partly because the program is voluntary, supply chains may have some partners who are compliant and some who are not. Often a transportation partner such as a freight forwarder will participate in C-TPAT while the manufacturer may not. Business partners cooperate with customs in developing security guidelines, with the explicit intention of keeping costs down and reflecting a realistic business perspective.

Noncompliant C-TPAT participants may have their benefits suspended or the participation canceled. Otherwise, C-TPAT creates no new liabilities beyond existing trade laws and regulations.

Complying with Import/Export Requirements

Compliance with import/export requirements can be complex due to the myriad requirements and trade agreements in both the importer's and the exporter's country. International shipping laws may also need to be considered.

Many times, these regulations contain numerous exceptions that can save the organization considerable expense if it understands and applies them without inadvertently violating the regulation.

For example, the harmonized system classification codes are used to identify a product's type, but there may be leeway to classify a good as one type or another, possibly resulting in a tax or customs advantage. However, a risk is that customs could disagree with the classification, resulting in delays and/or fines. Legal review is needed.

In addition, import/export can create significant risks of delays at customs. One way to mitigate this risk is to use electronic messaging to pre-clear product shipments rather than risking problems at the port of entry/exit. This is especially the case when the supplier lacks the trust of the importing government. Complex electronics or chemicals may experience customs delays as they are checked for contraband. Sourcing these goods domestically may be the only way to reduce this risk.

Two examples of import/export requirements are prohibited goods and labeling and documentation requirements.

Prohibited Goods

Countries may prohibit certain goods from entering or leaving the country for national security reasons, domestic trade protection, or protection of the health and safety of its citizens. Some potential suppliers are banned because they are connected to terrorist organizations or organized crime. For example, in the U.S., several agencies maintain lists of prohibited individuals and entities, including the Office of Foreign Assets Control (OFAC). U.S.-based organizations and citizens are not allowed to trade with or have financial transactions with these entities. It is the organization's responsibility to check such lists for the countries in which they operate, although trade relationship management software can automate verification.

Another reason goods may be prohibited is due to a pandemic outbreak of disease or other source of contamination of foods or other goods. For example, a country could ban imports of toys if testing confirmed the presence of lead. After the 2011 earthquake in Japan, the U.S. prohibited imports of milk, fruits, and vegetables from Japan due to the radiation from damaged nuclear reactors. Many nations prohibited the export of masks, medical equipment, and raw materials used to make vaccines as part of their response to the 2020 global pandemic.

Dangerous goods also face restrictions. There is a movement to support more thorough documentation and disclosure of potentially problematic material content of goods exchanged in trade. One risk is having out-of-date information, which can be prevented by regular checking.

Organizations face serious consequences such as significant fines for failing to verify that goods can be imported or exported prior to attempting the transaction. The risk of ones' own goods being prohibited due to contamination is likely a type of risk that cannot be adequately planned for and may or may not be covered by insurance.

Labeling and Documentation

Product labeling and documentation regulations for imports and exports often require organizations to label goods in the import country's local language(s). Delayed differentiation and delayed packaging strategies can reduce the risks of carrying too much product in one country and not enough in another solely due to packaging. Organizations should verify that they understand all labeling requirements such as product warnings, ingredient lists, or health facts. Also, many regulations exist related to misleading labeling, which creates a risk that a product could be banned.

There is a large amount of documentation for international trade, and as such there is a risk that some of it could be missing or incorrect. Documentation may include letters of credit, bank drafts, bills of lading, combined transportation documents, commercial invoices, certificates of origin, material safety data sheets, and insurance certificates. Each must comply with regulations. Such documentation may be required to be multilingual, not only for the country of import and export but for every country the goods pass through. When this documentation is complex, it creates a risk of delaying shipments to get the documents translated. One way this risk can be mitigated is for organizations to use standardized electronic messages when they are allowed (or required) in place of physical documentation.

Labor Law Compliance

Since global supply chains often employ workers in multiple countries, it is important to understand how to navigate country and local labor laws and to know some international labor considerations and best practices.

Country and Local Labor Laws

Country and local labor laws can differ significantly. Labor laws in centralized economies may look quite different from those in decentralized economies. Some governments are organized around religious law or have a dual system of civil and religious laws that need to be navigated when working to comply with labor laws.

Workers in centralized economies may have fewer rights to privacy or ability to lodge grievances. Even hiring may be regulated; managers in Chinese corporations used to be assigned for political reasons rather than for job skills. All Chinese employees also require an employment contract, while in other countries these are used for only a certain class of nonemployee worker. When a government requires employment contracts, these need to be formally amended whenever there is a change in contract or work period.

However, even in decentralized economies there is a wide difference in labor laws. Unlike the U.S., most other countries do not use the at-will employment law that allows for termination without cause. The European Union and Australia also have more stringent protections for worker privacy, collective bargaining, and employee benefits than the U.S.

Organizations therefore need to ensure that they have competent human resources staff that are knowledgeable about each of the countries and local areas in which they have significant operations. Even if local countries do not effectively enforce their labor laws, interest groups can bring home-country legal action against an organization that is operating in violation of a different country's labor laws. U.S. extraterritorial laws also exist to control the behavior of U.S. employees overseas. Finally, governments are often parties to treaties or global compacts that may apply to labor. These would be enforced through the courts.

A key point for supply chain managers, however, is to gain enough familiarity with the country and local labor laws of their suppliers to know when they are in compliance. An organization may have less legal liability in these cases but can face significant reputation damage and loss of customers if a supplier is operating in violation of laws or international ethical standards.

Two major areas where these laws may differ significantly are in collective and individual rights. Collective rights include rights to collectively bargain, congregate together, discuss employment matters, or receive fair warning of layoffs or plant closings. Individual rights are more extensive and include equal treatment of various classes of persons; child labor; forced labor; terminations; data privacy; wage and hour laws, including overtime, maximum hours, and pay reductions; vacation or sick pay and leave; pregnancy regulations; part-time, temporary, and contract worker restrictions; workplace health and safety; and alternative dispute resolution methods. Some countries even have laws in place that restrict companies from exclusively using independent contractors in order to avoid providing employee benefits.

International Labor Considerations

A number of international organizations support labor rights. For example, the United Nations has a large number of declarations that support human rights, labor organization, economic rights, and prevention of discrimination against women. The Organisation for Economic Co-operation and Development (OECD) has Guidelines for Multinational Enterprises, and the International Labour Organization (ILO) has a Tripartite Declaration of Principles Concerning Multinational Enterprises and Social Policy. The United Nations Global Reporting Initiative (GRI) draws upon information in these standards. Its categories of information on the social impact of organizations help illustrate some prominent international labor considerations. Organizations need to consider the impact of the following in each significant region of operations:

- How entry-level wages compare to local minimum wage laws and any gender disparity
- How average wages compare to market rates and any gender disparity
- Proportion of senior management positions filled by persons from local community
- Local infrastructure or job base investments
- Diversity of new hires and retention for age, gender, ethnicity, and so on

- Benefit differential between full- and part-time employees and if the proportion of the two groups is reasonably allocated
- Parental leave time support and post-leave retention
- How layoffs and plant closings are communicated with/without unions and whether support services for career transitioning are offered
- Whether employees are represented on health and safety committees
- Worker injuries or health issues by region or gender
- How well health and safety is handled in union/nonunion shops
- Proper and sufficient worker training by gender or employee category
- Existence and efficacy of grievance mechanisms

The labor practices regarding suppliers by region are also of concern:

- Proportion of local suppliers that are used
- Whether suppliers are screened for labor practices
- Proportion of suppliers with negative impact labor incidents and their significance
- Whether supplier labor ethical policies exist and their degree of enforcement, including any contract terminations for poor labor practices

A special international labor consideration is a deemed export.

Deemed Export

A deemed export can arise when certain technology or software source code is released to a foreign national, usually for purposes of employment or contract work. When this technology is not normally allowed to be exported to that foreign national's home country without a license, the home country considers this to be a deemed export. In the U.S., for example, the Bureau of Industry and Security of the U.S. Commerce Department requires submission of an export license application if the software or application would need an export license to be released to the foreign national's country in question.

The rule does not apply to lawful permanent residents of the U.S. or to persons with asylum status.

Topic 2: Import/Export Regulations and Documentation

Here we address regulatory and documentation details related to importing or exporting goods and services, including an overview that addresses the role of customs in both importing and exporting. This is followed by discussions of Incoterms® trade terms, export-import intermediaries, export packaging, and export and import documentation.

Import/Export Road Map

Customs refers to a country's regulation of import and export trade at its international ports and borders. The purposes of customs are to ensure border security, to collect all required tariffs, and to

enforce trade restrictions. A **tariff**, according to the *APICS Dictionary*, 16th edition, is “an official schedule of taxes and fees imposed by a country on imports or exports.”

Organizations that engage in international trade use global trade management to ensure that interactions with customs proceed in a smooth and cost-effective manner. The *Dictionary* defines **global trade management** as

the management and optimization of shipments across international borders including: ensuring compliance with all international regulations and documentation, streamlining and accelerating the movement of goods, to improve operating efficiencies and cash flows.

Global supply chains need to operate efficiently as goods and services move between countries. This includes making wise import and export decisions, including how to arrange contracts for carriage so all parties clearly understand their roles and where risk of loss transfers between parties, how to facilitate clearing customs between countries, how to package goods for export, and how to satisfy all related export and import documentation requirements. Let’s start with an overview of these subjects.

International contracts for carriage (contracts for transport and materials handling, as opposed to contracts for sale and transfer of title) often rely on Incoterms® trade terms, which are simply agreed-upon international standards for the language to use in certain portions of such contracts. While these terms are voluntary, the contracts create an obligation.

Facilitating customs clearance is often done through the use of intermediaries, such as freight forwarders or export management companies. Since complex international transactions often have many of these intermediaries, it is important to understand how the various roles interact with each other and what value each should provide.

Export packaging needs to meet a number of objectives. The primary objective of industrial packaging (as opposed to consumer packaging) is protecting the goods from damage in a way appropriate to the chosen mode. Other objectives include minimizing the use of unsustainable materials or the overall use of materials.

Imports and exports require a significant amount of documentation. It is important to understand what documents will be required and what information the organization will need to collect and report. In general, exports require certain proofs such as proof of sourcing origin while imports require proper classification for assessment of tariffs. The Harmonized Tariff Schedule is used to assign a numeric code to the shipment so the correct tariffs can be assigned. Goods also need to have their value declared.

Since customs regulations are driving much of the complexity in international shipping, let’s get an idea of why these regulations exist and learn about some best practices to follow in navigating customs. We

will look at some import regulations and restrictions at a high level after that.

Customs Regulations and Best Practices

The purposes of each country's customs regulations are twofold: to provide revenue and to protect domestic industries. Imported goods, therefore, can be seen as a source of national revenue, as a threat, or—ambivalently—as both. This built-in conflict of interest makes the job of importing (or exporting) into a country difficult and sometimes expensive.

Aside from assessing import duties, customs also inspects shipments with the following intentions:

- To confirm that the goods actually have the value stated on the shipment's documentation, since that value partly determines the amount of the import duties
- To determine that the items have all the correct markings, including safety labels, instructions, identification of country of origin, and any special marks required
- To weed out any forbidden items, such as illegal drugs and goods judged not to meet certain national standards
- To enforce quotas
- To ensure that the invoice is correct and that the shipment contains the number of items claimed in the documentation
- To discourage dumping of products by imposing a high-percentage duty (Dumping is when a company exports a product at a price lower than it normally sells for in the country where the company operates. There is a link for additional anti-dumping information online in the Resource Center.)

Clearing customs can be routine, or it can be a serious obstacle to delivering cargo on time. To expedite a successful clearance of customs, both importer and exporter should either do thorough research on the importing country's import regulations or hire competent intermediaries to guide them. Customs regulations are a moving target, subject to change whenever new threats arise (or are perceived to arise); hiring a specialist who keeps an eye on that target improves a company's chance of getting the job done right on the first try. Intermediaries such as freight forwarders, export management companies (EMCs), and export packagers can help with the preparations. Because clearing customs successfully is so important, most companies—even the largest ones—rely upon experienced customs house brokers.

Here are a few general considerations to keep in mind when formulating a strategy for getting your cargo through customs unimpeded:

- Use a customs house broker with proven expertise. Only a licensed broker can transact business with customs, which means that importers must use a broker to submit documents to customs to release their goods. Importers are responsible for providing the necessary documents and information to the broker according to customs time lines and regulations and arranging for the

payment of duties found due. (A broker can pay on the importer's behalf.) A licensed broker must have a power of attorney from the importer to act as its agent unless it is an in-house broker.

- Have the customs house broker begin the process before the shipment arrives at the port or air terminal, if possible.
- Use electronic documentation rather than hard-copy printouts whenever possible.
- Make sure your counterparty in the trade (or its intermediaries) has done its research.
- Check the backgrounds of your intermediaries carefully. Long-term relationships with trusted consultants are the most productive. The importer of record, or the company that caused the importation of goods, is responsible in the end. Inexperienced forwarders have been known to guess at the proper code for items, causing problems for the importer trying to pick up its goods at customs.

Import Requirements and Restrictions

Governments generally look with less favor on importing than on exporting, since exports bring money into the country and imports take money out. Moreover, goods coming into the country may pose various threats, including such hazards as competition with domestic goods; potential contamination of the environment; infectious diseases affecting livestock, wildlife, or humans; and terrorism.

Governments around the world create numerous import licensing requirements, regulations, and restrictions to guard against these dangers, and they enforce these regulations through customs inspections. These restrictions pose problems for importers and exporters alike. The problems for importers are obvious enough. In the United States, for example, there might be a market for European cheeses produced from nonpasteurized milk, but the Department of Agriculture won't license a distributor to sell such cheeses in the U.S. market—ostensibly for health reasons. Japan protects its domestic rice growers from imported rice for cultural reasons. On the other side of such restrictions, exporters may be easily able to acquire an export license from their own government but not able to get an import license to enable foreigners to buy their products.

The World Trade Organization, which includes in its membership the vast majority of trading nations, takes as part of its mission the creation of free and fair trade around the world by eliminating many of these barriers against imports. It pays special attention to providing less-developed nations with better access to world markets for their exportable products.

Membership in the WTO also means that businesses headquartered in one member nation should be able to open branches in another member nation and be subject to the same rules applying to domestic businesses in that nation, thus gaining access to their markets directly rather than through imports. After China joined the WTO in 2001, for example, many foreign companies rushed in, hoping to capture a slice of the potentially enormous market there. These early efforts were sometimes disappointing for a variety of reasons.

