Chapter 7
Domestic and Global Logistics

Logistics plays a significant role in supply chain management. Logistics is mandatory for moving materials from upstream (suppliers) to downstream (customers), recycling products or returning products and also storing these products along the way in the SC (supply chain). Effective systems are required for commerce to exist in any industrialized society. Goods have no value to consumers until they are delivered to end-customer usage areas, at a point in time when they are needed. Logistics accordingly explain what are called time and place utility. The utility of time occurs when "customers receive their required products, materials or components at the right time, not later and not earlier". The utility of place occurs when "customers receive their required products at their desired place".

According to the CSCMP (Council of Supply Chain Management Professionals), the definition of logistics is "that part of SCM that plans, executes and controls the effective, efficient reverse flow and forward flow and storage of services, goods and relevant information between the origin and the point of consumption in terms to fulfil customers' requirements".

7.1 The Fundamentals of Transportation

This section reviews a number of important factors of transportation within function of logistics, including the objective of transportation, transportation modes, legal forms of transportation, transportation pricing, regulation of transportation, security of transportation and deregulation in the United States. This offers a foundation for discussion of the remaining sections, as well as an appreciation for the complicated nature of issues and problems of transportation issues in logistics.

S. A. Rehman Khan, Z. Yu, *Strategic Supply Chain Management*, EAI/Springer Innovations in Communication and Computing,
https://doi.org/10.1007/978-3-030-15058-7_7

7.2 The Objective of Transportation

While you can think the overriding transportation objective is obvious—that is, moving things and people from one location to another—for-hire company transportation services may go broke doing this inefficiently. For instance, over the last two decades, many passenger airlines of the United States have sought bankruptcy protection and also asked for concessions from labour unions to keep operating. Some of these include Continental Airlines, US Airways, United Airlines, America West and Northwest Airlines. The period of the 2008–2010 economic downturn, combined with high prices of fuel, made things more troublesome for transportation firms. The airline industry lost around 30 billion dollars in 2008 and 2009.

Managers of logistics have found that to maximize value their staff must correctly communicate the company's service needs to transportation providers while negotiating prices and negotiating services such that the transportation provider's delivery costs are covered and allow sufficient profit contribution and then make sure the desired services are completed effectively.

In the industry of transportation, competitive prices may be low for a number of trucking companies and airlines as mentioned above. Generally, objectives of transportation should be to fulfil customer requirements and satisfy customers. For managers of logistics, this also means deciding upon which mode or form of transportation, material storage and handling with suitable vehicle routing and scheduling.

7.3 Legal Forms of Transportation

For-hire transportation firms are categorized legally as contract, common, and private carriers. The different characteristics of each of these categorizations are given below.

7.3.1 Common Carriers

Common carriers provide services of transportation to all shippers at published prices, between designated locations. Common carriers must provide their services of transportation to the general public without any discrimination. In simple words, they charge the same price to all customers. In the United States, a common carrier is legally bound to carry all freight or passengers as long as there is enough space, the charge/fee is paid and there are no reasonable grounds to refuse service. A common carrier refusing to carry a cargo or people may be sued for damages. Because the objective of common carriers is to serve the general public, they are the most heavily regulated of all carrier categorizations. For example, in the United States, common carriers are Greyhound, Southwest Air, Carnival Cruise Lines and Amtrak.

7.3.2 Contract Carriers

Contract carriers may be common carriers. On the other hand, they are not bound to serve the general public. Instead, contract carriers service only particular customers under agreements/contracts. Typical contracts are for goods movement of a specified cargo for a negotiated price. Some contract carriers offer lower prices than common carriers for the same services because they (contract carriers) have specific capabilities. For example, Southwest Air and Dallas Cowboys football team entered into a contractual agreement under which terms Southwest Air provided transportation for the team's out-of-town games. Carriers and shippers are free to bargain and negotiate contractual agreements for price, liability, commodity carried, types of service and delivery timing.

7.3.3 Exempt Carriers

Exempt carriers are also for-hire carriers, but they are exempted from regulation of services and rates. Carriers are categorized as exempt if they transport certain exempt items such as newspapers, coal and school buses. The status of exempt was initially established to allow farmers to transport agricultural items on roads. But today exempt status has been expanded to include various products. Rail carriers hauling coal between particular places/locations are exempt from economic regulation. Almost all carriers may also act as exempt carriers for particular routes and products and commodities.

7.3.4 Private Carrier

Private carriers are not subject to economic regulation and typically transport products and commodities for the firm owning the carrier. These companies transport their items, commodities and operate fleets large enough to make the transportation cost lower. Control of items and flexibility of items movement also play basic roles in the ownership of a private carrier. For example, Wal-Mart, with its private fleet of trucks, was able to respond even more quickly than the government of the United States and relief workers after Hurricane Katrina struck the Louisiana Gulf Coast in the year of 2005.

7.4 Modes of Transportation

There are basically five modes of transportation:

1. Motor
2. Rail
3. Air
4. Water
5. Pipeline

These transportation modes and the amount of freight they hauled every year between the years of 1980 to 2007 in the United States are presented in Table 7.1. Each of these modes offers distinct benefits to customers, and their selection is dependent on many elements, such as the products to be transported, how quickly the products are required, the price and location of shippers and customers. Further we will discuss each transportation mode below.

7.4.1 Motor Carriers

There is no doubt that motor carriers represent the most flexible transportation and, as presented in Table 7.1, account for almost 1/3 of all United States for-hire transportation expenditures. The motor carriage gives door-to-door service, delivery, local pickup, and large and small shipment hauling. It has low VC (variable cost) and FC (fixed cost) and can compete favourably with air carriers and rail carriers for

Table 7.1 Total United States for-hire logistics services contribution to gross domestic product (Current $ billions)

	1980	1985	1990	1995	2000	2005	2006	2007
Total United States GDP	2790	4220	5803	7398	9817	12,422	13,178	13,808
For-hire logistics services GDP (% United States GDP)	102.3 (3.7)	136.3 (3.2)	169.4 (2.9)	226.3 (3.1)	301.6 (3.1)	364.7 (2.9)	387.4 (2.9)	407.2 (2.9)
Truck GDP (% for-hire GDP)	28.1 (27.5)	39.0 (28.6)	52.6 (31.1)	70.1 (31.0)	92.8 (30.8)	118.4 (32.5)	122.5 (31.6)	127.6 (31.3)
Pipeline GDP (% for-hire GDP)	6.1 (6.0)	8.7 (6.4)	7.2 (4.3)	8.1 (3.6)	8.7 (2.9)	9.5 (2.6)	11.4 (3.1)	12.0 (3.3)
Air GDP (% for-hire GDP)	12.8 (12.5)	19.0 (13.9)	26.8 (15.8)	41.0 (18.1)	57.7 (19.1)	48.3 (13.2)	50.3 (13.8)	55.2 (15.1)
Water GDP (% for-hire GDP)	3.3 (3.2)	3.7 (2.7)	4.6 (2.7)	5.8 (2.6)	7.2 (2.4)	10.0 (2.7)	10.8 (3.0)	10.7 (2.6)
Rail GDP (% for-hire GDP)	22.4 (21.9)	23.1 (16.9)	20.6 (12.2)	25.0 (11.0)	25.5 (8.5)	33.5 (9.2)	39.0 (10.1)	40.5 (9.9)
Warehouse GDP (% for-hire GDP)	5.6 (5.5)	8.4 (6.2)	11.8 (7.0)	16.8 (7.4)	25.0 (8.3)	35.6 (9.8)	37.3 (10.2)	40.3 (11.1)
Other GDP (% for-hire GDP)[a]	24.1 (23.6)	34.3 (25.2)	45.7 (27.0)	59.5 (26.3)	84.7 (28.1)	109.5 (30.0)	116.1 (31.8)	120.8 (33.1)

Source: United States DOC (Department of Commerce), Bureau of Transportation Statistics
aIncludes transit, ground passenger and other transportation and support activities.

short to medium hauls and is still competitive with other forms of transportation for long cross-country consignments, specifically if there are several delivery destinations. The motor carriers can provide a variety of specialized services from livestock, to automobile and refrigerated hauling.

The basic drawbacks for motor carriers are traffic congestion and weather problems. The motor carriers are usually categorized as LTL (less-than-truckload) or TL (truckload) carriers. Less-than-truckload carriers deliver small shipments or packages that take up less than one truckload, and the fees of shipping are higher per hundred weights (cwt) than truck load fees, since the carrier need to consolidate many small packages or shipments into one TL, and then separate the TL back into individual packages or shipments at the destination. On the other hand, for limited product shippers, using less-than-truckload carriers is still a much less expensive alternative than using a truck load carrier. The less-than-truckload industry in the United States is made up of a small number of national less-than-truckload carriers such as FedEx Freight and UPS (United Parcel Services) and a larger number of regional less-than-truckload carriers. Many regional carriers are small, privately owned firms that specialize in 2-day and overnight deliveries.

The motor carriers may also be categorized on the basis of the types of items and commodities they haul. General freight carriers carry the majority of items dispatched in the United States, common carriers included, whereas specialized carriers deliver household goods, liquid petroleum, building materials, agricultural commodities and other specialized products.