Even when trade and investment barriers begin to fall, the export-import business may still be stymied by problems with entrenched bureaucracy, lack of infrastructure, and simple lack of buying power.

Incoterms® Trade Terms

Incoterms® (International Commercial Terms) trade terms, as defined in the *APICS Dictionary*, 16th edition, are

a set of rules established by the International Chamber of Commerce that provides internationally recognized rules for the interpretation of the most commonly used trade terms in foreign trade and are routinely incorporated in the contracts for the sale of goods worldwide to provide guidance to all parties involved in the transaction.

The terms are used in foreign trade contracts to identify which parties are responsible for which transportation and customs clearance costs as well as when responsibility for the cargo transfers to the other party. Instead of waiting for title to transfer, which may be held up by the financing side of the transaction, the transfer of control and thus risk of damage or loss is specified by these terms. This is an important distinction because Incoterms do not address the transfer of title or ownership; this is addressed in a different contract. Some Incoterms® trade terms define who needs to get insurance for which parts of the journey; others leave this up to the parties to specify themselves. Some of the terms also outline import or export obligations for customs clearance and packaging requirements.

The terms are defined and issued by the International Chamber of Commerce (ICC) in Paris. Although Incoterms® trade terms are not legally binding, exporters and importers around the world accept them as the standard terms to use in contracts of carriage (not contracts of sale). The Incoterms® rules are frequently included on shipping company websites and are frequently added to purchase orders to clarify the terms and conditions.

The key things to know about use of Incoterms® trade terms is to know enough about these terms to select the most appropriate rule, to clearly specify the correct port or other named place, and to ensure that these details are correctly recorded in the contract for carriage, the letter of credit or other financial instrument, and the invoice.

The ICC recommends using their most recent version, Incoterms® 2020, although parties to a contract for the sale of goods can agree to choose older versions. It is important, however, to clearly specify the chosen version—Incoterms® 2020, Incoterms® 2010, or any earlier version, along with the specific trade term being used and a location. Depending on the point of responsibility transfer, the location is either an origin shipping port, a port of call for pickup, or a plant location for local pickup or delivery. For example, CIF Los Angeles, U.S.A., Incoterms® 2020 would show that cost, insurance, and freight are paid by the seller when exporting to the Port of Los Angeles.

General changes in the 2020 version include a clarification that an owned fleet might be used instead of a third party. Who pays for what is now more obvious, in a clear table format, for all of the terms. Also, security requirement costs are now clearly allocated in the rules.

Incoterms® trade terms are organized into two groups:

- Rules for any mode or modes of transport
- Rules for sea and inland waterway transport

A complete list of Incoterms® 2020, organized into these two groups, and a definition of each term appear in Exhibit 5-22. Buyer and seller responsibilities are shown in Exhibit 5-23.

For more detailed information or to order a copy of the terms, visit the ICC website.

Exhibit 5-22: Incoterms Trade Terms—Definitions

Terms for Any Mode or Modes of Transport	
EXW	<i>Ex Works (Buyer loads goods and takes control at seller's location.)</i> The buyer pays all transportation costs and bears all risks for transporting the goods to their final destination. Therefore, the buyer (or its 3PL) must be experienced enough to do export tasks in the country of supply. The buyer gets maximum control but also the most liability risk with this method.
FCA	<i>Free Carrier (Seller delivers to main carrier; seller loads.)</i> The seller delivers the goods into the carrier's custody and loads the goods on the buyer's chosen carrier. This is where risk passes from seller to buyer. The buyer pays for the transportation from the named place. The seller is responsible for problems or costs of clearing export customs. Since a letter of credit requires an onboard bill of lading, FCA indicates that given both party's agreement, the buyer must tell the carrier to issue to the seller (at the buyer's cost and risk) an onboard bill of lading (to encourage the use of this term over FOB for container shipments, since FOB has more seller risk).
CPT	<i>Carriage Paid To (Seller selects and pays for main carriage.)</i> The seller pays for the freight to the named destination. Risk transfers when the goods are delivered into the first carrier's custody.
CIP	<i>Carriage and Insurance Paid To (Seller pays main carriage and insurance.)</i> Risk transfers when the goods are delivered into the first carrier's custody. Afterward, the buyer bears all risk and costs. CIP is similar to CPT except that the seller also pays for the insurance, which must be comprehensive insurance (more than just liability insurance). Under CIP, the seller is also required to clear the goods for export.
DPU	<i>Delivered at Place Unloaded (Seller delivers goods to a location and unloads them.)</i> The seller delivers the goods at a named location, such as a terminal at a named port or destination. Parties should specify the location where the risk is transferred from seller to buyer. If the parties agree that the seller is responsible for the costs and risks of taking the goods to another place, then DAP may apply. Note that in Incoterms® 2010 this was called DAT (delivered at terminal).
DAP	<i>Delivered at Place (Seller delivers goods and buyer unloads them.)</i> The seller delivers the goods to the buyer, who assumes responsibility for their unloading at a named destination. Parties should specify exactly at what point at the destination the risks transfer from seller to buyer. If the seller is responsible for clearing customs and paying duties, then DDP may apply.
DDP	<i>Delivered Duty Paid (Seller incurs all costs, including import duty.)</i> The seller pays for all transportation costs, bears all risk until the goods have been

	delivered, and pays the duty. This method allows buyers to have the lowest level of involvement of all the terms.
Terms for Sea and Inland Waterway Transport	
FOB	<i>Free on Board (Seller puts goods on main transport vessel.)</i> This term is only for ocean shipments. It is useful for bulk cargo, break-bulk cargo, and roll-on-roll-off cargo. Containerized cargo is better handled using DAT. FOB shifts control when goods are “on board” the vessel. “On board” is true after an ocean bill of lading or sea waybill is issued. Sellers pay for all costs to transport and load the cargo on the ocean vessel, including export customs. Buyers pay ocean carrier costs and inbound customs.
FAS	<i>Free Alongside Ship (Buyer lifts cargo onboard.)</i> The seller pays for transportation of the goods to the port of shipment. This includes oversized bulk or commodity cargo tendered to the carrier at the inland waterway or ocean port of loading. The buyer pays loading costs, freight, insurance, unloading costs, and transportation from the port of destination. Risk is passed once the goods are delivered to the quay (pier) at the port of shipment.
CFR	<i>Cost and Freight (Seller selects/pays main carriage.)</i> The seller pays for costs and freight of the goods to the named destination port. The buyer pays for the insurance and transportation from the port of discharge (POD). Risk of loss shifts when the goods are on board at the port of shipment. CFR is inappropriate for most container sea shipments. (The correct term for these is CPT.) CFR is intended for use in shipping ocean freight pier-to-pier cargo that is not containerized (e.g., oversized or overweight goods).
CIF	<i>Cost, Insurance and Freight (Seller pays main carriage and insurance.)</i> A price quoted as CIF means that the selling price includes the cost of the goods, the freight or transport costs, and the cost of marine insurance. Under CIF, the seller must obtain in transferable form a marine insurance policy to cover the risks of transit. The seller’s control transfers when the goods have been delivered on board the vessel at the port of shipment.

Exhibit 5-23: Buyer/Seller Responsibilities (B—Buyer, S—Seller)

	Terms for Any Mode or Modes of Transport							Terms for Sea and Inland Waterway Transport			
	EXW	FCA	CPT	CIP	DPU	DAP	DDP	FAS	FOB	CFR	CIF
Export packing	S	S	S	S	S	S	S	S	S	S	S
Export clearance	B	S	S	S	S	S	S	S	S	S	S
Inland transport (domestic)	B	B/S	S	S	S	S	S	S	S	S	S
Forwarder's fees	B	B	S	S	S	S	S	B	B	S	S
Loading on vessel	B	B	S	S	S	S	S	B	S	S	S
Ocean/airfreight	B	B	S	S	S	S	S	B	B	S	S
Cargo insurance	*	*	*	S	*	*	*	*	*	*	S
Duties, taxes, customs clearance	B	B	B	B	B	B	S	B	B	B	B
Delivery to destination	B	B	B	B	B	B	S	B	B	B	B

* Incoterms®2020 recommend explicitly stating who will pay for the insurance in a contract or quote. Incoterms®trade terms indicate where risk/liability is transferred but do not actually obligate the buyer or seller to carry insurance except when explicitly noted in the term. In most cases, companies will maintain cargo insurance as a backup.

Export-Import Participants

International commerce takes place between an exporter (the seller) and an importer (the buyer or customer). A number of intermediaries may perform one or more specialized services before the items

sold in one country arrive at the customer's dock in another. Elsewhere we cover the growing use of logistics specialists to carry out specific operations for a client company (3PLs) or to coordinate the entire logistics function (4PLs). The use of specialized logistics intermediaries is even more common in the export-import business than in domestic supply chains. There are simply many more issues to contemplate when you send a product across borders into countries with different rules, a different currency, and a different language. And so it may be cost-effective for a company sending or receiving an international shipment to pay considerable fees or commissions for these services.

We'll explore the roles of several types of intermediaries who assist in getting cargo across borders and through customs: freight forwarders, non-vessel operating common carriers, consolidators, customs house brokers, export management and export trading companies, shipping associations, ship brokers and ship agents, and export packing companies. After that there are flowcharts showing how the parties may interact and a summary of the types.

Freight Forwarders

The freight forwarder, foreign freight forwarder, or just plain forwarder is a company that arranges transportation for commercial cargo. The *APICS Dictionary*, 16th edition, defines a **freight forwarder** as

the “middle man” between the carrier and the organization shipping the product. Often combines smaller shipments to take advantage of lower bulk costs.

The *Dictionary* defines a **foreign freight forwarder** as

an entity that picks up goods at the production site and coordinates transport to the foreign customer's location.

Foreign freight forwarders are not themselves carriers, nor do they buy and resell space on carriers. They are, instead, independent agents. In the United States, for example, they are regulated by the Federal Maritime Commission.

A great majority of international shippers use forwarders. Small companies use them because they can't afford to maintain a staff with the expertise required to handle foreign shipping and because one of the forwarder's functions is to consolidate smaller shipments into larger ones that qualify for discounts. But even large companies use forwarders, because they can benefit from the expertise of such specialists.

Forwarders may perform many different functions in the course of moving goods across international borders, including

- Quoting carrier rates
- Arranging charters or booking vessel space
- Preparing and presenting documents

- Obtaining insurance
- Handling payments
- Translating
- Tracing and expediting shipments
- Arranging inland transportation.

Although forwarders in the United States must be licensed by the government, they are not subject to certification requirements. However, certification is available for ocean forwarders from the U.S.

National Customs Brokers and Forwarders Association, which will designate someone as a “Certified Ocean Forwarder” based upon a combination of experience and passing a certification exam.

Airfreight forwarders may be either independent contractors or affiliated with a single air carrier. They require neither licensing nor certification. However, they may obtain certification from the relevant country’s regulatory body. In the U.S., this is the U.S. Federal Aviation Administration (FAA). In that jurisdiction, clients generally prefer to work only with FAA-certified airfreight forwarders. A major source of competition for airfreight forwarders comes from the carriers themselves, who can work directly with shippers. Companies like FedEx and UPS Air also compete with forwarders for small shipments.

Forwarders derive income from a combination of fees, markups, and commissions from carriers.

Non-Vessel Operating Common Carriers

The non-vessel operating common carrier (NVOCC) buys space on inland carriers and resells it to shippers at a marked-up price. NVOCCs handle only the part of the shipment traveling from a port to the importer’s dock or from an exporter’s dock to a port.

NVOCCs originated in the United States in the 1970s as a cost-effective alternative to the carriers. At the time, trains and trucks often returned to port empty after unloading cargo at inland destinations and charged the shipper for both halves of the round trip—even though the shipper made no money on the turnaround. The NVOCCs were able to solve the problem by finding cargo for the return trips to port.

Using their own containers for the inland journey, NVOCCs scout around for port-bound shipments to consolidate into those same containers for the trip back to port. They also provide container service for trips to and from foreign ports. Both shippers and carriers benefit from the intermediary work of the NVOCCs. The shippers receive reduced rates; the carriers gain access to a wider market.

NVOCCs can be distinguished from forwarders in three ways:

- NVOCCs actually buy and resell space on carriers; forwarders do not.
- NVOCCs perform the physical work of consolidating, loading, and unloading cargo; forwarders do not provide labor.
- NVOCCs can handle inland freight in many cases, such as shipping by a motor freight carrier from Charlotte, North Carolina, to Hawaii.

A freight forwarder could perform those inland functions for the NVOCC, and this could very well be a division of the freight line or their contractor. The NVOCC can arrange for transport, but these are common carriers that do not operate the vessels by which the ocean transportation is provided and are considered shippers in their relationship with an ocean common carrier.

Some NVOCCs are affiliated with freight forwarders; some are independent and are therefore able to work with a variety of forwarders. The independent NVOCCs can offer lower rates than those affiliated with a forwarder, but the affiliated NVOCC and forwarder can offer door-to-door service.

Though they neither own nor operate vessels, NVOCCs are regulated in the U.S. by the Federal Maritime Commission, which requires them to publish rates and not discriminate in hiring. However, they are also subject to different regulations from carriers, and this may put them at a disadvantage. Under the Ocean Shipping and Reform Act (OSRA) of 1998, for instance, NVOCCs are forbidden to enter into service agreements with shippers, while carriers are allowed to do so.

Consolidators

The consolidator combines small shipments into larger ones to qualify for full-vehicle discounts. Generally this service is provided to fill containers for intermodal shipment, such as turnarounds carrying cargo between an inland warehouse and a port.

Consolidators are distinct from NVOCCs, but they may work under them. A consolidator that is not affiliated with an NVOCC contracts with a forwarder or a carrier to arrange the transportation.

Customs House Brokers

Customs house brokers assist importers by moving shipments through customs. Their job is to ensure that all documentation required to pass customs is complete and accurate.

These days, the information required to clear customs is electronic and paperless, such as the Automated Broker Interface System in the United States and the Pre-Arrival Review System in Canada. Replacing paperwork with electronic data transfer has sped up the process of getting cargo through customs.

The customs house broker pays all import duties under a power of attorney from the importer. Liability for any unpaid duties lies with the importer, not the broker.