7.4.2 Rail Carriers

Rail carriers compete the most favourably when the consignments are bulky or heavy and the distance is long. In the United States, at one time rail carriers transported the majority of products dispatched; however, since WWII (World War II), their share of the transportation market has steadily fallen. Recently, United States railroads account for only around 10% of total for-hire transportation expenditure as presented in Table 7.1.

Rail service is relatively inflexible and slow, while rail carriers are lowest cost compared with motor carriers and air carriers and may compete fairly well on long hauls. To better compete, railroads have begun buying motor carrier firms and can thus offer delivery and pickup service (point-to-point) using flatcars and motor carriers that carry truck trailers. Nonetheless, railroads have drawbacks compared to motor carriers with respect to equipment availability, service frequency and shipment damage.

Since rail firms use each other's rail cars, keeping track of rail cars and getting them where they are needed could be tricky. However, with advances in scheduling software, and railroads routing and identification systems of rail cars, this has become less of a problem for rail carriers. RTLS (real-time location system) on rail cars uses active, WiFi-enabled RFID tags to allow tracking and tracing of rail cars

and their goods in real time. The RFID tag is programmed to broadcast a signal detecting its place at regular time intervals. Sensors also can be added to the "Real-time location system" tags to monitor the temperature inside of refrigerated cars, for instance, and transmit a signal if the temperature inside of a refrigerated car goes out of a defined range. In the United States, infrastructure of railroad and ageing equipment have also been issues and problems for railroads; however, there has been a spending resurgence since the 1980s to replace rail cars and worn track segments, to upgrade terminals and to consolidate through acquisitions and mergers.

One of the trends in the transportation by rail is the use of high-speed trains. In the United States, they are operated by Amtrak along the northeast corridor (Boston–New York–Washington). These trains may make the Washington-to-Boston trip in almost 6.5 h (lack of straight-line track have tended to minimize the speed of trains).

7.4.3 Air Carriers

Transportation by air is very expensive relative to competing modes. On the other hand, it is very fast and reliable for long distances. In Table 7.1 it can be seen that carriers of air account for around 15% of total annual United States for-hire transportation expenditures. The amount of freight hauled is quite small, however, since airlines cannot carry much bulky and heavy cargo. For high value, light and small commodities that need to be moved for long distances quickly, transportation modes by air are the best of the modal alternatives.

For movement over water, the only other modal alternative is water carriage, where the decision of transportation is based on cost, weight of shipment and timing. Though the incidence of consignment damage is relatively low and schedule frequency is good, transportation by air is limited in orders of geographic coverage. In the United States, most small cities do not have airports; therefore air service transportation must combine with motor carriage service for these places.

7.4.4 Water Carriers

Water carrier is cheap but inflexible and slow. There are many types of water transportation including lake, inland waterway, coastal, global deep-sea and ocean carriers. Much of the inland waterway transportation is used to haul bulky, low-value and heavy goods such as grain, sand and coal and competes basically with rail and pipeline carriers. Transport by inland water services is obviously limited to areas accessible by water; hence, growth in this area of transportation is also limited. Based on information from Table 7.1, transportation by water as a % of total for-hire logistics services has remained fairly steady at about 3% for the past 30 years. Like transportation by rail and air, water carriers are typically paired with motor carriers to enable door-to-door delivery and pickup service.

In the United Kingdom, efforts are underway to increase the usage of inland waterway carriers, as this is somewhat environment friendly compared to motor freight carriers. The British Waterways, the association responsible for managing waterways in the United Kingdom, is investing to minimize highway pollution and congestion by increasing trade and business along their inland waterways. For instance, a single river barge can carry almost the equivalent of 24 truckloads of freight. Freight on inland waterways also generates less noise and lower emissions and is visually unobtrusive. At present, approximately 3.5 million tons of non-time-sensitive freight is moved every year via 2000 miles of United Kingdom inland waterways.

There have also been developments in deep-sea transportation that have made transportation more desirable and cheaper, even with the slow transportation times. The use of containerships, super-tankers has added a new dimension to transportation by water. Today's many super-tankers are more than 1200 feet in length; oil super-tankers are the *seawise giants*, measuring 1500 feet in length and are able to carry approximately four million barrels of oil. Now the oil-producing countries can ship larger quantities of oil at lower cost. However, small shippers also can dispatch their products at lower cost, because of the ability to combine or consolidate small consignments in containers that are placed on board containerships.

7.4.5 Pipeline Carriers

Pipeline carriers are very specialized with respect to the goods they can carry; additionally, fixed cost of the initial investment is very high. Once the initial cost is recovered, there is very small additional cost of maintenance. Limitation of the pipeline carrier is "pipeline mode can only be used for gas or liquid items". Today, pipelines are being constructed to haul larger quantities of oil and gas from desolate areas to existing processing facilities hundreds of miles away. There is no doubt that, day by day, the need for pipeline transportation is increasing, because pipeline carrier VC (variable cost) is very low and also secure as compared to other modes of carriers.

7.4.6 Intermodal Transportation

The combination of many transportation modes or intermodal transportation is becoming a very popular arrangement of transportation and makes the movement of products much more efficient and convenient. Most intermodal transportation firms today, such as United States firms FedEx and J.B. Hunt, offer one stop, door-to-door shipping capabilities. They transport goods of shippers for a price, then determine the best warehousing and intermodal transportation to fulfil their customer requirements at as low price as possible.

Here is an example of shipping using intermodal transportation:

A firm packs a standard 8-foot container for consignment to an overseas client. The container is connected and sealed to a motor carrier trailer for transport to a nearby rail terminal. The container is then loaded onto a double stacked and flat car with another container, where it is then transported to a seaport on the United States West Coast. Upon arrival, the container is placed aboard and transported on a container ship to Japan. In Japan, the container is moved and off-loaded through customs, where it is then loaded onto another carrier (motor carrier trailer) for transport to its last destination, where it finally is unpacked.

In this above example, products were only unpacked and packed one time. The container was used in three modes of transportation and remained sealed until it arrived at its last destination when custom authorities unsealed, examined and accepted the products/goods.

The above example mentioned a number of intermodal combinations. The most common are COFC (container on flatcar) and TOFC (trailer on flatcar), also called piggyback service.

The same containers can be located and boarded on container ships and freight airliners. These combinations of intermodal transportation attempt to combine the flexibility of motor carriers with the economy of rail and/or water carriers.

7.5 Transportation Pricing

The two primary strategies of pricing used by LSP (logistics service providers) are value-of-service pricing and cost-of-service pricing. Further, when the consignments are large enough, shippers and carriers enter into negotiated pricing. Obviously, carriers want higher profits and shippers want lower prices, and these desires are usually at odds with one another. Not many years ago, carriers such as UPS (United Parcel Service) simply distributed their costs evenly and charged a uniform rate to all clients. As pricing models (computer) improved, logistics firms were able to identify more closely their cost for various types of clients, and differential pricing become more the norm, with infrequent users and residential customers clearly seeing significant price increases. More recently, as economic conditions have worsened causing extra capacity because of lower shipping demand, pricing has once again been varied to stay competitive and shippers have been able to negotiate better terms. These topics are discussed below.

7.5.1 Value of Service Pricing

In this situation, the prices of carrier services are at the highest levels the market will bear. Prices, accordingly, depend on the current volume of demand for each service and the level of competition. This approach is called profit-maximizing approach. If

a carrier has a service that is in little competition with high demand, prices will tend to be slightly high. As other carriers notice the high profit potential of this service, competition will ultimately increase and prices will decrease. As the level of competition rises, carriers will seek techniques and ways to minimize costs to maintain their profitability.

In the competitive airline industry, which was hit hard through 2009 by lower demand for travel, Southwest Airlines has been able to keep their costs low by using only one type of airplane, flying short distances among stops, using strategies of fuel price hedging, and keeping their airplanes in the air, which measures have enabled them to remain profitable through the year 2009, their 37th consecutive annual profit. The system of online booking for airlines, combined with revenue management software to control prices as demand fluctuates have allowed airlines to use value-of-service pricing to increase their revenues.

7.5.2 Cost-of-Service Pricing

In this case, carriers establish their prices based on variable and fixed costs of transportation. To achieve this, carriers must have ability to identify the relevant costs and then accurately allocate these to each consignment. This strategy (cost-of-service pricing) varies on the basis of distance and volume. As the volume of shipping goes up, the portions of FC (fixed costs) that are allocated to every consignment reduce, allowing the carrier to reduce their prices. The volume of large consignments also allows carriers to charge truckload rates/carload instead of LTL (less-than-truckload) rates. As the distance of shipping increases, prices will also tend to increase, but not proportionally with distance, because FC are essentially constant regardless of distance. The cost-of-service pricing shows the lowest shipping price for carriers, and in a highly competitive market, carriers will price just near or above these levels to maintain some profit. As we have seen in the last economic downturn in the year of 2008, many carrier companies were unable to maintain their prices at even these lowest levels, resulting in several companies filing bankruptcies.

7.5.3 Negotiated Pricing

In the United States, since the deregulation of transportation, negotiating prices of transportation has become very common among business logistics providers and shippers. Additionally, today's shippers are inclined to build alliances with logistics firms because of the main role they play in allowing companies and their SC (supply chain) to be more responsive to changing demand. This also has inclined to increase the use of negotiated prices. Shippers want carriers to use cost-of-service pricing; however, carriers want to use value-of-service pricing. To manage and maintain an equitable partnership, prices are negotiated such that they fall somewhere between

the two levels, allowing shippers to receive the logistics services they want at a sensible price, and also allowing carriers to cover their VC (variable costs) and FC (fixed costs) and make a sensible profit.

7.5.4 Terms of Sale

In many situations, suppliers' terms of sale affect costs of transportation. When goods are bought from a supplier, the supplier can quote a price that covers transportation to the location of the buyer. This is known as FOB (free-on-board) destination pricing to the destination of the buyer. This also means that the supplier will be the legal owner of the goods until the shipment safely reaches its destination. For consignments of high value, small consignments, or when the purchaser has little expertise of transportation, FOB (free-on-board destination) is typically preferred. Otherwise, the purchaser can decide to buy products and supply its own transportation to the shipping destination; in this scenario, the supplier quotes the lower FOB (free-on-board) origination pricing. The goods or products then become the legal responsibility of the purchaser at the location of consignment pickup.

7.5.5 Rate Categories

Rates or prices of carriers can be classified in many different ways. Line haul rates are the charges for transferring products/goods to a nonlocal destination, and these can be further categorized as exception rates, class rates, commodities rates and miscellaneous rates.

In the United States, class rates are published on an annual basis by NMFTA (National Motor Freight Traffic Association) a non-profit group comprised of almost 1000 motor carrier firms. The class rate standards, called the NMFC (National Motor Freight Classification), are based on the value of the type of freight, its weight and dimensions, its ease of handling. There are 18 classes numbered from fifty to the five hundreds—the higher the class rating, the higher the price.

Exception rates are lower than NMFC class rates for particular origins and destinations and volumes and are commonly established on an account-by-account basis. Commodity rates apply to minimum quantities of goods that are dispatched between two specified places. Miscellaneous rates apply to agreement rates that are negotiated between two parties and to shipments covering a variety of goods (in this situation, the price is on the basis of the overall weight of the consignment). Nowadays, several of the rates charged by carriers are classified as miscellaneous, since negotiated rates tend to be used mainly for larger consignments.

7.6 Transportation Security

In the United States, security of transportation, specifically airline security, has become a very important issue since 9/11. Congress passed the Aviation and Transportation Security Act in November 2011, creating a large organization (the TSA or Transportation Security Administration) to oversee security of transportation, while giving high hopes to the many government security contractors. Today, the Transportation Security Administration oversees more than four hundred United States air ports. In addition, the DHS (Department of Homeland Security) was established in 2003 with a first year budget of more than 41 billion dollars to provide overall United States security leadership.

In the United States, several actions and problems have resulted from this heightened emphasis on security. The TSA (Transportation Security Administration) has had many agency chiefs since November 11, 2011, and has spent more than 12 billion dollars to improve security in airports and on airplanes. In 2010, the DHS initiative outfitted AIT (Advanced Imaging Technology) units in hundreds of United States airports. Travellers need to go through these full-body scanners, which can identify any harmful devices hidden beneath clothing. The Advanced Imaging Technology uses harmless millimetre technology of waves to produce images reflected from the bodies being scanned.

Other forms of United States transportation have taken a backseat to the airlines when it comes to funding and security concerns. In fact, the Transportation Security Administration 2011 budget allocated 68% of its resources to aviation security and only 2% to all other modes of transportation. Currently, the DHS (Department of Homeland Security) scans 98% of imported cargo for radiation and United States Border Protection and Customs screen United States bound containers at 58 ports around the globe. In addition, the United States Congress passed a law which called for 100% scanning of all United States bound cargo by 2012.

With respect to the other transportation modes, the Transportation Security Administration has been working with railroads to minimize the number of hours that hazardous chemicals can spend in transit, resulting in a 54% reduction since 2006 in the overall risk of a rail tanker exploding and exposing people to hazardous and toxic gases. The Transportation Security Administration also has a Pipeline Security Division, which basically mandates all pipeline operators to execute a program of pipeline security. For various truckers and other transportation workers such as United States deepwater port workers, one of the latest initiatives of transportation security is the use of Safe Port Act of 2006 and the Maritime Transportation Security Act of 2002. In 2009, the TWIC (Transportation Worker Identification Credential) became compulsory for port workers, and the TSA is currently trying to upgrade the technology to allow use of a device that would read a biometric card without it being swiped, greatly reducing congestion at port entry location and also minimizing the card reader time. Another type of system (smart card) is the use of Prepass, which allows prequalified United States motor carriers to bypass weigh stations and state inspections, saving several thousands of lost gallons of fuel and work hours for truckers.

7.7 Transportation Regulation and Deregulation

In the United States, the transportation industry has gone through periods of both government deregulation and regulation. However, the regulation of transportation is argued by many to be good because it tends to assure adequate transportation service throughout the country when protecting final customers in order of safety and liability and monopoly pricing. On the other side, deregulation of transportation is also argued to be good in that it encourages competition and also allows prices to be adjusted as supply, demand and negotiations dictate. Additionally, laws of anti-trust already in existence tend to protect transportation consumers. In 1994, this debate was the subject of a study to determine the impact deregulation had on the United States motor carrier industry. The study concluded that deregulation of transportation has resulted in larger use of cost-of-service pricing, rising freight prices/rates for LTL consignments and more safety issues and problems as operators have tended to let fleets age and to reduce the level of maintenance. In the United States, today's transportation industry remains essentially deregulated; however, carriers must adhere to a number of regulations that still exist. Some of the history of transportation deregulation and regulation in the United States is reviewed next.

7.7.1 Transportation Regulation

Table 7.2 summarizes the main regulation of transportation in the United States, starting with the Granger Law of the 1870s, which led to the Interstate Commerce Act of 1887. Before that time, in the United States the railroads were charging higher rates and discriminating against small shippers. So many Midwestern states passed laws to broadly regulate the railroads to establish maximum rates, prohibit local discrimination, forbid rail mergers (to encourage competition) and prohibit free passes to public officials. Though the United States Supreme Court later struck down these laws, the Granger movement made Congress realize the impacts of railroad monopolies. This led to the passage of the Interstate Commerce Act of 1887.

In the act of 1887, the ICC (Interstate Commerce Commission) required rail carriers to charge sensible or reasonable rates; to publish rates, file them with the ICC and make them available to the public; and prohibited practices of discrimination (charging lower prices than other shippers). The act of 1887 also prohibited agreements between railroads as to revenues or pool traffic. During 1887 to 1910, several amendments made to the 1887 act increased ICC enforcement power and control. All these amendments restricted railroads from offering service and rates that were not in the interest of the public, created penalties for failure to follow published rates or for accepting and offering rebates, set maximum rates and prevented railroads from owning water carriers or pipelines, unless approved by the ICC.

In the year 1917, increased competition combined with the restrictions of rates had built a rail system unable to offer the efficient service that the United States government needed in its war efforts, and thus the federal government seized the

Table 7.2 The United States transportation regulations

Date	Regulation	Summary
1870s	Granger Laws	Midwestern states passed laws to establish maximum rates, prohibit discrimination and forbid mergers for railroads
1887	Interstate Commerce Act	States cannot regulate transportation; established Interstate Commerce Commission; regulated and published rates, outlawed discriminatory pricing, prohibited pooling agreements to encourage competition
1920	Transportation Act	Instructed the ICC to establish rates that allowed RRs to earn a fair return; established minimum rates; gave control to ICC to set intrastate rates; allowed pooling agreements if they were in the public's best interest
1935	Motor Carrier Act	Extended the ICA of 1887 to include motor carriers and brought them under ICC control; established five classes of operators; common, contract, private, exempt and broker; mergers must be OK'd by ICC
1938	Civil Aeronautics Act	Established the Civil Aeronautics Board to regulate air carriers; new entrants had to get CAB approval; CAB controlled rates; Civil Aeronautics Administration control air safety
1940	Transportation Act	Extended the ICA of 1887 to include ICC control over domestic water transportation; ICC controlled entry, rates and services
1942	Freight Forwarders Act	Extended the ICA of 1887 to include ICC control over freight forwarders; ICC controlled entry, rates and services
1948	Reed-Bulwinkle Act	Amendment to the ICA of 1887 legalizing rate bureaus or conferences
1958	Transportation Act	Amended the rule of rate making by stating that rates couldn't be held up to protect the traffic of any other mode
1958	Federal Aviation Act	Created the Federal Aviation agency to assume the mission of the CAA; FAA empowered to manage and develop US airspace and plan the US airport system
1966	Dept. of Transportation Act	Assumed mission of FAA and a number of other agencies for research, promotion, safety and administration of transportation; organized into nine operating and six administrative divisions; also established the National Transportation Safety Board
1970	Railway Passenger Service Act	Created the National Railroad Passenger Corp. to preserve and upgrade intercity rail passenger service; resulted in the creation of Amtrak

railroads. Railroad companies were guaranteed a profit while the government poured large sums of money into advancing the rail system. By the end of WWII (World War II), Congress had come to realize that all of the negative controls imposed on railroads were unhealthy for the industry. They wanted to return the railroads to private ownership. This brought about the first of a number of regulations aimed at positive control, namely the Transportation Act of 1920.