Export Management Companies and Export Trading Companies

When companies want to expand from domestic to foreign markets, they may turn for assistance to foreign trade specialists in either export management companies (EMCs) or export trading companies (ETCs) rather than adding internal expertise. While there may be some overlap in the types of services offered by EMCs and ETCs, there is a distinct line between their approaches. The EMC is generally not

an exporter itself but rather a consultant to the exporters that hire it. The ETC, on the other hand, is itself an exporter.

A common reason to hire an EMC is to acquire representation in a particular market where the EMC has special knowledge and connections. By working with an EMC, the exporter gains access to current information about the preferences of consumers in that market and about local customs and government regulations. Knowledge of local conditions enables an EMC to help the exporter avoid offending consumers or officials by inadvertent misinterpretations of the culture or the politics of the importer's country. Finally, EMCs often cultivate friendly relationships with host governments, and this can help ease the exporter's goods through customs. EMCs may also buy the exporter's goods and resell them in the foreign market (in the manner of an ETC), but generally they act as a company's long-term consulting partner, not as a buyer of its products.

An ETC, by contrast, looks for companies making goods that it wants to buy and resell in a foreign market. Its functions, therefore, may include locating importers to buy the goods, overseeing export arrangements, preparing and presenting documentation, arranging transportation overseas and inland, and complying with regulations.

More expansively structured ETCs are known as general trading companies. These entities may comprise banks, steamship lines, warehouses, insurance services, a communications network, and a sales force. Japan's success in international trade has been facilitated by such general trading companies, known in Japan as "sogo shosha." These enormous conglomerates are some of the world's highest revenue generators, including familiar names such as Mitsui and Mitsubishi. With offices in over 100 countries, the sogo shosha handle more than three-fifths of Japan's imports and over one-third of its exports. Other countries with very large general trading companies include Germany, South Korea, China, and the Netherlands.

Shipping Associations

Before deregulation, ocean liners were required to publish their rates. Smaller shippers, seeing the rate schedules, could ask for similar deals. Since deregulation, carriers and the larger shippers have been able to sign confidential rate agreements. In response, smaller shippers have formed shipping associations—usually nonprofit organizations—to negotiate with carriers for rate discounts on the same terms as larger shipping companies.

Ship Brokers and Ship Agents

Ship brokers and ship agents assist exporters with the details of arranging ocean transport. A ship broker is an independent contractor that brings exporters together with ship operators that have appropriate vessels available to carry the shipper's freight. With detailed knowledge of carrier schedules, the broker can help the exporter find a ship that will be in port when its cargo is ready to travel. A ship agent works for the carrier rather than being an independent contractor. When a ship is

headed for port, the ship agent arranges for its arrival, berthing, and clearance; while the ship is in port, the agent coordinates unloading, loading, and fee payment. Shippers contact ship agents for information about the arrival and availability of ships.

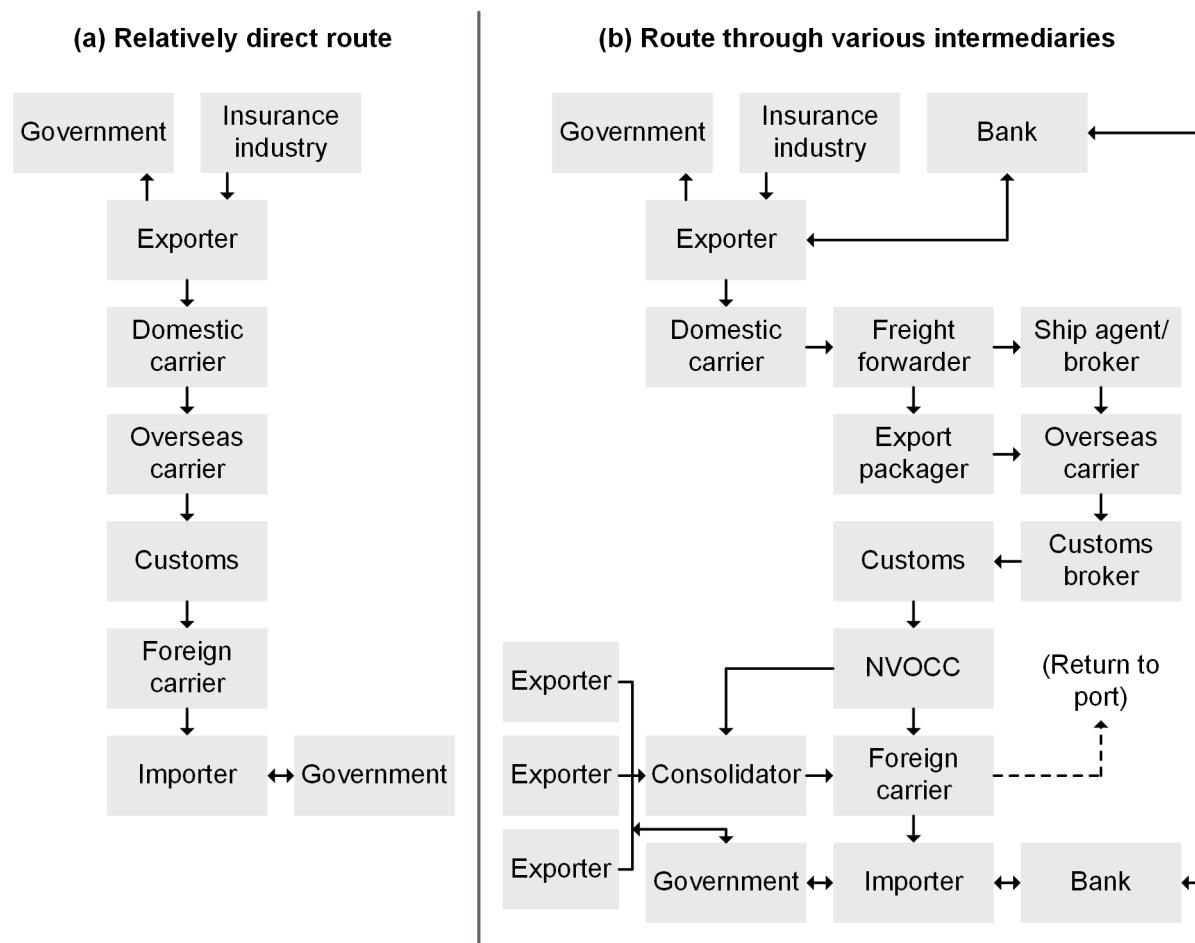
Export Packing Companies

Export packing companies provide the specialized packaging services required for cargo that may have to undergo long journeys and pass customs inspections in another country. The packing company can choose packaging materials that provide adequate protection with the least bulk and weight.

Export-Import Participant Flows and Summary

Exhibit 5-24 illustrates two paths that cargo might travel to get from an exporter to an importer—(a) the simplest possible journey and (b) a journey aided by a full complement of intermediaries.

Exhibit 5-24: Export-Import Flowcharts



In sum, the participants in export-import trade have the features and advantages described in Exhibit 5-25.

Exhibit 5-25: Roles of Export-Import Participants

Participant	Role
Exporter	Shipper and seller of the cargo
Importer	Exporter's customer, who buys the cargo and is sometimes responsible for payment of import duties at customs (usually handled by customs house broker)
Domestic carrier	Train, truck, or air carrier that takes cargo to the outgoing port

Participant	Role
Overseas carrier	Ship operator or air carrier that takes the cargo from the domestic port to the foreign port (assuming overseas transport)
Freight forwarder	Contractor responsible for getting goods from dock to dock and who arranges transportation for exporter's cargo
NVOCC	Non-vessel common carrier that arranges transport of cargo from port to importer and contracts for or purchases space on the ocean vessel for resale or its own use
Consolidator	Independent company or affiliate of NVOCC that consolidates shipments to load into empty vehicles for return trip from importer's dock to port
Customs house broker	Licensed broker who has the expertise to move a shipment through customs expeditiously and to ensure complete, accurate documentation
Export management company (EMC)	Company that acts as a consultant or an export department for one or several producers of goods and services; often has well-established network of foreign distributors, accelerating access into foreign markets
Export trading company (ETC)	Company that identifies companies making goods that it wants to buy and resell in a foreign market
Shipping association	Nonprofit association of smaller shippers banded together to negotiate better rates from carriers
Ship broker	Independent contractor who brings together the exporter with a ship operator that has a vessel available with the right services at the right time
Ship agent	Representative of a ship operator who is available to coordinate import activities for the shipper with cargo to export
Export packing company	Specialist in packaging cargo for export so as to combine lightest practical weight (for reduced duties) with maximum protection

Export Packaging Concerns

Industrial packing and proper labeling for export present special problems and may be handled by an export packaging company. Packaging for delivery to a foreign buyer requires consideration of issues such as the following.

Packaging for Rough Ride

International cargo needs to be packaged with materials and techniques chosen to protect the cargo from damage caused by rough handling, rough seas, extremes of temperature, and other hazards of long international journeys. The choice of mode has a large impact on the type of packaging that will be needed. For example, air requires and demands very little packaging due to the gentle ride and need to maximize the amount of cargo. On the other hand, ocean shipping requires significant industrial packaging, for example, internal braces built around the cargo in a container to keep the load from shifting. Export packaging companies are familiar with what materials are available and which are most suited to the destination, type of cargo, and mode of transportation

Packaging for Perishables

Perishable shipments include (but are not limited to) foodstuffs, floral products, plants, animals, and medical and chemical products. Due to their nature, perishables deteriorate over time or if exposed to harsh environmental conditions, such as excessive temperature or humidity and other forms of improper care and handling.

Numerous domestic and international safety regulations and packaging standards are in place to ensure that perishable shipments are properly insulated and cushioned and to prevent leakage, spillage, and contamination from other cargo during transit. Temperature extremes and transit times are also monitored. Live plants and animals need additional considerations.

Packaging for Customs

Customs will need to be able to access the cargo, and industrial packaging needs to accommodate this possibility. Also, for some countries, customs duties are based in part on the weight of the cargo (package included) and on the country of origin. For certain other countries, customs duties are based on weight only. In either case, this means that packaging needs to be as lightweight as possible while still protecting the cargo. Export packagers should be familiar with the customs requirements of each country.

Packaging for Sustainability and Reverse Logistics

Packaging using lighter materials or fewer materials can provide multiple benefits simultaneously. Not only can it reduce customs costs and save money on non-value-added items for increased profitability; it can also help an organization meet its sustainability goals. For example, Walmart used its leverage to get its suppliers to reduce their total amounts of packaging significantly. It developed an online scorecard to help suppliers meet these goals. When it extended these goals to Asia, it significantly reduced its environmental impact.

Packaging for reverse logistics can include reusable packaging or packaging that is designed to be biodegradable so it can be disposed of responsibly.

Packaging can enable sustainability and reverse logistics in the following ways:

- Use of the fewest resources possible compatible with the other demands of export packaging
- Selection of reusable materials as often as possible—and preparing to harvest them for reuse
- Selection of biodegradable materials when reusable materials aren't available or appropriate
- Preparation for disposal of any nonreusable, nonrecyclable materials in a responsible landfill, with use of released energy if possible

Labeling

When the shipment arrives at the buyer's port, customs will inspect the items to be sure that they contain all necessary markings, including safety labels, instructions, country of origin, and any special

marks required. Experienced packagers who are familiar with regulations in the importer's country can help ease shipments through the customs inspection by getting the labeling right.

Consolidation for Backhaul

Consolidators, export packagers, freight forwarders, and NVOCCs all should be able to deal with the problem of empty turnaround trips in the importer's home country, either directly or by contracting with a knowledgeable specialist. Packaging needs to be chosen with an eye to the available transportation in the destination country and the potential packaging needs of exporters whose shipments can be consolidated for the backhaul trip to the port or terminal. Generally this means using containers.

Export Documentation

Export requires considerably more extensive documentation than domestic transactions. Using the U.S. as an example, an overview of the major export document types follows.

Export Declaration

The U.S. Census Bureau uses the Automated Export System (called *AESDirect*) to capture and store U.S. export data electronically. *AESDirect* is provided free of charge to allow exporters to self-file their Electronic Export Information (EEI), previously known as the Shipper's Export Declaration (SED). The EEI must be filed for exports valued at US\$2,500 or more when shipped to any country except Canada. (Shipments to Canada are exempt from the AES regulation.) Paper copies of the EEI are no longer accepted. In most cases, the broker will file the EEI instead of an individual person working in the supply chain. Related links about the AES program and *AESDirect* are available online in the Resource Center.

The U.S. form includes such basic information as

- A description of the commodity
- The shipping weight (with packaging)
- A list of marks and numbers on the containers
- The number and dates of any required export license
- The place and country of destination
- The parties to the transaction.

Although some commodities are forbidden for export or limited in some way, the form exists as much for the purpose of compiling trade statistics as for enforcement.

Export License

Shippers need to acquire an export license. The licenses come in two types:

- A general export license allows export of most goods without restrictions.

- A validation export license is required for shippers who wish to sell strategically sensitive items abroad. (Countries may limit export of certain items of strategic significance, including military hardware, medical supplies, and high-tech products.)

Commercial Invoice

The commercial invoice states the value of the goods in the shipment and specifies payment terms and methods. It constitutes the seller's and buyer's invoice for the transaction. It also may be required for the letter of credit and by other entities that need to know the value of the goods for insurance or the assessment of duties. The information required and the language it's written in may vary from country to country.

A consular invoice, required by many countries for incoming shipments, is similar to the commercial invoice but also contains information needed for customs in the importer's country. Generally the consular invoice must be written in the language of the importing country, where it will be used for compiling trade statistics.

A pro forma commercial invoice is basically a quoted invoice (not yet official) that may be sent to a potential buyer in advance of the actual sale. It may contain the same information as a regular commercial invoice and serve as both a price quote and documentation for the potential buyer to use in securing a letter of credit to finance the purchase. Carefully documenting all costs in the pro forma invoice can help the exporter properly price the product by accounting for hidden costs.

ATA Carnet

Containers traveling under an ATA Carnet can cross several boundaries duty- and tax-free without customs inspection. (ATA stands for "Admission Temporaire/Temporary Admission.") The Carnet convention was adopted for western Europe in 1961 and was intended to apply to commercial samples, professional equipment, and items for presentation at tradeshows and other similar events that were merely passing through a jurisdiction, not being imported into it. Despite their original use for these specific purposes and items, Carnets now cover almost any type of goods, excluding disposable and consumable items, and they are used worldwide.

Certificate of Origin

A certificate of origin provides information on the country where the goods were produced (country of origin) for assigning tariffs and for compliance with government trade restrictions. It often accompanies cargo exported into a country that has signed a treaty granting favorable import duty rates to the exporting country. The certificate states that the goods actually did originate in the exporting country and are not merely being reshipped from there to benefit from the lower duty. There is more discussion on the complexities of the origin of goods elsewhere.