The Act of 1920 instructed the ICC to ensure that rates were high enough to give a fair return for the railroads on a yearly basis (initially Congress set this at 6% return per annum). When firms made more than the agreed 6%, half of the excess was taken to fund low-interest loans to the weaker operators to increase their efficiency and

update their systems. This act also permitted the ICC to set minimum rates, allowed joint use of terminal facilities, allowed railroads to enter into pooling contracts and allowed rail firm consolidations and acquisitions. Lastly, to keep the railroads from becoming overcapitalized, the act prohibited railroads from issuing securities without approval of the ICC. The rail system accordingly became a regulated monopoly.

During 1935 to 1942, regulations were passed that applied to other transportation modes and these were almost the same in nature to the Act of 1920. A great deal of money was spent during the 1920s and during the period of depression building the United States highway system. The time became ripe, then, for the emergence of for-hire motor carriers. Many small trucking firms grew tremendously during 1935 to 1942, creating competition for the railroads, as shippers opted to use the low-priced for-hire motor carriers.

The Motor Carrier Act of 1935 brought motor carriers under ICC control, thus controlling entry into the market, establishing motor carrier classes of operation, setting sensible rates, mandating ICC approval for any acquisitions or mergers and controlling the securities issuance.

In 1938, the federal government enacted another extension of the ICC by including regulation of air carriers in the CAA–Civil Aeronautics Act of 1938. This act fostered the development of air safety and the system of air transportation and airline efficiency through establishing the Civil Aeronautics Board to oversee market entry, establish routes with suitable levels of competition, develop regional feeder airlines and set sensible/reasonable rates. The CAA (Civil Aeronautics Administration) was also established to regulate air safety.

A transportation act in 1940 further extended the Act of Interstate Commerce of 1887 by establishing ICC control over domestic water transportation. The provisions for domestic water carriers were similar to those imposed on motor and rail carriers. In 1942, the act of 1887 was once again extended to cover freight forwarders, with the usual entry, service and rate controls of the ICC. Freight forwarders were also prohibited from owning any carriers.

Many other Congressional enactments occurred up through 1970, further refining and strengthening control of the market of transportation. In 1948, the Act of Reed-Bulwinkle enabled groups of carriers to form rate conferences where they could suggest rate changes to the ICC. The act of 1958 established temporary loan guarantees to railroads, liberalized control over intrastate rail rates and amended the rule of rate-making to clarify the difference between for-hire motor carriers and private carriers. The Act of Federal Aviation 1958 replaced the Civil Aeronautics Administration with the FAA (Federal Aviation Administration) and gave the FAA authority to prescribe rules of air traffic, make safety regulations and plan the system of national airports. In the year of 1966, the Department of Transportation Act created the DOT (Department of Transportation) to coordinate the executive functions of all government entities dealing in matters related with transportation. It was hoped that centralized coordination of all the agencies of transportation would lead to more effective transportation planning and promotion. Lastly, to improve the ability of the rail system to service passengers, in the 1970s, the Act of Railway Passenger Service was passed, thus creating Amtrak.

7.7.2 Transportation Deregulation

In 1976, Congress enacted many laws to eliminate and reduce transportation regulations. These are summarized in Table 7.3. This starts the movement towards less regulation by permitting market forces to determine prices, services and entry. In the United States, at this point in the history of transportation, politicians and consumers had the opinion that regulation of transportation was administered more for the profit of the carriers than the public. Additionally, with the bankruptcy filing of many railroads in the 1970s, combined with the Arab oil embargo of the same period of time, regulation was receiving much of the blame for an inefficient system of transportation.

The Railroad Revitalization and Regulatory Reform Act, generally known as the 4-R Act, was passed in 1976 and made several regulatory changes to assist the railroads. First, railroads were allowed to change rates without approval of the ICC, limited by *threshold costs* on one end and *market dominance* on the other. The costs of threshold were defined as the company's VC (variable costs) and the ICC determined whether the company was in a market dominant position (lack of market competition). Several procedures of the ICC were also sped up to aid decision making of transportation managers. These same ideas appeared again in later deregulation efforts.

In 1977 air freight was deregulated. No longer were there any barriers to entry provided the companies were deemed fit by the Civil Aeronautics Board. Size

Table 7.3 United States transportation deregulation

Date	Deregulation	Summary
1976	Railroad Revitalization and Regulatory Reform Act	The "4-R Act". Railroads were allowed to change rates without ICC approval, within limits; ICC procedures were sped up
1977	Air Cargo Deregulation Act	Freed all air cargo carriers from CAB regulations
1978	Air Passenger Deregulation Act	Airlines freed to expand routes, change fares within limits; small community routes were subsidized; CAB ceases to exist in 1985
1980	Motor Carrier Act	Fewer restrictions on entry, routes, rates and private carriers
1980	Staggers Rail Act	Freed railroads to establish rates within limits; legalized contract rates; shortened ICC procedure turnaround
1982	Bus Regulatory Reform Act	Amended the 1980 MCA to include buses
1984	Shipping Act	Partial deregulation of ocean transportation
1994	Trucking Industry Regulatory Reform Act	Motor carriers freed from filing rates with the ICC
1994	FAA Authorization Act	Freed intermodal air carriers from economic regulation by the states
1995	ICC Termination Act	Eliminated the ICC and moved regulatory duties to Dept. of Transportation
1998	Ocean Shipping Reform Act	Deregulated ocean liner shipping; allowed contract shipping; rate filing not required

restrictions were also lifted and carriers were free to charge any rate offered provided there was no discrimination. Lastly, carriers did not have to file freight rates with the CAB. This was followed soon after by deregulation of air passenger service in 1978. The targeted beneficiary of passenger airline deregulation was the traveller. In introducing the bill to the Senate, Senator Ted Kennedy, one of the bill's principal sponsors, proclaimed, "This bill, while preserving the authority of government to regulate safety and health, frees airlines to do what business is supposed to do serve clients/consumers better for less". This was a staged-in approach, wherein carriers could slowly add routes to their systems while protecting other routes from competition. Fares could be adjusted within limits without approval of the CAB. To protect small communities from losing service, all cities with service in 1977 were guaranteed service for ten additional years. In the era of 1981, all restrictions of routes were to be released, allowing any carrier to operate any route. In 1983, airline mergers and rates were to be released from regulation. Finally in 1985, the CAB was to shut down.

The impacts of regulation on the United States airline industry were enormous—in 1977, there were 34 air passenger carriers and by 1982 the number had dropped to nine. Some fares dropped substantially, while other fares went up, and routes to low-demand areas were reduced substantially. By 1981, among the main airlines of the United States, TWA and Delta were making revenue. Several notable airline failures also occurred in the year following deregulation. For example, after deregulation Braniff expanded speedily in the United States, purchased a larger number of planes, loaded up on debt and then declared bankruptcy in the period of 1982. They emerged from bankruptcy as a small airline, then seven years later declared bankruptcy again, after failing to obtain financing. A short period later, Braniff ceased their operation completely. People Express, a new low-fare, no-frills airline that began right after deregulation followed the Braniff model of large-expansion-high-debt, similarly had trouble operating in the era of 1986, eventually selling out to rival Texas Air, which filed for bankruptcy as well in 1990. In all, some 150 airline companies came and went during this era.

In 1980 motor carriers were deregulated. The objectives of this act were to promote competitive as well as efficient and safe motor transportation. Entry regulations were relaxed to make it easier to enter the market—companies had only to present that a "useful public purpose" would be served. Route restrictions were eliminated, and restrictions deemed to be wasteful of fuel, contrary or inefficient to the interest of the public were also removed. As with the Act of 4-R, a zone of rate freedom was also used. And, as with air passenger deregulation, a large number of new motor carriers began service. By 1981, in the United States, more than 2400 new motor carriers had begun business.

Railroads were further deregulated with the Act of 1980 (Staggers Rail Act). The financial situation of railroads was worsening, and this act was aimed at enhancing finances for the rail industry. With this act, rail carriers were free to change rates within a zone of rate freedom, but the market dominance or ceiling rate was set more definitively as 160% of VC (variable costs) and varied up to 180%, dependent

on ICC cost formulas. After the era of 1984, rate increases were to be tied to the rate of inflation. Agreement rates were also allowed between shippers and railroads.

The Act of 1984 (Shipping Act) marked the end of the initial push by Congress to deregulate the entire United States industry of transportation. This act allowed ocean carriers to share or pool consignments, publish rates, assign ports and enter into agreements with shippers. More recently, with the passenger of the Ocean Shipping Reform Act of 1998 and Interstate Commerce Commission Termination Act of 1995, the ICC was eliminated and the requirements for ocean carriers to file rates with the Federal Maritime Commission also came to an end.

Therefore, many changes in the United States industry of transportation have occurred over the past century. Economic regulation of transportation occurred for various reasons. Primary transportation regulations were instituted to establish the ground rules as new forms of transportation developed and to control service, routes and prices when monopoly power existed in the transportation industry. Later, regulations were eased to increase safety and efficiency and encourage competition. In the future, as conditions of economic change and as political, social and technological changes occur, regulations of transportation will also continue to change, as we have seen since 2001 with regulation of transportation security.

7.8 Warehousing and Distribution

There is no doubt that warehouses offer a strategic SC (supply chain) service, in that warehousing enables companies to store their materials, finished goods, WIP (work-in-process); and warehouses are also used for value-added services including consolidation, postponement, assembly and break-bulk activities. Warehouses allow firms to make more frequent, smaller and faster deliveries to customers, which in turn result in higher customer service when the systems are designed and managed properly. For further in-depth discussion about warehousing see Chaps. 4 and 5. Here we will describe some roles of warehousing and distribution in the perspective of the United States.

In the United States, systems of freight distribution move products/commodities or goods from producers to consumers in an efficient manner; the growth in demand for warehouse space has outpaced this improved efficiency. Not only is the number of DCs (distribution centres) and warehouses growing, but they are also getting larger. Almost ten years ago in the United States, the average size of a warehouse was almost 250,000 square feet. But today, average warehouse size is 400,000 square feet. Denver-based ProLogis, a real estate builder, calculates that the available square footage of commercial warehouses in the United States is greater than 5 billion square feet (excluding private warehouses).

Now in many situations, warehouses are not only used for storing goods, but also used for value-added services, including consolidation, break-bulk, repackaging of various products into outgoing orders and then dispatching these orders to a retail centre or location of manufacturing. All these activities are referred to as cross-

docking. In this situation, the warehouse is more accurately described as a DC. In other situations, companies are moving warehouses near customer/centralized locations, near suppliers, depending on the requirement of customer service and storage objectives. This section discusses the types of warehouses, risk pooling, lean warehousing and warehouse location.

7.9 The Types and Importance of Warehouses

Companies hold inventories for many reasons as explained in Chap. 5; warehouses are used to support production, distribution and purchasing activities. Companies place orders for parts, assemblies, components or raw materials, which are usually dispatched to a warehouse located close to the buyer's location, and then are finally transferred to the purchaser's various operations as needed. In a retail system, the warehouse may be located regionally, with the retailer receiving bulk orders from many suppliers, breaking these orders into small sizes (break-bulk) and reassembling outgoing orders for delivery to every retail location, and then using for-hire transportation providers or private fleet trucks to move orders to the locations of retail. Similar DCs are used when producers deliver bulk consignments to regional market areas and then break these orders (break-bulk) and dispatch LTL (less-than-truckload) quantities to customers.

On the other hand, companies may operate consolidation warehouses to collect large numbers of less-than-truckloads consignments from nearby regional sources of supply, where these are then consolidated and transported in CL (container load) or TL (truck load) to a user facility placed at some distance from the consolidation warehouse. The use of consolidation DCs and warehouses allows companies to realize both transportation economies and purchase economies. Companies may purchase products/goods in bulk at lower unit costs and then dispatch these products/goods at CL (container load) or TL (truck load) rates either directly to a production centre or to a DC. They can also buy and move small quantity purchases at less-than-truck rates to nearby warehouses (consolidation).

7.9.1 Private Warehouses

Just as with the private forms of transportation, *private warehouses* refers to the warehouses that are owned by the company for storing their products. For companies with large volumes of products to transfer or store, private warehouses show an opportunity to minimize the warehousing costs. Presently, UPS, Sears Holding Corp and Wal-Mart are the three largest private warehouse operations in North America. Besides the long-term benefit of costs private warehouses can provide, another consideration is the level of control provided by private warehouses. Companies can decide what to store and process, type of equipment and security

system to use, among other operational aspects within the warehouses. This warehousing can also allow the company to maximize use of its workforce and expertise in orders of transportation, DC and warehousing activities. Also, as SC becomes more global to benefit from low-priced sources of labour and supply, the use of private warehouses is inclined to increase. Lastly, these warehouses can generate tax benefits and income through leasing of extra capacity. For these causes, in the United States, private warehousing accounts for the vast majority of overall warehouse space.

Private warehouses, though, can also show an important and critical loss of flexibility and financial risk to the companies. The costs to build, equipment and then run a warehouse can be very expensive, and usually small-size or medium-size companies cannot afford their own warehouse. Private warehouses bind companies to places that may not prove optimal as time passes. At least in the short term, capacity or size of warehouse is also somewhat inflexible. Another issue can be insurance. Firms' insurance coverage, in many situations, is non-existent or meagre, creating significant concerns about robberies, theft or fires resulting in the loss of products.

7.9.2 Public Warehouses

Public warehouses are for-profit organizations that lease or contract a broad range of light production, distribution and warehousing services to other firms. These warehouses offer several specialized services that companies may use to create customized services for many goods and consignments. Usually these services are the following:

- *Repackaging*—after break-bulk products are repackaged for particular customer orders. Warehouses can also do individual item labelling and packaging.
- *Break-bulk*—large consignments are broken down into smaller ones, so that products can be consolidated into specific customer orders and then dispatched out.
- *Assembly*—some warehouses offer final assembly operations to fulfil requests of customers and to create customized final goods.
- *Quality inspections*—warehouse staff can perform outgoing and incoming quality inspections.
- *Material handling, documentation services and equipment maintenance.*
- *Short-term storage* and *long-term storage*.

Besides the services mentioned here, these warehouses offer the flexibility (short-term) and investment cost savings that private warehouses cannot provide. If product changes or demand changes, the short-term commitments needed at warehouses (public warehouses) allow companies to quickly change locations of the warehouses. Public warehouses enable companies to test marketplace and withdraw quickly if demand does not materialize as expected. The cost for companies to use

a public warehouse may also be very small if the requirements of capacity are minimal. For example, Nabisco spends millions of dollars every year to outsource to ten main warehouse providers and about 200 carriers for its delivery business and warehousing, which deliver to large food chains, drugstores and grocery wholesalers.

One of the primary drawbacks associated with public warehouses is the lack of control offered to the owner of products. Other issues include lack of specialized services or capacity on the desired locations, communication issues with warehouse staff/workers and the lack of security and care that might be given to goods.

Currently, public warehouses are finding new methods and techniques to add value for their customers, including the offering of specialized services such as customs clearance, freight consolidation, refrigerated warehouses, claims processing, reverse logistics, direct store deliveries and real-time information control. During the last economic recession period in the United States, use of public warehousing services grew tremendously as shippers sought to minimize supply chain costs. New Jersey-based Ultra Logistics grew meaningfully during the recession for exactly this reason. It now handles more than 40,000 just-in-time truckloads each year for customers such as Con-Agra, L'Oreal, Kraft Foods and Anheuser-Busch.

7.10 Risk Pooling and Warehouse Location

One of the critical decisions about private warehouses is where to place them. This decision will affect the number of warehouses and capacities required, customer service level, costs of warehousing system and system inventory levels. For a given market place, as the number of warehouses grows, the system becomes more and more decentralized. In a decentralized system of warehousing, delivery service levels and responsiveness will increase since products can be delivered more speedily to consumers or final customers; however, inventory costs and warehousing system operating costs will also rise. Other costs that come into play here are outbound transportation costs to consumers and the associated transportation costs with the inbound deliveries of products to every warehouse. Thus, the trade-off between customer service and costs must be carefully considered as the company makes its decision regarding warehouse location. This brings up the significantly important matter of risk pooling, which is discussed further below.

7.10.1 Risk Pooling

Risk pooling defines the correlation between the system inventories, the number of warehouses and customer service, and it can be described as follows:

"As market demand is random, it is likely that higher-than-average demand from few customers will be offset by lower-than-average demand from other customers." As the number of customers served through a single warehouse rises, these demand

variability will incline to offset each other more frequently, thus minimizing overall demand variance and the likelihood of stock-outs; therefore, the amount of safety stock in a system of warehouse required to guard against stock-outs fall. Thus, the more centralized a system of warehousing is, the lower the safety stock needed to accomplish a given system-wide customer service level (recall that in inventory jargon the level of customer service has negative relationship with the number of stock-outs per period).

As described above, risk pooling assumes that demand of the markets served through a warehouse system is negatively correlated. In smaller market places served through warehouses, this cannot hold true and warehouses would then need higher levels of safety stock. This is why a smaller number of centralized warehouses serving a large market place requires lower overall inventories in a system, compared to a larger number of warehouses (decentralized) serving the same markets.

A good illustration of this principle occurred in Europe after the formation of the EU (European Union) in 1993. Prior to that period, logistics systems of Europe were formed along national lines. In simple words, every country's distribution system operated autonomously of the others, with warehouses placed in each country. In 1993, with the arrival of a single European market, these distribution systems no longer made economic sense. For example, Becton Dickinon (a producer of diagnostics equipment in the United States) was burdened in Europe in the 1990s with a costly and inefficient system of distribution. Their stock write-offs and inventory carrying costs were high; however, their stock-outs were numerous. After the formation of the EU, the firm closed their DCs in France, Belgium, Sweden and Germany and shifted all of their distribution operation to a single automated centre in Belgium. Within one year, average stock levels declined 45%, write-offs fell by 65% and stock-outs were decreased by almost 75%. Other firms in Europe had almost the same results.

The effect of risk pooling may be calculated numerically by the rule of square root, which holds that the system average inventory is equal to the original system inventory times the ratio of the square root of the new number of warehouses to the square root of the original number of warehouses. An example of risk pooling is presented in Example 7.1.

In this example, reducing the number of warehouses from 2 to 1 causes a decrease in average inventory of around 29%.

The differences between decentralized and centralized warehousing systems can be summarized as follows:

- *Avg. system inventory and safety stock*—as the company moves towards a more centralized warehousing system and fewer warehouses, safety stocks and thus average inventory levels across the system are reduced. The magnitude of the minimization depends on the correlations of demand in the several market areas/places.
- *Customer service*—as centralization increases, level of customer service offered by warehouse supplier is likely to rise, reducing the likelihood of stock-outs for a given level of average system warehouse inventory.