Bills of Lading and Air Waybills

A shipping company issues a bill of lading (B/L) with the buyer as a way of demonstrating ownership of goods. All international shipments are initiated by a B/L that serves as the carrier's contract and receipt for goods the carrier will transport from one destination and shipper to another specified destination and recipient. The B/L also serves to document claims if the shipment is delayed, damaged, or lost.

An international shipment may be covered by multiple B/Ls, each initiating a new leg of the journey. An export B/L applies to the carriage from the exporter's dock to its country's port, while an ocean B/L governs the port-to-port portion of the shipment. A combined transportation document groups the B/Ls from various modes into one document.

Order bills of lading provide evidence of ownership and are negotiable. Sellers may use them to transfer title to an intermediary, bank, or importer. A straight bill of lading, by contrast, is nonnegotiable and governs cargo that must be delivered straight to the consignee. A clean bill of lading, issued by the carrier, certifies that the goods have arrived at the ship undamaged. If the goods appear to have been damaged, the carrier will note that on the original B/L and will not issue a clean bill.

The ship's manifest, based on processed B/Ls, summarizes the vessel's cargo, noting the port where the cargo came aboard and the port to which it's bound.

A statement of liabilities appears in the primary B/L. According to the U.S. Carriage of Goods by Sea Act (1936), the shipper bears responsibility for losses that result from perils of the sea, acts of God, acts of public enemies (such as pirates or terrorists), or its own negligence. The carrier is responsible for maintaining the ship in good working order—literally, “ship-shape”—and is liable for its own acts of negligence. (Ocean carriers have fewer legal responsibilities than overland carriers.)

The air waybill (AWB), or airway bill of lading, is a standardized form used for all air shipments. Use of a uniform document has reduced processing costs for air shipping and facilitated faster clearing through customs. Unlike a steamship B/L (and except for a straight B/L), the air waybill doesn't provide title to the cargo. Instead, it serves only as a receipt for goods and as evidence of the contract of carriage. The cargo is delivered straight to the consignee named in the letter of credit financing the transaction—which may be either the importer or the bank issuing the letter of credit. If the goods are not designated for delivery to the bank, the importer can simply show up at the carrier's destination and claim the cargo. Therefore, unless there has been a cash payment to the exporter (or the importer is known and trusted at the destination), the AWB arrangement involves some risk. Some destinations provide for cash on delivery, with consignment contingent upon receipt of the payment from the importer. The exporter often engages a freight forwarder or consolidator to handle the shipment and provides a Shipper's Letter of Instructions authorizing the forwarding agent to sign the AWB on its behalf.

Exhibit 5-26 shows an air waybill.

Exhibit 5-26: Universal Air Waybill

000	1234 5678	Shipper's Name and Address	Shipper's Account Number	Not Negotiable Air Waybill (Air Consignment Note) Issued by	000-1234 5678							
					Member of International Air Transport Association							
Consignee's Name and Address		Consignee's Account Number		Copies 1, 2 and 3 of this Air Waybill are originals and have the same validity.								
				It is agreed that the goods described herein are accepted in apparent good order and condition (except as noted) for carriage SUBJECT TO THE CONDITIONS OF CONTRACT ON THE REVERSE HEREOF. THE SHIPPER'S ATTENTION IS DRAWN TO THE NOTICE CONCERNING CARRIERS LIMITATION OF LIABILITY. Shipper may increase such limitation of liability by declaring a higher value for carriage and paying supplemental charge if required.								
Issuing Carrier's Agent Name and City												
Agent's IATA Code		Account No.		Accounting Information								
Airport of Departure (addr of First Carrier) and Requested Routing												
To	By First Carrier	Routing and Destination	To	By	To	By	Currency	Chgr	Wt/Mtl	Other	Declared Value for Carriage	Declared Value for Custom
							PPO/COLL	PPO/COLL				
Airport of Destination		Flight Date	For Carrier Use Only	Flight Date	Amount of Insurance		INSURANCE - Carrier offers insurance and sum insurance requested in accordance with conditions on reverse hereto, indicate amount to be increased in figures in box marked Amount of Insurance.					
Handling Information												
No. of Pieces RCP	Gross Weight	Kg Lb	Rate Class Commodity Item No.	Chargeable Weight	Rate Charge	Total	Nature and Quantity of Goods (Ind. Dimensions or Volume)					
Prepaid <input type="checkbox"/> Weight Charge <input type="checkbox"/> Colct <input type="checkbox"/>						Other Charges						
Valuation Charge <input type="checkbox"/>												
Tax <input type="checkbox"/>												
Total Other Charges Due Agent <input type="checkbox"/>						Shipper certifies that the particulars on the face hereof are correct and that neither any part of the consignment contains dangerous goods, such part is properly described by name and is in proper condition for carriage by air according to the applicable Dangerous Goods Regulations.						
Total Other Charges Due Carrier <input type="checkbox"/>												
						Signature of Shipper or his Agent						
Total Prepaid <input type="checkbox"/>		Total Colct <input type="checkbox"/>										
Currency Conversion Rates <input type="checkbox"/>		Charges in Destination Currency <input type="checkbox"/>				Executed on (date)		at (place)		Signature of Issuing Carrier or Agent		
For Carriers Use Only at Destination <input type="checkbox"/>		Charges at Destination <input type="checkbox"/>				Total Colct Charges <input type="checkbox"/>						
COPY 8 - FOR FIRST CARRIER												

Dock Receipt

A dock receipt, issued by a ship agent, signifies that a steamship company has received cargo from a domestic carrier.

Certificate of Insurance

If the terms of sale require insurance, a certificate of insurance will attest that either the buyer or the seller (according to the relevant Incoterms® trade terms) has taken out a policy covering the cargo. The certificate indicates types of insured losses, the amount of insurance, who issued it, and so on.

TIR Convention and TIR Carnet

The Customs Convention on the International Transport of Goods under Cover of TIR Carnets (TIR Convention) is a 1975 United Nations treaty that established a common customs document called a TIR Carnet and established other trade-facilitating agreements, such as a mutual recognition of customs controls among participating countries. TIR stands for “transport international routier”

(international road transport). As of 2021, the TIR Convention has 77 contracting parties, one of which is the European Union. There are over 30,000 authorized operators (trusted carriers) and 3,500 customs offices in the system. In May 2021, the fully digitalized eTIR system came online.

The TIR Carnet enables sealed road transport trailers and containers to avoid customs inspections until they reach their destination country. (However, customs can still claim the right to conduct an inspection.) In the case of the European Union, the TIR Carnet is used only when the shipment originates or ends outside of EU customs territory or if the transit will involve movement temporarily out of and back into EU customs territory. Because the United Kingdom has exited from the European Union, it now needs to use TIR Carnets for European Union trade.

CMR Convention and CMR Waybill

The Convention on the Contract for the International Carriage of Goods by Road (CMR Convention) is a 1956 United Nations treaty that has been ratified by 58 parties, including most of Europe and almost all of the European Union. Its main instrument is a CMR waybill or consignment note. This is a standardized waybill provided in electronic form since 2017 as an eCMR waybill. Otherwise it is prepared in triplicate. It is prepared in three languages for ease of use in Europe or elsewhere. This waybill helps regulate carrier liability and requires standardized information about the shipment, origin, and destination, including information about dangerous goods. It also requires carriers to provide prompt notification of damages.

ATR Certificate

The APICS Dictionary, 16th edition, defines an **ATR certificate** as

a certificate that is required for trade between the EU and Turkey. It grants zero duty to “free circulating” goods in the EU, which are goods originating in the EU or imported to the EU with all import duties and taxes paid. Agricultural goods, minerals, and steel are excluded and must use form EUR1.

Import Documentation

Most countries are eager to promote the international sale of domestic manufactures and agricultural products. However, getting the goods into the buyer’s domain can often be a struggle. The consignee’s country has to worry about the balance of trade, contaminants, invasive species, and collecting the full amount of import duties. The customs office is the focal point of the importing country’s concerns.

In this section on the documentation concerns of importers, we’ll look at

- Classifying merchandise using the Harmonized Tariff Schedule
- Declared value and duty drawbacks
- Calculating import costs

Harmonized Tariff Schedule

It's imperative that all parties, including customs, know exactly what is being shipped. The Harmonized Tariff Schedule (HTS), which is administered by the World Customs Organization in Brussels, serves as a set of standard numerical descriptions of products exchanged in export-import transactions.

The *APICS Dictionary*, 16th edition, defines the **Harmonized Tariff Schedule** as follows:

The mechanism by which international tariffs are standardized. Importers and exporters classify all goods moved across international borders using the Harmonized System of the country of import. Then based on this classification the HTS is used to determine the amount of tariff they must pay.

A synonym is the **harmonized system classification codes**, which the *Dictionary* defines as

an internationally standardized description of goods that uses a system of numbers to provide increasingly detailed classification and descriptions.

The HTS coding system is used by more than 200 countries and economies as a basis for their customs tariffs and for the collection of international trade statistics. Over 98 percent of the merchandise in international trade is classified in terms of the HTS. It is important to note that while HTS codes are required for businesses selling merchandise internationally, they are not currently required for individuals (for example, selling from a website like eBay and shipping internationally). If you do not provide a code while shipping an item, the broker will typically assign an HTS code.

The basic HTS number is made up of six digits. Each country can assign up to four additional numbers, to make a 10-digit code. The United States, for example, maintains two versions of the harmonized code, both expanded to 10 digits. One is used for imports and is administered by the U.S. International Trade Commission (USITC); the other, called Schedule B, is used to classify exports and is administered by the Census Bureau. Many other countries use six- to nine-digit versions of the HTS number. For instance, Japan uses 39 codes to classify its salmon products. As you see in the excerpt of codes in Exhibit 5-27, Japan has used nine-digit codes to classify its live, fresh, chilled, and frozen salmon products.

Exhibit 5-27: Import and Export Salmon Commodity Codes for Japan

<i>Live</i>	
0301.99-290	Fish (excluding ornamental fish, fry for culture and 0301.99-210), live (import)
0301.99-900	Other live fish (export)
<i>Fresh or chilled</i>	
0302.11-000	"Masu" (<i>Salmo trutta</i> , <i>Oncorhynchus mykiss</i> , <i>O. clarki</i> , <i>O. aguabonita</i> , <i>O. gilae</i> , <i>O. apache</i> and <i>O. chrysogaster</i>) (import and export)
0302.12-000	Pacific, Atlantic or Danube <i>sake</i> (export only)
0302.12-011	"Benizake", red salmon <i>O. nerka</i> (import only)
0302.12-012	"Ginzake", silver salmon <i>O. kisutch</i> (import only)
0302.12-019	Pacific salmon excluding <i>O. nerka</i> and <i>O. kisutch</i> (import only)
0302.12-020	Atlantic or Danube Salmon (import only)
0302.70-000	Livers, eggs and soft roe of fishes (export only)
0302.70-090	Livers, eggs and soft roe of fishes (not <i>Clupea</i> , <i>Gadus</i> or <i>Merluccius</i> spp.) Fish livers and roes nes (import only)
<i>Frozen</i>	
0303.10-000	Pacific <i>sake</i> (prior to 2002) (export only)
0303.11-000	"Benizake" Sockeye salmon or red salmon <i>O. nerka</i> 2002 onward (imports and exports) – prior to 2002, code 0303.10-010 was used for imports and 0303.10-000 was used for exports)
0303.19.000	Other Pacific "sake" 2002 onward (export only)
0303.19-010	"Ginzake" silver salmon <i>O. kisutch</i> 2002 onward – previously 0303.10-020 (prior to 2002) (import only)

Declared Value and Duty Drawbacks

Once the exporter has determined the identity of the cargo by reference to the harmonized code, the importer is responsible for declaring the value of the cargo. That value, along with other factors, influences the amount of any import duty. According to the World Trade Organization (WTO), the declared value of the cargo should ideally be the actual price paid (or to be paid) by the importer. Goods shipped between one company's divisions located in different countries are valued by a transfer price, which is a standard cost plus a surcharge. The WTO recognizes other reasonable ways of determining value, such as the value of identical or similar merchandise.

Duty drawback is a refund of all or part of duty paid on goods that were first imported and then reexported. Governments differ on the details of drawbacks. In every case, however, the importer pays the import duty when the goods initially come into the country and then applies for the drawback after reexporting. The duty will be based on the increase in value based on a component or module, not on the increase in value due to transformation.

Calculating Import Costs

The assessment of costs due at customs varies from country to country. In addition to the import duty or tariff (the words "duty" and "tariff" are interchangeable), there will be customs-related fees and, in some countries, a value-added tax (VAT). Note that Canada has a VAT equivalent called a goods and services tax (GST) and that the provincial tax plus the federal GST is called a harmonized sales tax (HST).

Import duties are generally assessed as a percentage of either the Incoterms® CIF (Cost, Insurance, Freight) or FOB (Free on Board) value. (Note that there is also a UCC F.O.B. term used just in North

America but this is not what is being discussed here.) The FOB value includes the cost of goods plus the amounts paid by the exporter to transport the freight from its dock and load it on the ship. If the cargo consisted of goods subject to a 5 percent tariff and the CIF were 1 million euro, then the tariff (duty) would be 50,000 euro.

Value-added taxes (which resemble sales taxes in the United States) are assessed on the CIF or FOB plus the import duties. In the EU countries, for example, VAT is assessed against the CIF plus the import duty. VAT percentages in the EU are subject to change, of course, but as of 2021, the standard VAT in the U.K. was set at 20 percent. Reduced or zero VAT (5 or 0 percent) rates are available from each country for certain goods and necessities such as home energy, food, clothing, and books.

Topic 3: Trade Zones and Blocs

Here we discuss the importance of taking advantage of free trade zones and trading blocs.

Free Trade Zones

A free trade zone (FTZ), called a foreign trade zone in the United States, is a geographic area in a country in which some normal trade barriers such as tariffs and quotas are eliminated and bureaucratic requirements are lowered in hopes of attracting new business and foreign investments. Typically, goods may be landed, handled, manufactured or reconfigured, and reexported without the intervention of the customs authorities. Only when the goods are moved to consumers outside the zone do they become subject to the prevailing customs duties.