- *Responsiveness*—as warehouse centralization increases, there is an increase in the lead time of deliveries and/or risk of late deliveries, and a reduction in the ability of the company to respond speedily to changes in market demand. Service level to the customer may thus decrease because of problems such as weather delays and traffic congestion/problems.
- *Transportation costs*—as warehouse centralization increases, costs of outbound transportation increases, as LTL (less-than-truckload) consignments must travel farther to reach destinations. Costs of inbound transportation decrease, since producers and other suppliers are able to dispatch larger quantities at TL (truckload) rates to fewer warehouse locations. The overall impact on transportation costs thus depends on the particular warehouse locations, the products stored, the modes of transportation and the location of suppliers.
- *Warehouse system operating costs and capital costs*—as warehouse centralization increases, warehouse operating costs and capital costs decrease because there are fewer employees, less maintenance cost, fewer warehouses and less equipment.

Example 7.1 Risk Pooling
Perkins Western Boot Emporium currently owns two warehouses in Houston and Seattle to store its boots before shipping them out to various retail customers across the western USA. Greg Perkins, the owner, is considering a change to one centralized warehouse in Denver to service all of their retail customers and is curious to know the impact this will have on their system inventory requirements. Their current average inventory level is approximately 6000 boots at each warehouse. He has found that this level of stock will result in warehouse stock-outs approximately 1% of the time. Using the square root rule, he calculates the new average inventory level needed at the central Denver warehouse to maintain the same low level of stock-outs:

$$S_2 = \frac{\sqrt{N_2}}{\sqrt{N_1}}(S_1) = \frac{1.0}{1.41}(12{,}000) = 8511\,\text{boots},$$

S_1 = Total system stock of boots for the N_1 warehouses
S_2 = Total system stock of boots for the N_2 warehouses
N_1 = Number of warehouses in the original system
N_2 = Number of warehouses in the proposed system

7.11 Warehouse Location

Many location theories and models have been proposed over the years to optimally locate warehouses and factories. Initially in the development of modern warehousing and transportation networks, several well-known economists posited theories regarding locations of warehouse that are discussed below:

German economist Johann Heinrich, who is usually regarded as the "father of location theory", discussed in the 1820s that costs of transportation alone should be

reduced when considering location of facilities. His model assumed that despite of the different warehouse location, manufacturing costs and market prices would be the same, so the optimum location would be the one that resulted in the minimum costs of transportation. Another German economist an era later, Alfred Weber, proposed an industrial location theory almost the same as Johann Heinrich's; he argued that the optimum location would be found when the sum of the incoming and outgoing transportation costs was reduced.

In the period of the 1940s, Edgar Hoover suggested three types of location strategies: product positioned, product intermediately positioned and market-positioned strategies. The product positioned strategy places warehouses near the sources of supply to allow the company to collect many products while reducing incoming transportation costs. This strategy works well when there are large numbers of products bought from various sources of assortments and supply of products ordered by customers. The market-positioned strategy locates warehouses near customers, to maximize the level of customer service. This strategy is suggested when high level of customer service and distribution flexibility is desirable. The intermediately positioned strategy locates warehouses midway between the customers and the sources of supply. This strategy is suggested when distribution service requirements are relatively high and customer order item assortments are purchased from numerous suppliers.

In the 1950s, Melvin Greenhut's location theory was dependent on profit rather than transportation costs. Greenhut argued that the optimum location would be the one that maximized revenue, which may not be in accordance with the minimum cost location, because prices and demand can potentially differ, based on location.

7.12 Lean Warehousing

As companies develop their SCM (supply chain management) capabilities, products will be moving more speedily through incoming and outgoing DCs (distribution centres) and warehouses. These DCs will thus have to create leaner capabilities. Examples of these capabilities are the following:

- *Reduced shipping quantities and lot sizes*—incoming and/or outgoing shipping quantities are likely to be smaller and more frequent, containing mixed quantities of products, and thus requiring more handling.
- *Greater emphasis on cross-docking*—warehouse employees must receive consignments and mix these quickly into outbound consignments. Far limited products will be stored for any appreciable time and average warehouse inventory levels will decline, while the number of stock-keeping units will grow.
- *Service quality*—warehouse employees must perform warehouse activities so as to fulfil the requirements of their incoming and outgoing customers and suppliers.

- *Increased automation*—to improve reliability and handling speed, more warehouse activities will become computerized/automated, from barcode and scanner computer tracking systems, to warehouse management software applications, to automated retrieval and storage systems.
- *Increased assembly operations*—as more companies execute mass customization and lean systems, warehouses will be called upon to perform final assembly operations to fulfil particular customer requirements. This will change the skill requirements of warehouse employees, along with equipment requirements.

Most DCs have adopted several concepts of lean warehousing. Indiana-based PDS (Prime Distribution Services) offers distribution services to suppliers in club-store grocery SCs (supply chain). They offer cross-docking, warehousing, freight consolidation and packaging to suppliers who are looking to reduce costs and increase speed to compete in the highly competitive low-profit-margin grocery industry. Consequently, Prime Distribution Services' capabilities have had to evolve to survive. They recently combined many DCs into a single 1.2 million square foot heavily automated facility that offers greater control over inventory, more speedy order management, and easier building of mixed SKU (stock keeping units) pallets. They have state-of-the-art systems of warehouse management to manage picking operations, routing and sorting capabilities to divert orders to packing stations and automated barcode scanning. They have seen enhancements in order accuracy and output since moving to the new facility. "Our leadership and our company are geared towards a lean warehousing operation", says Scott Zurawski, director of Prime Distribution Services. "We are trying to build quality and sustainability into each process".

7.13 The Impact of Logistics on SCM

For global SCs, the function of logistics is more critical and complex than for domestic SCs. Providing adequate storage and transportation, getting products through customs, delivering to foreign places in a timely fashion and logistics pricing may all impact the ability of a SC to serve a foreign market competitively. In many situations, companies are forced to use 3PLs to move products into foreign locations effectively.

Purchases from overseas suppliers are also similarly affected by logistics considerations. When companies start using and evaluating overseas suppliers, timing and costs of logistics become critical elements in the sourcing decision. For example, Chinese suppliers supplying products to purchasers along the United States East Coast are in various cases favouring an all-water route through the Panama Canal, rather than dealing with traffic and port congestion on the United States West Coast and then rail and trucking transportation within the United States. Purchasers get low freight rates and can plan on consignments arriving at a particular time when using an all-water route, whereas the possibility of domestic consignments of

United States being held up because of traffic and port congestion cause uncertainties. All-water consignments have grown almost 65% since the 1990s. Containerized cargo numbers are up in each port of Eastern United States. Basically, the growth has been the result of increased growth in worldwide trade in common and an increase particularly in Asia Pacific trade. For example, the port of Virginia has more than 50 DCs and has seen its business increase as retailers dispatch to the port and then feed products to their nearby East Coast DCs. In many situations, purchasers with limited experience of overseas purchasing must use a knowledgeable "Third-Party Logistics" service to purchase from overseas suppliers and make logistics decisions efficiently and effectively.

Consequently, the value created for SC by logistics can easily be seen. It is what effectively connects each partner of SC. Poor and ineffective logistics management can clearly bring a SC to its knees, regardless of the quality of the products or manufacturing cost. On the other hand, good and effective logistics management can be one of the factors creating competitive benefits for SCs. Many of these subject matters are discussed at greater length in sections that follow.

7.13.1 Third-Party Logistics Services

Usually logistics service firms provide both warehousing services and transportation services, enabling companies to make better use of distribution alternatives such as storage location, customs clearance and transportation mode. A number of third-party firms even offer complete supply chain management (end-to-end) services, including light manufacturing and network optimization. Several companies outsource part of or complete logistics to enable more attention to be focused on core competencies. In tough economic times, companies look to third-party firms to help minimize costs while maintaining levels of customer service. In the year 2009, 80% of United States firms used a third-party logistics service for at least one area of their SCs. In Europe, almost 66% of every logistics Euro spent was on outsourcing. Whatever the cause, demand for third-party logistics services is increasing quickly.

7.13.2 Outsourcing End-to-End SCM Activities

In some situations, companies may select to partner with third-party logistics for the provision of all or most activities of SCM. For small companies, it can be a big question of lack of expertise. The sheer scale of SC activities and cost can also attract larger companies that prefer to free up valuable resources for core activities. For instance, GM (General Motors) formed a joint venture with CNF, Inc. to manage the automaker's entire SC, specifically all of General Motors' existing 3PL providers for both outbound movements and inbound movements over a 3-year transition

period. The joint venture firm, Vector supply chain management, termed a 4PL or a lead logistics provider, managed all of General Motors' worldwide third-party logistics providers. Vector also assumed responsibility for managing some 180 million pounds of components/material from General Motors' 12,000 global suppliers each day.

7.13.3 Third-Party Supply Base Reduction

Reducing the supply base may provide many benefits for the company. With third-party logistics suppliers, using a smaller number of third-party logistics allows the company to use and select only the best-performing third-party logistics providers as well as to give these third-party logistics a larger share of the company's logistics needs. This in turn results in improved levels of service and also lower prices. The bigger share of business given to every third-party logistics can be used as leverage when negotiating prices, shipping services and schedules. In the year 2005, for example, Hewlett-Packard halved the third-party logistics it was using to minimize this number. In the same way, other firms are seeking to achieve an "irreducible minimum" number of suppliers (third-party logistics). Consequently, third-party logistics supply base reduction should become an integral part of an effective logistics management strategy, specifically in markets considered by many third-party logistics choices.