FTZs are part of a wider category of special economic zones (SEZs). Types of SEZs include

- FTZs with an objective of supporting domestic or re-export trade
- Export processing zones (EPZs) with an objective of enabling export manufacturing (Subtypes include traditional EPZs, which designate the entire area for export manufacturing, hybrids, which designate some part of the area as open to all industries regardless of export status, and single-factory EPZs, which designate the activities of an individual enterprise somewhere in the country as EPZ activities. A bonded logistics park [BLP] is a type of EPZ.)
- Urban enterprise zones, which have an objective of urban revitalization
- Freeports, which have an objective of multi-use, integrated development

Free trade zones are usually organized around major seaports, international airports, and national frontiers. The United Arab Emirates has created 45 “free zones,” including one at its international airport. China has 13 FTZs as of 2021 and will be designating the entire island of Hainan as another FTZ in 2025. This is an effort to attract more European companies to invest in mainland China.

In the U.S., a foreign trade zone is a federally sanctioned site where foreign and domestic goods are considered to be outside of U.S. customs territory. Merchandise can be brought into an FTZ to be stored, exhibited, repackaged, assembled, or used for manufacturing free of customs duty, quota, and other import restrictions until the decision is made to enter the goods into the U.S. market. No duty is ever paid on foreign goods that are reexported from the FTZ. There are approximately 250 FTZs in the United States, with at least one in each of the 50 states.

Benefits

Importers and manufacturers benefit from FTZs in the following ways:

- **Exemption from customs formalities, duties, or quotas.** Shippers land their goods in FTZs without going through customs formalities or import duties. They are also exempt from quotas.
- **Exemption from duties or quotas on reexports.** Goods can be reexported from an FTZ without having been subject to duties and, therefore, without having to go through a lengthy process to receive a duty drawback refund.
- **Deferral of duties on imports.** Duties and federal excise taxes are deferred on imports while they are in the FTZ. They will go through customs on the way out of the zone into customs territory.
- **Avoidance of fines.** Imports can be processed, remarked, and repackaged in an FTZ before going through customs. Therefore, a shipment with potential compliance problems can be brought into compliance in the FTZ before going through customs.
- **Reduction of import duties on some cargoes.** Shippers can land cargo in an FTZ, complete the break-bulk, and then go through customs with just those goods destined for that country.
- **Inspection of merchandise before paying duties.** An importer can have cargo brought into an FTZ for inspection and testing before paying import duties, thus eliminating the possibility of having to reject a shipment after paying the duty on it.
- **Avoidance of quota problems.** If a shipment of goods exceeds an import quota, the shipper can hold the cargo in an FTZ until it can come in under quota.
- **Indefinite, cost-effective storage.** Goods can be stored in an FTZ indefinitely without being subject to local and state inventory taxes. The zones are under customs control, so they provide excellent security for stored items.
- **Manufacture and assembly without “inverted duties.”** When the duty on imported components is higher than the duty on the finished product, it is called an “inverted duty.” To avoid paying an inverted duty, a domestic manufacturer can bring low-priced production materials into an FTZ and process them into a finished product for export. When going through customs, the manufacturer pays

the duty on either the components or the finished goods, whichever is more advantageous. The FTZ board (in the United States) must approve any manufacturing or processing that results in a tariff reclassification.

It's important to emphasize that any retail trade is forbidden in a free trade zone.

Drawback

A disadvantage of having a free trade zone is that the host country receives reduced revenues from import duties. However, with the numerous advantages of an FTZ, many countries do provide them.

Trading Blocs

As defined in the *APICS Dictionary*, 16th edition, a **trading bloc** (or **trade bloc**) is

an agreement between countries intended to reduce or remove barriers to trade within member countries. Frequently, but not always, those countries are geographically close.

According to Mansfield and Milner in their book *The Political Economy of Regionalism*, there are different types of trading blocs, including

- Free trade areas or zones
- Preferential trade agreements (which allow member countries to have preferential access to certain products from other member countries)
- Customs unions (made up of free trade areas with common external staff)
- Common markets (made up of free trade areas in which physical, technical, and fiscal barriers are reduced as much as possible)
- Economic unions (made up of common markets and customs unions as described above)
- Customs and monetary unions (made up of customs and currency unions that share the same external trade policy and currency)
- Economic and monetary unions (made up of common markets and customs and monetary unions).

In these instances, “union” refers to a group of two or more countries that form a unit that shares the same philosophies on certain aspects of trade. (This is not be confused with an employee collective bargaining group.)

Countries can belong to a variety of different trading blocs, and the World Trade Organization tracks the status of proposed blocs. There are also regional trading blocs that form when nations within a particular region join together to reap the benefits. The European Union (EU) is a regional organization that is a trade bloc. Some of the larger stand-alone agreements between states to form trading blocs include the United States-Mexico-Canada Agreement (USMCA), the European Free Trade Association (EFTA), the Caribbean Community (CARICOM), the African Union (AU), the Union of South American Nations (UNASUR), the Eurasian Economic Community (EurAsEC), the Arab League (AL), the

Association of Southeast Asian Nations (ASEAN), the Central European Free Trade Agreement (CEFTA), and the Pacific Islands Forum (PIF). One of the newer agreements is the Regional Comprehensive Economic Partnership (RCEP), which was signed in 2020 and had been ratified by China, Japan, and Singapore at the time of this writing. Other parties that have yet to ratify and put the agreement into full force include South Korea, most of the South-East Asian island countries, Australia, and New Zealand.

There is a dynamic range of opinions on how trading blocs impact the global economy—that is, whether they create or divert trade. According to the author of the *Routledge Encyclopedia of International Political Economy*, the answer is not clear-cut.

Now let's take a closer look at one of the major trading blocs, the USMCA.

USMCA

The USMCA went into effect on July 1, 2020. It replaces the North American Free Trade Agreement (NAFTA). The USMCA is generally consistent with NAFTA; for example, steel and aluminum tariffs are unchanged. The new agreement is designed, however, to deliver greater consistency among ports of entry, improved efficiency and less paperwork, and greater transparency. Notable differences between the two agreements include the following.

- **Agricultural tariffs.** Zero tariffs remain for agricultural products, but the U.S. is allowed to export more dairy products to Canada—3.6 percent of the Canadian dairy market rather than the 1 percent allowed under NAFTA.
- **Rules of origin.** To qualify for zero tariffs, products must meet certain levels of manufacture within the treaty area, called rules of origin. Rules of origin are product-specific, and USMCA rules may have changed from NAFTA requirements. For example, the rule of origin for automotive manufactures has been raised to 75 percent, as opposed to 62.5 percent under NAFTA. This increase is seen as an attempt to strengthen automotive manufacturing in North America. Shippers should consult the agreement for guidance on their own situations.
- **Certificate of origin.** Certificates of origin have been eliminated to reduce paperwork for shippers. Importers can claim favored trade status by providing certain data, including the name of the importer, exporter, or producer and their addresses; the name and address of the certifier; the tariff classification code; the criteria under which the good meets rule-of-origin requirements; the blanket period (which can be as much as 12 months for multiple shipments of identical goods); and a dated signature. Certification is not required for imports of US\$2,500 or less. While these changes have simplified the import process, they do not relieve importers of the need to document transactions carefully.

- **De minimis levels.** To streamline trade and support small and medium-sized enterprises (whose imports may be small), the USMCA raised thresholds (de minimis levels) for taxes and duty-free treatment. Canada treats North American express shipments valued at up to US\$40 as exempt from taxes; express shipments up to US\$250 are duty-free. Mexico provides duty-free treatment for express shipments up to US\$117.
- **Environmental and labor chapters.** These new chapters require the U.S., Canada, and Mexico to enforce environmental and labor laws, such as commitments to air quality and prohibitions against forced labor. These requirements reinforce the importance of conducting due diligence of supply chain members.
- **Sunset clause.** While NAFTA was declared to be in force until the agreement was removed by its members, the USMCA actually has an expiration date of 16 years, or July 1, 2036. The parties must formally review the agreement every six years, address problems, and discuss extensions.

Effects of Trading Blocs on Supply Chains

In order to have the complete picture of trading blocs, the effects on supply chains within and outside blocs should be explained.

Effects Within Blocs

The gravity model is used by social scientists to predict the movement of people and ideas between two population centers as a function of the population of each area and the distance between the areas. According to the gravity model, countries that are geographically closer tend to have a high volume of trade. Because transportation costs and trade barriers tend to be lower, countries that are closer to one another are more likely to become trading partners by forming a trading bloc. Supply chains in the respective member countries usually reap the benefits of volume, quantity, and better prices and terms as well as lower levels of tariffs.

With membership in a bloc, supply chain management may find that it's easier and less complicated to negotiate with fewer partners. With this smaller number, concessions between members can be more easily made and enforced, making the process less painful.

Supply chains from lesser-developed member countries with more economic and political variability can take advantage of agreements with larger entities that they would otherwise not be able to access.

Effects Outside Blocs

If a trading bloc is large, nonmembers may see their prices and demand for exports decrease. This can result in deterioration in trade terms and decreased market power of these nonmembers. Seeing a decrease in their exports, they may resort to protectionist tactics and increase their lobbying efforts.

The effects of trade diverted from nonmembers' supply chains can impact the nonmembers' ability to make multicountry negotiations feasible and increase the difficulty of doing business across borders, even if it's with the country right next door or one with which they've previously traded. Sometime if they are fortunate enough to continue to trade, the nonmembers may be forced to pay optimal tariffs to the bloc members.

Section D: Reverse Flow

This section is designed to

- Identify activities supported by reverse logistics
- Enumerate the business advantages and common requirements motivating development of a reverse logistics supply chain
- Describe the strategic impact on reverse logistics and design considerations related to network locations, warranty policies, return authorization policies, logistical network make-or-buy decisions, and product life cycle
- Describe the benefits of a well-organized reverse supply chain
- Explain how the waste hierarchy provides various options for handling waste but places prevention ahead of mitigation
- Show how in some cases waste exchange can repurpose certain types of waste and provide an additional revenue stream
- Explain how a waste exchange is a market exchange that links buyers with sellers of waste and byproducts
- Define hazardous waste and describe how it requires special transportation, storage, and disposal.

In this section we'll look at reverse logistics and explore some of the strategic approaches that, in some cases, not only mitigate the negative impact of product returns but also help in finding ways to make a profit on the back side of the supply chain.

Topic 1: Reverse Logistics

Reverse logistics facilitates returns, repairs, remanufacture, and recycling. After providing an overview of the subject, this topic addresses the processes of developing reverse logistics requirements and designing a reverse logistics system in more detail.

Reverse Logistics Road Map

Reverse logistics is defined in the *APICS Dictionary*, 16th edition, as

a complete supply chain dedicated to the reverse flow of products and materials for the purpose of returns, repair, remanufacture, and/or recycling.

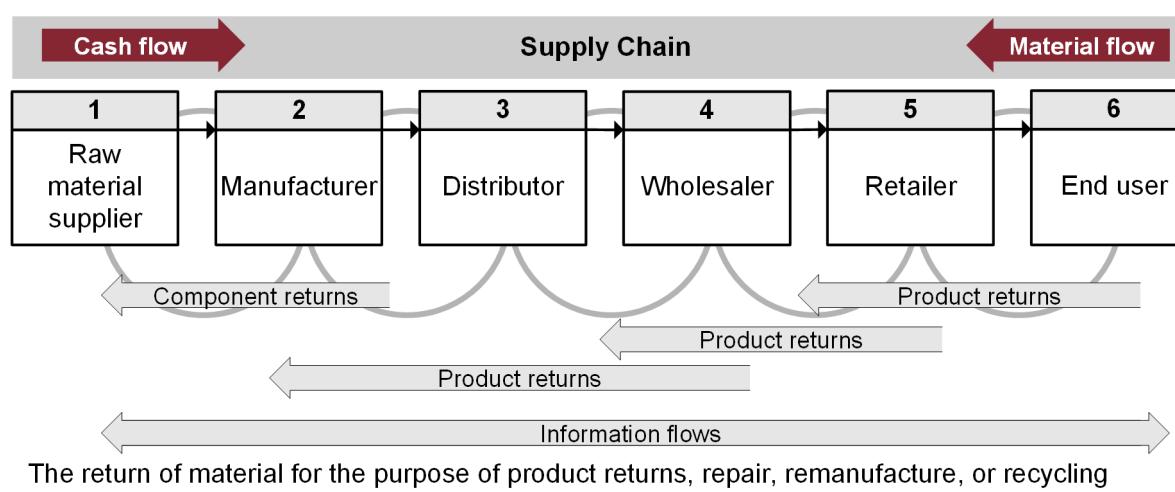
The *Dictionary* defines the **reverse supply chain** as

the planning and controlling of the processes of moving goods from the point of consumption back to the point of origin for repair, reclamation, recycling, or disposal.

The reverse supply chain is a complete chain, a mirror image of the forward chain that carried the product to the customer in the first place. As such, it has operations that are similar to those in the forward chain—customer service (marketing in reverse), warehousing and transportation going in the opposite direction, unpackaging, disassembly, and disposition in the form of resale, remanufacturing, recycling (a return to raw materials), donation, or disposal. The products in the reverse chain won't necessarily move through the same nodes as products in the forward chain because fewer, and different, warehouses, may be required.

Exhibit 5-28 shows the direction of material and cash flows in the reverse supply chain and lists some reverse logistics activities.

Exhibit 5-28: Reverse Logistics



Reverse logistics can occur not only as customers are returning products that were purchased but also as retailers or distributors return products that failed to sell (e.g., if there are contractual agreements to take back unsold inventory for some amount of refund or rebate on future purchases) or were defective. Similarly, manufacturers might return defective or excess components to suppliers.

As a relatively new concern, reverse logistics does not yet have the same level of support by strategists and software engineers as forward logistics, but it isn't a small phenomenon. In some online businesses, returns can be as high as 50 percent; in addition, returns can include containers, etc., as well as products. At one time, Estée Lauder was dumping about US\$60 million worth of its products into landfills every year. Some estimates put the total spent on reverse logistics in the United States as high as US\$50 billion, with the value of returned goods at around \$550 billion. Strategic solutions are on the way, though.

Reverse logistics is often a required cost of doing business, especially in a "customer is always right" world. It can be a severe drain on organizational profitability and could eventually contribute to an organization's demise if it is continually just an expensive afterthought. However, if it is handled strategically and the organization invests time and energy in planning the returns, repairs, reuse, recycling, and responsible disposals they are obligated to handle—including the disposal of hazardous

waste—the organization can, in some cases, generate revenue from these sources to offset the costs, and the costs themselves can be kept reasonable by focusing on smart policy and efficient practices.

Many major companies have taken up the challenge of improving their management of the reverse flow of products, among them Dell, HP, Home Depot, Lenovo, and Google. Since at this point reverse logistics is unlikely to be a core business for many companies, 3PLs and 4PLs are adding reverse logistics to their portfolios. UPS, for instance, features its expertise on its website. GENCO ATC is a 3PL that has been in the reverse logistics business since the 1980s and includes clients such as Walmart, Target, Levi's, Dell, and Kraft-Heinz. It also sells reverse logistics software for the retail industry.

The focus needs to be on integrating returns, recalls, repairs, remanufacturing, and other end-of-life topics into the supply chain so that these can not only be dealt with efficiently but also become a source of revenue. National and local governments are increasing regulations in this area, so getting reverse logistics right will help compliance be just a regular part of doing business and keep waste and hazardous materials out of landfills.

Reverse Information, Cash, and Product Flow

Information, cash, and products flow through the reverse logistics chain just as in the forward chain. Software for managing this process does exist but isn't as well adopted as software for forward logistics applications.

- **Reverse information flows and reverse logistics information systems.** Legacy systems cannot effectively be used for tracking returns. Cloud-based systems will be needed to capture data on product identifiers and link them to the point of return, the reason for the return (e.g., defective, unsatisfactory, incorrect order, unsold or excess inventory, repairs or refurbishment, remanufacture, or regulatory recycling or disposal), and warranty status. The status of each product also needs to be tracked from its entry into the reverse flow until its final disposition, along with the costs or revenues accumulated at each step. A bill of material for disassembly can be produced to help track the disposition of components. Unique product (and, in some cases, subcomponent) identifiers are needed for this type of information to be tracked. The path that a returned item takes through the reverse supply chain may also require the management of new partners that handle tasks such as material recovery. An organization also needs information on product failures for product redesign or recall purposes.

Organizations lacking reverse logistics information systems will need to acquire these to provide the required visibility, possibly as add-ons to existing systems. Such systems should be capable of managing return center operations; repair, remanufacture, and recycling centers; product recalls; vendor returns; and tracking, tracing, and compliance reporting.

- **Reverse cash flows.** Cash flows in the reverse supply chain take the form of credits and discounts. This all needs to be done as simply as possible from the perspective of the customer (who is often not happy while these transactions are taking place) as well as placing the least possible burden on customer service. Product return policies should match strategy. The total cost of returns needs to be calculated in the aggregate by product line.
- **Reverse product flows.** Product returns require reverse forecasting and establishment of locations for collecting, reprocessing, or disposing of the goods on their return trips.

Reverse Logistics Benefits

The benefits of a carefully designed reverse logistics supply chain that maximizes resource conservation, reuse of components, and recycling of materials include

- Potential for highly lucrative customer service contracts and extended warranties (especially if the products are well designed and reliable)
- Mitigation or elimination of the unprofitable effects of high-volume returns
- Enhanced customer loyalty and corporate reputation
- Return of valuable raw materials for other industrial uses
- Development of more efficient products and logistical tactics
- Profits from resale of refurbished products and parts that would otherwise go into landfills at a cost to the company
- Creation of new types of jobs
- More efficient use of energy
- Conservation of resources for future generations
- Reduced emission of many greenhouse gases and water pollutants
- Development of “greener” technologies
- Reduced need for new landfills and incinerators.

A key benefit of reverse logistics is that many activities can generate revenue. These revenues come from several sources:

- Service contracts and extended warranties bring in substantial cash flows and provide peace of mind for customers.
- Remanufactured products and recovered materials are finding profitable markets.
- Repair fees can be in excess of repair costs.
- Recycling fees can offset any costs involved in taking back products. Charges for recycling motor oil after an oil change, for example, are now taken for granted in some markets.

Reverse Logistics Costs

Costs from several sources have to be considered when determining profitable fees and prices, for example, costs for providing return labels in packaging. Other associated expenses affect the supply

chain in the following ways:

- Only a small percentage of returned items may be easily restocked or resold.
- Warranty repairs have to be charged off.
- Spare parts may be needed for repairs.
- There may be special processing and handling costs involved in returned materials, including new packaging for resale items.
- Freight costs can be high for sporadic, low-volume shipment, and extra transportation legs may have to be added to the network to accommodate destinations specific to returns and recycling.
- Warehousing costs can be higher for small numbers of items that need to be restocked or stored in separate locations.

Total cost calculations for returns sum the various revenues and deduct the various expenses. This amount can be tracked for benchmarking purposes and for comparison to other options in a make-versus-buy analysis.

The total cost of reverse logistics can be calculated as follows:

+ Returned product liquidation revenue
+ Recycling revenue
+ Repair revenue
+ Restocking charges and warranty/service program fees
+ Increase in sales from warranties, remanufacture programs, environmental reputation, etc.
+ Capture of tax savings or incentive program benefits
- Returned product cost of goods sold
- Processing and handling costs
- Transportation costs
- Repair and spare parts costs
- Warranty expenses and returns credits
<hr/> Total cost of reverse logistics

Processes for Managing Reverse Logistics

Key processes that supply chain managers need to be able to perform related to managing reverse logistics are

- Identifying requirements of reverse logistics
- Designing a reverse strategy and process
- Implementing reverse logistics.

The following is a general overview of these processes.

Identifying Requirements of Reverse Logistics

Identifying the requirements of reverse logistics involves the following steps:

- Assessing the as-is state of reverse logistics strategy and processes
- Determining the stakeholders for each product family's reverse logistics requirements (e.g., customers; finance and other executives; health, safety, and environmental regulators; interest

groups; transporters and 3PLs, etc.)

- Gathering requirements from each stakeholder group
- Consolidating and categorizing requirements
- Determining the impact of stakeholder requirements on strategic priorities (e.g., customer service impact)
- Reviewing organizational and supply chain strategy to determine if stakeholders' reverse supply chain requirements necessitate modifications to these strategies (i.e., these requirements are often overlooked during strategic planning)

Designing Reverse Strategy and Process

Designing a reverse strategy and process involves the following steps:

- Prioritizing requirements based on organizational and supply chain strategy
- Designing the to-be state of reverse logistics, either during the product development and introduction stages or as modifications to existing operations
- Analyzing the gaps between the as-is and to-be states
- Developing a quantitative and qualitative benefit-cost analysis to justify strategic choices and tradeoffs
- Generating a reverse logistics strategy, including how the strategy might need to change at various points in the product life cycle
- Influencing executive support to champion and lead the strategy and allocate funding
- Designing information systems and network locations for reverse supply chain activities
- Designing processes and policies for each product, subcomponent, waste item, and raw material entering the reverse logistics hierarchy (i.e., whether to reduce, reuse, recycle, recover energy during disposal, or dispose in a responsible landfill)

Implementing Reverse Logistics

Implementing reverse logistics involves the following steps:

- Gaining final executive approval and funding for specific infrastructure and process changes or contract negotiations to implement the strategy
- Planning and implementing projects to change processes and infrastructure
- Contracting with third-party participants
- Using change management and training to alter the culture of the organization to support the changes over the long term
- Setting up metrics and goals for monitoring and controlling operations and customer service impact
- Monitoring and controlling the processes and operations
- Gathering feedback and implementing continuous improvement

Requirements for Reverse Logistics

What drives the upsurge of organizations' interest in reverse logistics? Here are a number of motivating factors underlying various stakeholders' requirements.

- **Cost avoidance.** A primary purpose of reverse logistics for many organizations is to mitigate loss from returned items. A return is a reduction in sales revenue. Traditional brick-and-mortar retailers experience returns in the range of 8 to 10 percent, while online retailers have it even worse, with 20 to 30 percent or more of products being returned.

In addition to the loss of revenue, return processes are typically more expensive than their forward supply chain counterparts. This includes higher transportation costs for handling small shipments of oddly assorted items; warehouse costs that may include testing, refurbishment, repair, and restocking; and inventory costs of write-down or write-off and proper recycling or disposal. Returned items that are unused and fully functional may or may not be able to be marketed as new, depending on regulatory requirements for the industry, and may need new packaging if they can be resold as new. Since certain items such as electronics become obsolete quickly, the longer the return process takes, the less value returned items have from a resale standpoint.

Administratively, organizations often are unable to properly quantify how much returns are actually costing, because it is difficult to estimate the value of any returned items (if any) until they are actually refurbished and resold or recycled. This results in a lack of priority for reverse logistics and thus inefficiencies in the reverse supply chain.

- **Savings in the aftermarket.** Sometimes there is literally gold in the reverse supply chain, not to mention silver, platinum, copper, zinc, mercury, lead, and the whole range of commercial metals. Returned products can be “mined” for scarce materials—many of which should definitely be kept out of landfills. Products can be repaired for continued use, refurbished for resale, or disassembled for their usable components. AT&T’s Network Systems Division, for example, realizes significant savings by operating a reverse logistics system for telephone switching equipment.
- **Competitive edge.** Consumers can be wooed and won with products that promise good service. For example, if customers have easy and free return experiences, they are far more likely to become loyal and profitable. A study by Moore et al. placed this value at 5 to 20 times the initial sales price of the returned product. Ease of return, repair, and recycling may add to a product’s value in the consumer’s mind. Many consumers are daunted by the need to pay to dispose of a defunct television or appliance. The idea that a manufacturer or retailer might take responsibility for such items at the end of their days—as AT&T has done with phone equipment—can definitely be attractive to some customers.
- **Consumer and shareholder pressure.** Consumer groups have learned to make themselves heard through direct action and lobbying. As part of this movement, shareholder groups bring resolutions to corporate annual meetings proposing various “green” or consumer-oriented policies. Sometimes

these pressures result in changed corporate policies when companies sense an opportunity to turn such sentiments into customer loyalty and sales. Or consumer pressures result in the adoption of new government regulations at the local, national, or regional level.

- **Growing market for environmentally safe products.** The desire for access to products that are simple, clean, and less threatening to the health of persons or the environment can be a legitimate source of ideas for innovative approaches to product design. Some customers will pay a premium for products that promise to protect their health and their world. Some corporations provide incentives for product ideas that incorporate reverse logistics thinking.
- **Safety and environmental awareness and regulations.** In 1962, with the publication of *Silent Spring* by oceanographer Rachel Carson, the usually quiet undercurrent of concern for nature erupted into the public consciousness. Carson's subject was the unacknowledged side effects of the use of the pesticide DDT. The world has never again been able to view the impact of our activities on the environment with casual disregard for unintended consequences. That concern is a root cause of the growing attention to the afterlife of commercial products—especially hazardous materials such as pesticides and industrial chemicals. We know now that discarded items don't harmlessly fade away unless they are quickly biodegradable.

Safety and environmental regulations on hazardous waste or items that need to be kept out of or reduced in landfills provide a reason for logistics managers to pay more attention to the defective or obsolete products that return and move back up the supply chain. The EU has made a strong commitment to waste reduction. For example, Germany requires that all German businesses must accept returns of their packaging. In the Netherlands, a disposal fee is charged when many kinds of new products—appliances, TVs, cars—are purchased. These funds are used to disassemble products at the end of their life.

Reverse Logistics Design

Reverse logistics networks need to be consciously designed to satisfy reverse logistics requirements while also avoiding causing too many tradeoffs or issues for the forward supply chain. When designing the reverse logistics network, keep the following factors in mind:

- Warranty and returns authorization policies strongly affect the cost of reverse logistics, so these need to reflect strategy in their designs.
- The infrastructure and processes in reverse logistics networks also need sound strategy and designs.
- Reverse logistics affects all stages of a product's life cycle, not just the last stage; a design for reverse logistics strategy can be used to ensure that product design considers how to promote reverse logistics efficiency.

Next we'll look at how these factors affect the strategy and design of reverse logistics.

Warranty Strategy and Design

A product's warranty period creates a liability for an organization since defective products will need to be replaced for no charge during this period. Warranties are offered to promote sales by providing peace of mind for buyers, so both the costs and the benefits of these programs should be estimated. The benefit is the increase in sales from the warranty. The costs are the cost of returns that need to be charged off as well as the financial uncertainty of how many returns there will be. (It could be as much as all products sold, for example, in a recall situation.)

A complication arises when the warranty periods on supplier components differ from the warranty period on the final product offered to customers. A repair on a product warranty may require replacing parts that are not under warranty for the manufacturer, meaning that this cost cannot be passed on to the supplier. This can create a hidden liability that is difficult to calculate when determining the costs of reverse logistics.

Returns Authorization Strategy and Design

Organizations need to set policies for how and when returns will be accepted as part of their overall reverse logistics strategy. Many retail organizations promote liberal returns policies, for example, allowing returns of any unbroken item with no reason needed, given just the receipt or the credit card used to make the purchase. This is a strategic decision to prioritize customer service and thus encourage customer loyalty. The costs and benefits of these policies need to be measured over time. Other organizations will impose more strict returns policies, such as only defective returns or all sales being final.

The idea is to reduce the number of returns without having too many unintended consequences for customer service and thus sales. Ensuring that this process is fast and easy for customers and clearly communicating the return policy at the time of the sale (setting expectations) can go a long way toward creating a good customer experience. Companies often contract with external returns specialists who provide customer service support while minimizing unnecessary returns.

For B2B returns, a lot-size return policy might make sense. This involves requiring corporate customers to hold returns until full truckload quantities can be sent, to make transportation more economical. In a B2C (business-to-consumer) example, Dell allows products to be returned only after the customer speaks directly with a live customer service representative. While there is a cost for this direct support from what they call "gatekeepers," the representative is given the opportunity to provide instructions on how to properly set up the device, up-sell support devices, or otherwise talk the customer out of the return. This investment is cost-effective; it results in a 5 percent level of returns, much lower than the average return rate.

Logistical Network Strategy and Design

The design of the reverse logistics network involves determining where in the process to locate the various reverse logistics activities. Returns happen at the retail level and back up the chain from there to distribution centers, manufacturers, suppliers, and so on. Determining where products will be tested, remanufactured, and so on requires a total cost of ownership analysis that may involve collaboration among many supply chain partners to determine the best point overall. The location or locations that make the most sense may involve weighing cost, customer service, and speed. These activities could be centralized at one location or distributed among retailers, distribution centers, or suppliers.