7.13.4 Mode and Third-Party Logistics Selection

When attempting to reduce logistics costs and/or enhance customer service along the SC, companies must recognize the most desirable modes of transportation and third-party logistics services available for the several markets they serve as well as for their incoming purchased components/materials, and also for miscellaneous costs, warehousing costs, consignment damage costs and packaging costs. The second part of this text describes the subject matter of selection and evaluation suppliers. Companies use a mix of qualitative and quantitative elements to evaluate and also select third-part logistics services and there are many other comparative methods in existence to aid in the decision process. In many surveys conducted, significant and important factors of selection were found in transportation rates, transit-time reliability, damage-free delivery, total transit time, financial stability, willingness to expedite deliveries and use of electronic data interchange.

7.13.5 Building Strategic Logistics Alliances

Creating an effective SC very often includes the creation of strategic alliances with 3PLs. In fact, in many surveys of various industries and businesses, warehousing and transportation firms were included as SC partners by more than 50% of the survey respondents who were actively managing their SCs. In the recent business climate, partnering with a third-party logistics provider makes even more sense. "Now, many firms are moving from older and costly processes to outsourcing their logistics in favour of more concentration on their core business and competencies", says Tony Zasimovich, VP of logistics services at APL logistics (California-based). These partnerships underscore the essential role played by logistics in SCM. A couple of examples are given below.

Automobile SCs are getting more difficult and complex as firms search for higher quality and lower cost suppliers. This has made collaborations with third-party logistics even more vital. A couple of years ago, in the United States, automakers focused on squeezing 3PLs for cost minimizations. "They considered logistics a commodity", says Gregory Hines, President of NLM (National Logistics Management), a third-party logistics (Michigan-based). "The right cost is not always the lowest cost. One firm cannot do partnership alliances which are vital", he adds. In the United States, partnerships between automakers and railroads means that seven out of ten vehicles manufactured are moved by rail to dealerships, along with a great percentage of the vehicle parts moving to assembly factories. Railroads have invested billions of dollars manufacturing special boxcars designed to the automakers' requirements, auto-rack rail cars with premium cushioning, auto-carrier trucks, a network of vehicle DCs and information systems that enable railroad firms to function as an integral part of automaking companies.

7.14 Other Transportation Intermediaries

In some situations, firms utilize intermediaries of transportation that may not own any major logistics capital assets to find the most suitable mode of transportation or third-party logistics service. For several small size firms, where expertise of logistics may be limited, and in some situations for large size firms, where the scale of logistics needs is greater, use of these services (transportation) can make good economic logic. A couple of these intermediaries are discussed below.

7.14.1 Freight Forwarders

Freight forwarders consolidate many small consignments to fill rail cars or trucks to achieve truckload transportation rates. They also can offer consolidation services of air transportation. These firms pass some of the savings on to the small shippers and then keep the rest as fees. On the other hand, freight forwarders offer valuable services to both the carrier (higher equipment utilization and extra business) and the shipper (low shipping rates). The freight forwarders can specialize in global consignments or domestic consignments, as well as ground or air consignments. These firms can offer customs clearance, special freight handling and other documentation services.

7.14.2 Transportation Brokers

Transportation brokers, also referred to as load brokers, bring transportation and shipping firms together (primarily truckers). Load brokers are legally authorized to act on the carrier's or shipper's behalf, and typically these firms are recruited or hired because of their broad knowledge of the many transportation alternatives available. Transportation broker (Minnesota-based) C.H. Robinson Global provides an example of the way these middlemen can be profitable even in the down transportation industry. They purchase low-cost transport capacity on railcars, cargo ships, and trucks on the spot markets and then resell it to shippers at high price. According to Jon Fisher (fifth-ranking portfolio manager at Third Asset Management Inc.), the firm "does well in a world where there is more [transport] supply than there is demand for items to dispatch/ship".

Typical arrangements can find small firms using a load broker to handle many of their requirements of shipping, or trucking firms using brokers to find a back-haul job after a delivery is done. Many transportation broker or load broker directories exist, allowing carriers and shippers to find one fulfilling their requirements. For example, direct freight services and FreightQuote.com provide services such as matching up empty cargo space with shipper requirements for a monthly service charge.

7.14.3 Shippers' Associations

The AISA (American Institute for Shippers' Association) describes shippers' associations as "non-profit membership cooperatives which make international or local arrangements for the movements of members' cargo". Therefore, AISA's job is to consolidate only their members' consignments into full truckloads, container loads or carloads to accomplish discounts on volume for the members and to negotiate for

improved terms of service. These associations also benefit the transportation firms, in that they help to maximize the utilization of their machines and equipment. Because associations of shippers do not recognize themselves as third-party logistics providers, or brokers, they are not required to adhere to or publish a number of United States transportation regulations and can keep service contracts confidential. A couple of drawbacks of membership include minimum volumes of consignment to achieve the benefits of low rates and a couple of ocean carriers' refusals to do business with these associations (shippers). Many of these cooperatives exist for diverse industries.

7.14.4 Intermodal Marketing Firms

IMCs (Intermodal Marketing Companies) are firms that act as intermediaries between shippers and intermodal railroad firms. Typically, they buy large blocks of flatcars for piggyback service and then find shippers to fill motor carriers with truckloads, to load the flatcars. Basically these are brokers of transportation for the rail industry. They get discounts on volume from the railroads and also pass small discounts to the shippers. These firms facilitate intermodal shipping and have become an essential service to railroads. Many intermodal marketing firms utilize cell phones, satellite transmission and the Internet to enable real-time communications among themselves, the shippers and the carriers.

7.15 Environmental Sustainability

To enhance environmental performance today, companies are facing increasing pressure from consumers as well as governments. In logistics, one of the large energy wastes comes from trailers coming back from their deliveries empty. Empty Miles, an internet subscriber service offered by "Voluntary Inter-industry Commerce Solutions Associations", seeks to reduce much of this issue. Members post regularly available trailer backhaul capabilities on their routes of delivery; hence, carriers obtain profit from an otherwise empty backhaul. For example, the retailer Macy's has seen its costs of delivery reduced significantly from use of the Empty Miles portal, while 3PL Schneider National has seen its backhaul profit increase by 25%. The potential economic and environmental advantages are huge—the NPTC (National Private Truck Council) calculates that 28% of the trucks on United States highways are presently running empty. Empty Miles is also better for SC relationships. According to Bill Connell, executive VP of logistics at Macy's, "It enables partnerships to evolve that would not naturally evolve".

Actually, many non-profit organizations have been formed to help companies in their efforts of sustainability. In the United States, the EPA (Environmental Protection Agency) launched SmartWay, a certification that represents a more fuel

efficient transportation option. The SmartWay brand signifies a service or item that minimizes transportation-related emissions. The SmartWay website enables users to locate alternative fuel station locations, recognize greener vehicles to select and buy certified SmartWay transportation firms. The CRT (Coalition for Responsible Transportation) covers exporters, motor carriers, water carriers and importers who are taking roles of leadership in their industries to develop green transportation initiatives. In 2007 its inception, members such as Gap, Wal-Mart, Home Depot, Target have been instrumental in developing sustainable solutions to minimize truck pollution and emissions at United States deepwater ports without disturbing the flow of commerce.

Europe's third-party logistics and ports have been prominently the way towards sustainability by introducing many green management initiatives. The logistics arm of Denmark's AP Moller-Maersk Group has launched a system (graphical representation) called SC Carbon Dashboard that enables customers to track their SC carbon footprint. As per Erling Nielsen (head of Maersk SC), "It immediately enables you to identify carbon hotspots in your SC". Global freight management firm Geodis Wilson (based in The Netherlands) has tools that calculate and measure the environmental impact of its customers' transport solutions. For example, it might find that a consignment to the United States from Gothenburg, Sweden could decrease carbon emissions by 16% compared to one created in Rotterdam.

7.16 Global Logistics

For products and material movements, managers of logistics must be aware of many issues not impacting local logistics movements such as third-party logistics services and costs, regulatory requirements, port and warehousing issues, export or import limitations, and availability of transportation modes. In the United States, movement of freight to Asia or Europe involves either water transportation or air transportation and then most likely rail transportation and/or motor transportation to the final destination. Between most neighbouring countries, motor carrier consignments and rail carrier consignments tend to be the most common transportation modes. There are several differences in logistics infrastructure and problems found as goods are moved from one country to other country. In Europe, rail transportation tends to be much more reliable and prevalent than rail transportation in the United States, because European facilities and equipment and rail tracks are better maintained. This is partially because most modes of transportation in Europe are government maintained and owned. Water carriers may be the dominant transportation mode in countries with a great deal of developed and coastline inland waterways. In undeveloped and underdeveloped countries, ports may be poorly equipped; and the highway system may be more or less non-existent.

7.16.1 Global Logistics Intermediaries

These intermediaries offer global shipping, export/import services and consolidation for companies and offer expertise that may prove useful for most companies involved in global commerce. Many of these global logistics intermediaries are briefly discussed here.

7.16.2 Customs Brokers

Brokers of customs move global consignments through customs for firms as well as handle the essential documentation required to accompany the consignments. These specialists are usually used by firms requiring expertise in exporting goods; their knowledge of the many requirements of imports of various countries can reduce the document processing time.