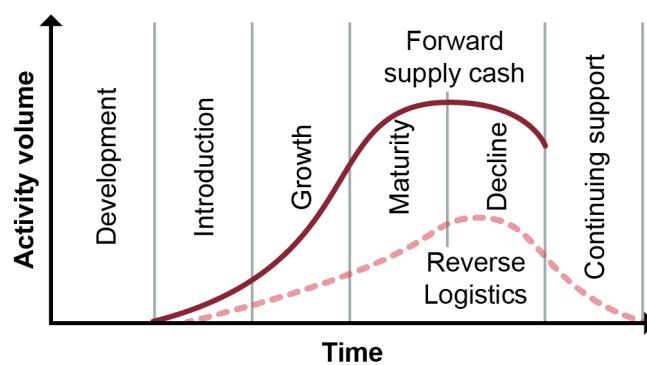
Another important consideration in the design of the reverse logistics network is whether all or parts of the function will be contracted out to 3PLs. Organizations such as Frito-Lay remove expired inventory as part of the process of stocking new inventory at retail locations using their own drivers.

Transportation might be outsourced to small package services such as UPS or FedEx, while testing and refurbishment is retained as a distribution center responsibility. At the other end of the spectrum, the entirety of the process could be outsourced. Organizations such as GENCO ATC specialize in liquidating returns, which could result in some amount of revenue inflow to the organization or at least lower revenue losses than the organization could achieve on its own.

Life Cycle Design

Reverse logistics considerations affect the entire product life cycle, not just the last phase. Exhibit 5-29 shows how the forward product life cycle and the reverse logistics cycle create similar curves when measured as volume of activity over time. However, the reverse logistics curve is shifted forward, since returns don't start until products are shipped, and it is smaller, because only a percentage of products will be returned.

Exhibit 5-29: Product Life Cycle with Reverse Logistics Cycle



A continuing support phase is also added in the exhibit. This is added here to illustrate that the reverse logistics cycle may have ongoing costs and revenues. Such a period may be necessary if there is a warranty period, a service contract period, a period of guaranteed service or parts availability for discontinued models, or a period in which products will be accepted for hazardous or other waste recycling or disposal. This period could last indefinitely, depending on organizational policy.

Design and Development

Using a design for reverse logistics strategy as one aspect of product/service development can help keep the costs of reverse logistics down. Several aspects of reverse logistics should be built into product design and ramp-up:

- Plans need to be made during product design for potential reuse of the product or its components.
- Avoiding use of hazardous or scarce materials, especially rare earth elements (REE) and metals (REM), can be designed in if substitutes can be found.
- How to make good use of resources, including energy, should be incorporated into design decisions.
- Consideration of how to package and ship the product most efficiently needs to be considered early in design.

As supply chains going forward and backward extend across oceans and national boundaries, reverse network design becomes increasingly important. Forecasts should be done for the amount of each type of product that is likely to be returned. Long-term return forecasts can be used to determine the number and location of return facilities as well as the number of dedicated staff that will be needed. Customer service, materials handling, and other functions need to be trained to handle the procedures and paperwork involved in returns, refunds, and repairs.

As an example of a process design, in the Netherlands, DAF Trucks has a long-term relationship with Van Gansewinkel, their garbage and scrap metal collector. Formerly, the garbage bins (rolling containers) were filled in the plant and pulled outside to a garbage compressor. Now a small garbage truck drives into the plant to collect the garbage. Not needing to tow containers back and forth has reduced costs by 5 percent per year. The same trucking company has also redesigned its product packaging. A DAF plant in Belgium produces body parts that are sealed in plastic to prevent scratching. Originally, DAF used the lowest-cost plastic and had to pay to dispose of the used plastic. Van Gansewinkel proposed using a different type of plastic, which was more expensive but had a market value after use. The total cost of plastic has worked out to be lower.

New Product Introductions

Even in the initial phase of a new product introduction, reverse logistics comes into play:

- Customer service has to be prepared for early returns of the new product, since defects and disappointments are more likely during ramp-up than during later stages of a product's life. High-quality customer service can prevent the worst effects of early product failures. (There's a role for sales and marketing here, too.) In addition to the negative impact on reputation, a flood of early returns can cause serious logistical problems if the reverse supply chain hasn't been set up to handle such an unpleasant surprise.
- If early product returns are heavy, design engineers need to be prepared to make rapid improvements in the product.
- The service department needs to be in place at this time, as does an inventory of replacement parts.

Maturity

Reverse logistics events continue into product maturity:

- Returns are a high-volume operation in some industries.
- Receiving areas need to be designed to accommodate operations required in handling returns, such as repackaging and inspections.
- Packaging for returns needs to be considered along with packaging for forward shipping. For example, HP laser cartridges are delivered to consumers in a box with simple instructions for how to repackage the used cartridge in the same box and give it, free of charge, to any UPS driver or facility for shipping back to the manufacturer. This reverse network, complete with training for UPS, had to be in place and ready to receive cartridges when the first products were shipped to retailers.

Decline, Return, and Continuing Support

The reverse supply chain should be designed to anticipate issues that will arise as products reach the end of their useful lives. The following are significant concerns relevant to product decline, return, and continuing support:

- Preparation should be made for any environmental and legal exposures. This is especially true with hazardous materials that are subject to extra regulations locally, nationally, and internationally.
- Nonhazardous materials may also be subject to extra regulations. For example, one beer manufacturer requires its distributors to have a permit to dump recalled beer. The glass and cardboard packaging also have to be recycled at the same time.
- Final disposal needs to be documented and the records kept for a period of years.
- Packaging as well as products should be designed for reuse or made biodegradable.
- Parts, customer service support, and other services may need to be provided for a certain period following the discontinuation of a product.

Topic 2: Waste

The waste hierarchy is a simple but powerful policy tool to help organizations design a reverse supply chain that prioritizes the most environmentally friendly disposition processes. Since the better methods are often also the more cost-effective options, this is a win-win. Waste, hazardous waste, and waste exchanges are addressed here.

Waste Hierarchy Elements

The APICS Dictionary, 16th edition, defines **waste hierarchy** as

a tool that ranks waste management options according to what is most environmentally sound. It gives top priority to preventing waste in the first place, and can be applied to various applications.

The waste hierarchy is sometimes called the reverse logistics hierarchy or the four Rs. In order of importance, the Rs are reduce (use of resources), reuse, recycle, and recover (energy). Exhibit 5-30 shows the relationship of the four Rs and places an additional item, the least desirable option—disposal in a landfill—at the bottom. We'll look briefly at each of these activities to see why they are considered beneficial to business, society, and the environment.

Exhibit 5-30: Waste Hierarchy



Reduce Resource Use.

Reducing the use of resources in the first place is considered the most responsible option in the waste hierarchy. Companies can incorporate this principle into their business in the following ways:

- Reduce costs by designing products and packaging that make the most efficient use of physical resources.
- Design products with an eye to reducing the consumption of energy in their manufacture and use.
- Design the logistics network for efficient use of resources and energy in warehousing and transportation. (This is a straightforward matter of cost containment.)
- Reduce excess inventories by investing in supply chain demand management, visibility, and so on.
- Repair or restore products and return them to the customer for an appropriate fee (unless under warranty). This strategy requires maintaining a repair department, contracting this service out, and/or allowing the market to provide these services independently (e.g., automotive repair shops).

The reduce step in the hierarchy is a preventive measure that ideally takes place during the design and development phase of a product's life cycle but could be implemented as part of a continuous improvement initiative. For example, a clean technology such as a new machine press that produces less waste could be included in production plans or as an upgrade. The *Dictionary* defines **clean technology** as

a technical measure taken to reduce or eliminate at the source the production of any nuisance, pollution, or waste and to help save raw materials, natural resources, and energy.

The importance of considering waste during product design and development is illustrated by the 40/30/30 rule. The *Dictionary* defines the **40/30/30 rule** as

a rule that identifies the sources of scrap, rework, and waste as 40 percent product design, 30 percent manufacturing processing, and 30 percent from suppliers.

While this is a rule of thumb and could differ depending on the product, it shows how up-front work during the design of products and manufacturing processes and supplier selection will have big payoffs in waste reduction, which will lead to efficiency improvements and thus to higher profitability.

Reuse Products or Components.

Potential reuse of products or parts of products is considered second in importance to resource conservation. The payoff is a reduction of the costs involved in purchasing, transportation, and disposal. This can be accomplished in several ways.

- Resell returned products that pass quality control, repackaging and relocating products as needed (to new selling locations, including resellers).
- Donate excess inventory to charities as appropriate and allowed, which may provide a tax benefit. (For example, Habitat for Humanity, a charity that builds homes, is a common recipient of excess building materials.)
- Remanufacture products to like-new condition by replacing worn parts with new parts and sell at a discount or as part of a trade-in program. This is especially appropriate for big-ticket items; for example, Caterpillar has a program like this for industrial equipment.
- Sell byproducts to organizations that can use them as raw materials (discussed in detail elsewhere).
- Design products so materials and components can be more easily separated for reuse. This is called design for disassembly and recycling.

In addition, intelligently designed product upgrades can extend the life of durable components if they are easy to install. Software upgrades delivered online, for example, extend the life of programs without requiring physical delivery. Such upgrades result in savings in the logistics network and for the consumer. Rechargeable batteries enable reuse of a battery that would otherwise need recycling.

Recycle Materials.

After resource conservation and reuse, recycling is the third most important aftermarket principle. The concept of recycling isn't easily separable from the concept of reuse, and, in fact, the two can be combined. When containers (bottles, barrels, totes, drums, etc.) are cleaned, sterilized, and filled again, they are reused. When containers are reprocessed into other products, such as landscaping materials, they have been recycled. When a product is broken down into components, some parts may be reused, some recycled, and some sent to the landfill. Recycling reduces disposal costs; reuse can reduce purchasing and transportation costs as well.

Recycling can run into problems when different regions enact different requirements, creating diseconomies of scale. Organizations are often forced to customize programs for multiple local areas, which entails different methods, different training, and so on.

Recycling requirements can also change. For example, a third-party recycling industry has not yet been developed for the lithium-ion batteries used in electric cars (such as Tesla). However, individual companies are reusing or recycling batteries. Volkswagen, for example, has a pilot battery recycling plant in Salzgitter, Germany. Since this market is growing fast, especially in Europe, there will soon be a huge number of electric cars reaching their end of life, and this issue will become critical. Advocating now for solutions at the federal levels of government would allow this process to be consistent.

Recover Energy.

Disposal with energy recovery doesn't put a product's physical materials or components back into service, but it can still provide benefits. "Trash to energy" facilities essentially harvest the energy contained in products that are no longer usable in their physical form. This results in savings for the community. Organizations might directly benefit from this practice as well, for example, by using oil that has already been used to the maximum extent as a lubricant as fuel to run generators. Some of the more modern trash-burning facilities in Europe have very low emissions. In addition to incinerators, energy can also be recovered from biodegradable materials by capturing the gases they release.

Dispose in Responsible Landfill.

The *Dictionary* defines a **responsible landfill** as

landfill operations designed to turn waste into recoverable resources, minimize the amount of space consumed, and maximize the operational life of the landfill.

Some physical products must go to the landfill, but this is the least desirable option. Incineration is generally considered the preferable alternative. If the landfill is the only possible way to dispose of a product, it's still important to choose the best available one. Not all landfills are equal, so the final leg of a product's reverse journey should end in a responsible landfill that prevents degrading items from leaching into a water source or polluting the air.

Waste, Hazardous Waste, and Waste Exchange

The *APICS Dictionary*, 16th edition, defines **waste** as follows:

- 1) Any activity that does not add value to the good or service in the eyes of the consumer. 2) A by-product of a process or task with unique characteristics requiring special management control. Waste production can usually be planned and somewhat controlled. Scrap is typically not planned and may result from the same production run as waste.

Waste is a consideration not only for compliance and ethical reasons but also for economic ones. Some forms of waste may be inevitable given the nature of a manufacturing process. Some options for processing or disposing of waste will result in significant costs, with some being more expensive than others. The idea is to find the best option that addresses compliance, organizational risks, liabilities, ethics, and reputation while remaining a cost-effective choice. Dealing with waste in this way is called total waste management. The *Dictionary* defines **total waste management (TWM)** as

a methodology that enables finding solutions to waste issues while keeping in mind financial elements and the business case.

Organizations that produce less waste have more of their cost of goods sold going into what the customer considers to be value-added. (Proper handling of toxic wastewater is an example of something that the customer indirectly pays for but does not value.) This is why the definition of waste discusses how waste “can usually be planned and somewhat controlled.” Preventing waste in the first place is the best option for keeping an operation profitable. This is never more true than for hazardous waste.

The *Dictionary* defines **hazardous waste** as

waste, such as chemicals or nuclear material, that is hazardous to humans or animals and requires special handling.

Hazardous material includes chemicals; wastewater; various forms of human and agricultural waste and sewage; radioactive, construction, electronic, and biohazard waste; and many other types. In many cases, hazardous waste is more than one type because multiple types of pollutants are mixed together. Some hazardous waste is relatively safe for humans but highly toxic to other organisms such as fish or bees.

Compliance with Regulations

Various government agencies enact regulations based on hazardous waste legislation. These agencies will monitor or audit organizations for compliance in addition to requiring reporting and record keeping. Monitoring and audits may include plant inspections, testing discharge sources at the point of discharge or in the local area (such as downstream from a river discharge point), or testing nearby groundwater.

Hazardous waste regulations also specify the means to be used for its transportation, storage, and disposal. These methods will differ by type of material. Necessary safety procedures take into account whether the waste could be explosive or corrosive, form a toxic gas cloud, and so on.

Compliance with hazardous waste regulations requires keeping careful records of what categories of hazardous waste are being processed along with a chain of custody that provides evidence that the materials were properly processed. When it comes to disposal, options may include supervised incineration on site or transportation to a specially designated hazardous waste disposal site with the

proper permits for handling the type of hazardous waste in question. Proof of delivery needs to be provided in reports and retained in archive records.

To assist with compliance efforts, the United Nations has created an international standard for identifying hazardous chemicals. The *Dictionary* defines the **Globally Harmonized System of Classification and Labeling of Chemicals (GHS)** as

an international standard, created by the United Nations Economic Commission for Europe (UNECE), for classifying chemicals according to their health, physical and environmental hazards. The system defines and classifies the hazards of chemical products, and communicates health and safety information on labels and material safety data sheets.

While this system exists primarily for hazardous materials used in products, it does specify how to properly dispose of hazardous waste once the product has been used or is no longer needed. In either case, safety data sheets (SDS) indicate proper safety gear to use, what to do if exposure occurs, and the possible effects of any exposure on humans, animals, or plants. When products with hazardous ingredients are provided to consumers, the consumers also need to be educated as to their proper use and disposal. Note that there is a link to an example of an SDS in the Resource Center.

Strict waste regulations exist in the European Union and in many other places. Let's look at two regulations used in the EU as examples.

- The Wastes of Electric and Electronic Equipment (WEEE) legislation in the European Union places the burden of disposing of computers, monitors, televisions, printers, and other peripherals on the manufacturers. Consumers can deliver the devices to the manufacturer, and the manufacturer cannot charge a fee. The manufacturer is required to properly identify and dispose of the materials. This legislation provides incentives to rely more on the higher activities in the waste hierarchy, for example, recycling before responsible landfill. A large number of U.S. states have similar “e-waste” legislation.
- The EU’s Restriction on Hazardous Substances (RoHS) Directive is aimed at the apex of the waste hierarchy—reduce—and the product development life cycle stage. It limits the amounts of lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyl, and polybrominated diphenyl ether that new electrical and electric equipment can contain for it to be sold within the EU from any source.

Organizations can partner with regulatory agencies to make compliance easier. They can also exert lobbying influence on the regulations themselves or through an industry nonprofit association to ensure that the regulations are clear and easy to follow.

Waste Exchange

Waste exchange is a way of reusing waste so that it does not need to be recycled or disposed of. The *APICS Dictionary*, 16th edition, defines **waste exchange** as follows:

- 1) Arrangement in which companies exchange their wastes for the benefit of both parties.
- 2) An exchange service of valuable information between generators and potential users of industrial and commercial wastes, whereby a beneficial use rather than disposal is the end result. This service identifies both the producers and potential markets for by-products, surpluses, unspent materials and other forms of solid waste that is no longer needed.

One organization's byproduct or other type of waste may be another organization's raw material. Long ago, tanners would collect chamber pots around the community each morning to use when tanning leather, which provided a side benefit of reducing the amount of human waste flowing through the streets. Today, many organizations seek to sell their byproducts or other waste at market rates, both generating revenue and reducing disposal costs. In the waste hierarchy, this would qualify as reuse of materials, so it is quite high on the scale of effective responses.

The second part of the definition of waste exchange reveals that organized information exchanges are the key to finding or creating a market for certain waste products. Tyson used to discard its chicken feet until it discovered that there was a huge demand for them in Asia. Now it ships these overseas. In fact, every part of the chicken is used for something. Even the feathers are baked and become a powder additive to pet food.

Nonprofit information exchanges exist on a regional basis to help connect buyers with sellers and thus create a market. Either party can specify what they have or need. Buyers may specify how frequently they need it and in what quantity. Transportation and handling could be part of the negotiated price; for example, a low-value waste product could be offered for free provided that the buyer pays for shipping and handling.

Index

A

- AESDirect [\[1\]](#)
- Air transport [\[1\]](#)
 - Air transport issues/challenges [\[1\]](#)
 - Air transport market structures [\[1\]](#)
- Anticipation inventory [\[1\]](#)
- Assortment [\[1\]](#)
- ATR certificates [\[1\]](#)
- Automated sortation systems [\[1\]](#)
- Automated sorting systems [\[1\]](#)
- Automated systems
 - Automated sorting systems [\[1\]](#)
 - Live racks [\[1\]](#)
 - Robotics [\[1\]](#)

B

- B/Ls [\[1\]](#)
- Bills of lading (B/Ls) [\[1\]](#)
- Break-bulk [\[1\]](#)
- Bridge cranes [\[1\]](#)
- Brokers
 - Customs brokers [\[1\]](#), [\[2\]](#)
 - Ship brokers [\[1\]](#)

C

- Capacity planning [\[1\]](#)
 - See also: Capacity control, Capacity management
- Carnets [\[1\]](#)
- Carousels [\[1\]](#)
- Carriers
 - Common carriers [\[1\]](#)
 - Contract carriers [\[1\]](#)
 - Exempt carriers [\[1\]](#)
 - Motor carriers [\[1\]](#)
- Cash flows
 - Reverse cash flows [\[1\]](#)

Certificates of insurance [\[1\]](#)

Certificates of origin [\[1\]](#)

Clean technologies [\[1\]](#)

COFC [\[1\]](#)

Commercial invoices [\[1\]](#)

Common carriers [\[1\]](#)

Compliance [\[1\]](#), [\[2\]](#)

Conflicts of interest [\[1\]](#)

Consolidation [\[1\]](#), [\[2\]](#)

Consolidators [\[1\]](#)

Container on a flatcar (COFC) [\[1\]](#)

Container shipping [\[1\]](#)

See also: Intermodal transport

Contract carriers [\[1\]](#)

Contracts [\[1\]](#)

See also: Terms and conditions

Contract warehouses [\[1\]](#)

Conveyors [\[1\]](#)

Costs

Import costs [\[1\]](#)

Reverse logistics costs [\[1\]](#), [\[2\]](#)

Transportation costs [\[1\]](#)

Cranes

Bridge cranes [\[1\]](#)

Wagon cranes [\[1\]](#)

Cross-docking [\[1\]](#)

Customer service [\[1\]](#)

Customs [\[1\]](#)

See also: Import/export

Customs brokers [\[1\]](#), [\[2\]](#)

Customs security [\[1\]](#)

D

Declared value [\[1\]](#)

Deemed exports [\[1\]](#)

Delivery patterns [\[1\]](#)

Density

Packaging density [\[1\]](#)

[Value density](#) [1]

[Design for reverse logistics](#) [1]

[Direct loading](#) [1]

[Direct-to-consumer model](#) [1]

[Distribution center location](#) [1]

[Dock receipts](#) [1]

[Duty drawbacks](#) [1]

[Duty paid-warehouse](#) [1]

E

[Echelons](#) [1]

[Economies of distance](#) [1]

[Economies of scale](#) [1]

[Environment](#) [1]

[EPZs](#) [1]

[ETCs](#) [1]

[Exempt carriers](#) [1]

[Export declarations](#) [1]

[Export licenses](#) [1]

[Export packaging](#) [1]

[Export packing companies](#) [1]

[Export processing zones](#) [1]

[Export processing zones \(EPZs\)](#) [1]

[Export trading companies \(ETCs\)](#) [1]

F

[Fixed-location storage](#) [1]

[Forecasting](#) [1]

[Foreign freight forwarders](#) [1]

[Foreign trade zones](#) [1]

[Forklift trucks](#) [1]

[Forwarders](#) [1]

[Fourth-party logistics \(4PLs\)](#) [1]

[Free trade zones \(FTZs\)](#) [1]

[Freight consolidation](#) [1], [2]

[Freight forwarders](#) [1]

[FTZs](#) [1]

G

Global trade management [\[1\]](#)

Government regulations [\[1\]](#)

H

Harmonized Tariff Schedule (HTS) [\[1\]](#)

See also: Harmonized system classification codes

Hazardous waste [\[1\]](#)

HTS [\[1\]](#)

I

Import/export [\[1\]](#), [\[3\]](#), [\[5\]](#)

See also: Customs

Import/export documentation

ATR certificates [\[1\]](#)

Carnets [\[1\]](#)

Certificates of insurance [\[1\]](#)

Certificates of origin [\[1\]](#)

Commercial invoices [\[1\]](#)

Dock receipts [\[1\]](#)

Export declarations [\[1\]](#)

Export licenses [\[1\]](#)

Import costs [\[1\]](#)

Incoterms [\[1\]](#)

Incoterms trade terms [\[1\]](#)

Information flows

Reverse information flows [\[1\]](#)

Intermodal transport

Container on a flatcar (COFC) [\[1\]](#)

Package delivery services [\[1\]](#)

Piggyback [\[1\]](#)

RoadRailer [\[1\]](#)

Trailer on a flatcar (TOFC) [\[1\]](#)

Trainship [\[1\]](#)

International Commercial Terms [\[1\]](#)

Inventory

Anticipation inventory [\[1\]](#)

L

Labeling [\[1\]](#), [\[2\]](#)

[Labor laws](#) [1]

[Landfills](#) [1]

See also: Waste

[Lead time](#) [1]

[Liabilities](#) [1]

[Line-haul costs](#) [1]

[Live racks](#) [1]

[Logistics](#) [1]

[Logistics service providers](#) [1]

[Logistics service providers \(LSPs\)](#)

Fourth-party logistics (4PLs) [1]

Third-party logistics (3PLs) [1]

[Logistics strategy](#) [1], [2]

M

[Materials handling](#) [1], [2]

[Mechanized materials-handling systems](#)

Bridge cranes [1]

[Carousels](#) [1]

[Conveyors](#) [1]

[Forklift trucks](#) [1]

[Towlines](#) [1]

[Tow tractors with trailers](#) [1]

[Wagon cranes](#) [1]

[Mixing](#) [1]

[Motor carriers](#) [1]

[Moving](#) [1]

O

[Order fulfillment channels](#) [1]

[Order picking](#) [1]

[Order selection](#) [1]

[Outsourcing](#) [1]

See also: Subcontracting

P

[Package delivery services](#) [1]

[Packaging](#)

[Export packaging](#) [1]

Packaging density [\[1\]](#)

Packing and marking [\[1\]](#)

Piggyback [\[1\]](#)

Pipeline transport [\[1\]](#)

Pipeline transport capability [\[1\]](#)

Pipeline transport issues/challenges [\[1\]](#)

Postponement [\[1\]](#)

Prepackaging [\[1\]](#)

Private carriers [\[1\]](#)

Private warehouses [\[1\]](#)

Product flows

Reverse product flows [\[1\]](#)

Product life cycle [\[1\]](#)

Product movement [\[1\]](#)

Prohibited goods [\[1\]](#)

Public warehouses [\[1\]](#)

Put-away [\[1\]](#)

R

Rail-road transport [\[1\]](#)

Rail transport [\[1\]](#)

Rail transport capability [\[1\]](#)

Rail transport issues/challenges [\[1\]](#)

Rail transport market structures [\[1\]](#)

Random-location storage [\[1\]](#)

Receiving [\[1\]](#)

Recycling [\[1\]](#)

Returns [\[1\]](#)

See also: Reverse supply chains

Reuse of materials [\[1\]](#)

Reverse cash flows [\[1\]](#)

Reverse information flows [\[1\]](#)

Reverse logistics [\[1\]](#) , [\[2\]](#) , [\[3\]](#) , [\[4\]](#)

Reverse logistics costs [\[1\]](#) , [\[2\]](#)

Reverse logistics hierarchy [\[1\]](#)

Reverse product flows [\[1\]](#)

Reverse supply chains [\[1\]](#)

See also: Returns

Risk pooling [\[1\]](#)

RoadRailler [\[1\]](#)

Road transport capability [\[1\]](#)

Road transport issues/challenges [\[1\]](#)

Road transport market structures [\[1\]](#)

Robotics [\[1\]](#)

S

Security partnerships [\[1\]](#)

SEZs [\[1\]](#)

Ship agents [\[1\]](#)

Ship brokers [\[1\]](#)

Shipper's agents [\[1\]](#)

Shipping [\[1\]](#)

Shipping associations [\[1\]](#)

Shipping costs

Line-haul costs [\[1\]](#)

Shipping patterns [\[1\]](#)

Sourcing

Outsourcing [\[1\]](#)

Special export zones (SEZs) [\[1\]](#)

Spot-stocking [\[1\]](#)

Stock locations [\[1\]](#)

Stockpiling inventory [\[1\]](#)

Storage

Fixed-location storage [\[1\]](#)

Random-location storage [\[1\]](#)

Temporary storage [\[1\]](#)

Storing [\[1\]](#)

Stowability [\[1\]](#)

Supply chain integration [\[1\]](#)

Supply chain partners [\[1\]](#)

Supply chains

Reverse supply chains [\[1\]](#)

Supply chain security [\[1\]](#)

T

Tariffs [\[1\]](#)

Temporary storage [\[1\]](#)

Third-party logistics (3PLs) [\[1\]](#)
TOFC [\[1\]](#)
Total cost concept [\[1\]](#)

Total waste management (TWM) [\[1\]](#)

Towlines [\[1\]](#)

Tow tractors with trailers [\[1\]](#)

Trade blocs [\[1\]](#)

Trading blocs [\[1\]](#)

Trailer on a flatcar (TOFC) [\[1\]](#)

Trainship [\[1\]](#)

Transportation [\[1\]](#)

Transportation costs [\[1\]](#)

Transportation documentation

Bills of lading (B/Ls) [\[1\]](#)

Waybills [\[1\]](#)

Transportation intermediaries

Export packing companies [\[1\]](#)

Export trading companies (ETCs) [\[1\]](#)

Foreign freight forwarders [\[1\]](#)

Freight forwarders [\[1\]](#)

Logistics service providers (LSPs) [\[1\]](#)

Ship agents [\[1\]](#)

Shipping associations [\[1\]](#)

Transportation mode selection [\[1\]](#)

TWM [\[1\]](#)

U

Uniform bills of lading [\[1\]](#)

V

Value density [\[1\]](#)

Variety [\[1\]](#)

See also: Three Vs

W

Wagon cranes [\[1\]](#)

Warehouse capacity [\[1\]](#)

Warehouse design [\[1\]](#)

Warehouse functions

[Assortment](#) [1]

[Break-bulk](#) [1]

[Consolidation](#) [1] , [2]

[Cross-docking](#) [1]

[Mixing](#) [1]

[Spot-stocking](#) [1]

[Stockpiling inventory](#) [1]

[Warehouse layouts](#) [1]

[Warehouse location](#) [1]

See also: [Warehouse number](#)

[Warehouse number](#) [1]

See also: [Warehouse location](#)

[Warehouse processes](#)

[Moving](#) [1]

[Order picking](#) [1]

[Packaging](#) [1] , [2]

[Packing and marking](#) [1]

[Prepackaging](#) [1]

[Put-away](#) [1]

[Receiving](#) [1]

[Shipping](#) [1]

[Storing](#) [1]

[Warehouses](#)

[Contract warehouses](#) [1]

[Private warehouses](#) [1]

[Public warehouses](#) [1]

[Warehousing](#) [1]

[Warranties](#) [1]

[Waste](#)

[Hazardous waste](#) [1]

[Waste exchange](#) [1]

[Waste hierarchy](#) [1]

[Water carriers](#)

[Private carriers](#) [1]

[Water transport](#) [1]

[Water transport capability](#) [1]

[Water transport issues/challenges](#) [1]

[Water transport market structures](#) [1]

Waybills [\[1\]](#)