7.16.3 International Freight Forwarders

The freight forwarders move products for firms from local/domestic manufacturing facilities to foreign destinations using surface and air warehousing and transportation. They consolidate small consignments into larger carloads, container consignments or truckload consignments, decide what modes of transportation to use, handle all requirements of documentation and then disperse the consignments at their final destination. They also determine the best overseas storage, requirements of repackaging and break-bulk and best route to use. Use of international freight forwarders may reduce costs of logistics, increase customer service and enable shippers to focus resources on core competencies or other activities. Many firms importing products or exporting products use the services of international forwarders because of their presence and expertise in international markets.

In recent times, many shippers were shipping and importing low-cost, high-quality products from “far-shore” operations (United States buyers purchasing products from Chinese producers). Today, some purchasers are utilizing a strategy called right-shoring. Right-shoring strategy combines far-shore, domestic opportunities and near-shore into a single, cost-driven and flexible approach to logistics and purchasing. As labour costs increase and prices of crude oil fluctuate and the value of the United States dollar decreases, global shippers find they must be much more flexible concerning where goods are purchased. This has built an even better and greater need for worldwide involved freight forwarders.

7.16.4 Trading Firms

Trading firms put sellers and buyers from different regions, countries together and handle all the import or export arrangements, transportation and documents for both services and products. Most trading firms are covered in exporting and they usually take title to the products until sold to international purchasers. They enjoy low price on economies of scale when exporting products as they dispatch larger quantities of consolidated consignments using established services of warehousing and transportation. In the United States, the 1982 act of export trading firms promotes United States exports and helps United States exporters enhance their competitiveness. Within the United States DOC (Department of Commerce), the ETCA (Export Trading Company Affairs) office helps promote the development of joint ventures between foreign firms and United States firms and the use of intermediaries (export trade).

7.16.5 NVCO: Non-vessel Operating Common Carriers

NVCO operates similarly to foreign freight forwarders, but normally uses only scheduled ocean liners. They consolidate small consignments from many shippers into FCL (full container loads) and then handle all of the transportation and documentation arrangements from the shipper's dock area. Non-vessel operating common carriers assume responsibility for cargo from origin to destination. On the other hand, they do not own any vessels. They enter into agreements/contracts with ocean liners, which can then subcontract with motor or rail carriers for land travel.

7.17 Foreign-Trade Zones

FTZs (Foreign-trade zones) are secure sites with the United States under the supervision of the United States Customer Service. These sites are well authorized by the FTZs board, chaired by the United States Secretary of Commerce, and are comparable to the so-called "free-trade zones" that are available in many countries today. FTZs are considered to be outside United States Customer territory, where domestic or foreign merchandise may enter without formal customs payment or entry of excise taxes or duties. Firms working in FTZs bring material, components and products into the site and might use assembly, repair, storage, packaging, testing and export services. No retail activities are enabled, however. If the finished goods are exported out of the United States, no local excise taxes or duties are levied. If the finished goods are imported into the United States from the FTZ, taxes and duties are paid only at the time the products leave the FTZ.

7.18 North American Free Trade Agreement

NAFTA (North American Free Trade Agreement) was primarily agreed upon in 1992, with the United States Congress passing it in 1993, and put into effect since 1994. It will finally eliminate many hurdles and barriers to investment and trade among Canada, Mexico and the United States. Many quotas and tariffs were removed immediately and many others were to be removed by 2008. NAFTA forms the world's second largest open market with a combined economy of more than 14 trillion dollars and a population exceeding 435 million people—somewhat smaller in size than the EU. The aims of NAFTA are to facilitate international trade among the three countries, increase opportunities of investment and promote fair trade.

NAFTA has not been without its detractors. Labour groups of the United States have argued that jobs are being lost as firms move to neighbour country (Mexico) to take benefit of low-cost labour, undermining labour union negotiating power. As mentioned before, free access to United States highways by Mexican truckers is not presently allowed by the United States. Environmental groups have been concerned that food safety, emission and pollution laws have become harder to enforce. Others argue that due to subsidies on agricultural items exported to Mexico, the small farmer (Mexican) is being run out of revenue. Some communities in the United States saw the "North American Free Trade Agreement" as a way to develop the economy of Mexico and control illegal immigration into the United States. On the other hand, migration into the United States, both illegal and legal, has risen since NAFTA started, majorly because of the Mexican peso crisis, enduring poverty in Southern Mexico and the influence of Chinese competition on Mexican industries. On account of these and other reasons, supplementary agreements continue to be added to NAFTA.

7.19 Reverse Logistics

Reverse logistics refers to the backward flow of products, components from consumer or final customer in the SC occurring when products are returned, either by the business customer or by an end-product consumer within the SC. In simple words, reverse logistics refers to the storage and movement of returned products. Today's returned products are increasing in part to the growth of online shopping, direct-to-home and direct-to-store consignments. Currently, the use of untested and low-price international suppliers has also caused relatively many goods recalls in the United States. During 2007, the world's largest toymaker (California-based Mattel) recalled around one million Chinese-made toys because they were covered with paint containing lead. The next couple of weeks later, Mattel again was forced to announce a big recall for toys containing small magnets that posed a choking hazard. In fact, eight of Mattel's nine toy recalls during 2004–2007 were for Chinese-made goods.

Customer (retailer) returns account for around 6% of sales and can sometimes be higher than 40%. The logistical cost to process these returned products can also be

high-now running around one hundred billion dollars every year in the United States for handling of goods, repackaging, transportation, lost sales and disposal costs, refurbishment and remarketing. Besides the significant impact on costs, return goods also can have a direct inverse impact on customer service, reputation and profitability of firms, and also environment if not managed properly.

7.19.1 The Impact of Reverse Logistics

Returns can show big challenges to a SC. In many situations, reverse logistics is viewed as an unwanted activity of SCM. In these situations, reverse logistics is seen as a cost of regulatory compliance or doing business issues. Problems and issues cover the inability of information systems to monitor and handle reverse flow of product, lack of personnel training in reverse logistics procedures, inadequate or no identification on returned products/packages, the need for adequate testing and inspection of returns, and the placing of damaged returned goods, items into stocks of sales. A poor system of reverse logistics can affect the whole supply chain financially and can have a significant impact on how a final consumer views an item brand, potentially impacting future expected sales. According to recent research by GBCC (Global Business Consulting Company), Accenture found that reverse logistics costs are four to five times higher than forward logistics and on average requires 12 times as many processing stages. Their results, though, also suggest that reverse logistics illustrates a greater source of untapped value.

From a viewpoint of marketing, a good returns process may enhance customers' perceptions of purchase risk, product quality and also create goodwill. From a quality perspective, item failure and returns information may be used by quality staff in root cause analysis and by design staff to minimize future errors in products design (usually the reason for product return is a damaged or defective item). From a viewpoint of logistics, returned goods can still build value as original goods, repair components or refurbished goods. This also tends to minimize costs of disposal. Thus, while 46% of firms report losing money on goods returns, about 8% actually report making money. Wal-Mart recently stated in a meeting with government officials and 1000 suppliers in Beijing that they intend to do away entirely with defective item returns by 2012 using on-site audits, enforcement of social and environmental standards and the threat/risk of lost expected future business.

7.19.2 The Environment and Reverse Logistics

Reverse logistics can significantly and positively impact on the environment through activities such as reusing products and materials, recycling, refurbishing or remanufacturing used items. Environmental reverse logistics programs cover minimizing the environmental impact of certain transportation modes used for returned

products, minimizing the amount of disposed product material and packaging by redesigning processes and products, and using reusable pallets and totes. According to Paul Vassallo (marketing director of United Parcel Service—UPS), "Sustainability is playing a key role in reverse logistics". More and more firms are looking to minimize their impact on the environment and search for carbon-neutral methods and approaches to dispose of goods.

Traditionally, firms have used landfills for routine material and product disposal, but now, landfills have become more and more expensive to use. Federal and local governments are also imposing strict laws and higher costs regarding the use of landfills. These changes have led to new methods of dealing with used components, products or waste of products.

In the United States, Texas-based Advanced Micro Devices, Inc. works with their suppliers to find new methods to reduce handling activities and packaging waste. For example, the firm had traditionally used 55 gallon drums to store some of their bulk chemicals, but changed to 300 gallon totes and finally to bulk tankers to decrease packaging waste that would finally be disposed or delivered to a landfill.

Discussion Questions

1. Why are logistics issues significantly important for success of business?
2. What are the important factors or activities in logistics?
3. List the legal forms of transportation modes. Which mode is the lowest-cost? Which mode carries the most freight?
4. What are some alternatives within intermodal transportation?
5. What is the difference between value-of-service pricing and cost-of-service pricing?
6. Is US government regulation of transportation bad or good? Why?
7. What is a lead warehouse?
8. Discuss the types and importance of warehouse.
9. Is transportation in the United States regulated or deregulated today? Why?
10. What is the fundamental difference between a warehouse and a distribution centre?
11. What are International trade zones? What advantages do they provide?
12. How does reverse logistics impact supply chain management?
13. How can reverse logistics have a significant positive impact on the environment? On customer service? On repeat buying? On profits?
14. Describe several global logistics intermediaries and their roles.
15. Discuss the role of NAFTA in global and local logistics.

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